2024

A Study on Reducing Motor Stereotypy With Response Interruption and Redirection Using Functionally Matched and Unmatched Stimuli

Alana Fallucca
Nova Southeastern University

A Study on Reducing Motor Stereotypy With Response Interruption and Redirection Using Functionally Matched and Unmatched Stimuli

by
Alana Fallucca

An Applied Dissertation Submitted to the
Abraham S. Fischler College of Education
and School of Criminal Justice in Partial
Fulfillment of the Requirements for the
Degree of Doctor of Education

Nova Southeastern University
2024

Approval Page

This applied dissertation was submitted by Alana Fallucca under the direction of the persons listed below. It was submitted to the Abraham S. Fischler College of Education and School of Criminal Justice and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

Khrystyna Bednarchyk, EdD, BCBA
Committee Chair

Judith Galician, EdD
Committee Member

Kimberly Durham, PsyD
Dean

Statement of Original Work

I declare the following:

I have read the Code of Student Conduct and Academic Responsibility as described in the *Student Handbook* of Nova Southeastern University. This applied dissertation represents my original work, except where I have acknowledged the ideas, words, or material of other authors.

Where another author's ideas have been presented in this applied dissertation, I have acknowledged the author's ideas by citing them in the required style.

Where another author's words have been presented in this applied dissertation, I have acknowledged the author's words by using appropriate quotation devices and citations in the required style.

I have obtained permission from the author or publisher—in accordance with the required guidelines—to include any copyrighted material (e.g., tables, figures, survey instruments, large portions of text) in this applied dissertation manuscript.

Alana Fallucca
Name

04/07/2024
Date

Abstract

A Study on Reducing Motor Stereotypy With Response Interruption and Redirection Using Functionally Matched and Unmatched Stimuli. Alana Fallucca, 2024: Applied Dissertation, Nova Southeastern University, Abraham S. Fischler College of Education and School of Criminal Justice. Keywords: stereotypy, response interruption, matched stimuli, autism

This applied dissertation was designed to expand the scope of existing literature on the use of response interruption and redirection intervention with functionally matched and unmatched stimuli to reduce motor stereotypy in children with autism. While response interruption and redirection is an effective, evidence-based strategy for the reduction of vocal and motor stereotypy, it requires interruption of each instance of stereotypic behavior and implementation of an alternative behavior. This process can be laborious, implementation of which depends upon the frequency of stereotypy. To mitigate the intervention difficulties with response interruption and redirection implementation, a single-step functionally matched stimulus that is readily available in the individual repertoire could be implemented.

The researcher recruited two children with autism who engaged in hand-flapping motor stereotypy. Relying on an alternating treatment design, the researcher evaluated the effectiveness of response interruption and redirection with functionally matched and unmatched stimuli on potential reduction of motor stereotypy of participants over a series of eight 5-min intervals that accounted for baseline and two intervention phases. The function and topography of the participant's motor stereotypy were determined using a functional behavior assessment, and the sensory modality of the stereotypy was assessed using a sensory modality assessment. The function of motor stereotypy was found to be automatic for both participants and the sensory modality of the motor stereotypy for both participants was found to be tactile and visual stimulation.

Data analysis revealed the effectiveness of response interruption and redirection intervention on the reduction of motor stereotypy for both participants. A significant reduction in motor stereotypy was witnessed with the use of response interruption and redirection with matched stimulus for one of the participants. There was no significant difference in the reduction of motor stereotypy with the use of response interruption and redirection with unmatched stimulus versus matched stimulus for another participant. The outcome of the study yielded inconclusive results as to response interruption and redirection with matched stimulus versus unmatched stimulus and warrant further research.

Table of Contents

Tables

Figures

Chapter 1: Introduction

Motor stereotypy may have a negative impact on lives of individuals with autism by interfering with access to learning opportunities and engagement in activities of daily living (Gordon, 2006; Ledford et al., 2022). Persistent motor stereotypy can also lead to increased social stigmatization. Response interruption and redirection intervention has been successfully used as an evidence-based, minimally invasive approach to redirecting and replacing motor stereotypy with socially appropriate activities, thereby leading to reduced engagement in motor stereotypy and improved overall functionality for the individuals (Ledford et al., 2022; Martinez & Betz, 2013; Ryan et al., 2022). Response interruption and redirection requires interruption of each instance of stereotypic behavior followed by redirection. It also offers an alternative behavior replacement opportunity with the use of functionally matched and unmatched stimuli that are readily available in the individual repertoire (Davis et al., 2013; Favell et al., 1982; Rapp, 2006; Piazza et al., 2000).

Statement of the Problem

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that affects approximately 1% of the global population (American Psychiatric Association [APA], 2013, p. 50). The Centers for Disease Control and Prevention ([CDC], 2023) estimated that one in 36 children are diagnosed with ASD in the U.S. The diagnostic criteria for autism include persistent deficits in communication, social interactions, and restricted repetitive patterns of behavior and interests (APA, 2013). The symptomology of autism varies across individuals and the severity of its symptoms are determined by how significantly they interfere with the individual’s functioning. Restricted repetitive patterns of behavior can include stereotyped or repetitive motor movements which can present as rocking, flapping, spinning, or repetitive vocal sounds (Heather et al., 2019; Rapp, 2006). High levels of stereotypy can interfere with an individual's access to learning opportunities and can lead to social ostracization (Gordon, 2006; Ledford et al., 2022). Response interruption and redirection is an effective, evidence-based strategy for the reduction of vocal and motor stereotypy (Ledford et al., 2022; Martinez & Betz, 2013; Ryan et al., 2022). Ledford et al. (2022) described response interruption and redirection as an evidence-based protocol for reducing stereotypic behaviors by physically or vocally blocking or interrupting the behavior and placing an imitative or other demand on the individual. Effective response interruption and redirection requires individualized involvement to interruption of each instance of stereotypic behavior that is followed by a chain of appropriate alternative behaviors (Ledford et al., 2022; Martinez & Betz, 2013; Ryan et al., 2022). This process can be laborious, implementation of which depends upon the frequency of stereotypy. Saini et al. (2015) and Detrich (1990) found response interruption and redirection to be effective but also noted that the implementation of procedures poses difficulties for nonprofessionals. Moreover, Lanovaz et al. (2013) recommended considering a replacement behavior because when stereotypy decreases in intervention conditions, socially desirable and undesirable behaviors appear in the individual repertoire during post-intervention. To mitigate various difficulties with response interruption and redirection implementation, a single-step functionally matched stimulus that is readily available in the individual repertoire could be used (Saini et al., 2015). Response interruption and redirection can be used more effectively when it is simplified to a simple one-step direction.

It is important to note that stereotypy is often automatically maintained (Beavers et al., 2013; Davis et al., 2013; Piazza et al., 2000). Because automatically maintained behaviors produce a specific sensory stimulation that serves as reinforcement, they are difficult to treat (Piazza et al., 2000). One way to approach this problem is to find an alternative form of stimulation that matches the properties of the target stereotypy. Noncontingent matched stimulation has been used to reduce levels of automatically reinforced behaviors (Davis et al., 2013; Favell et al., 1982; Rapp, 2006; Piazza et al., 2000). For example, Favell et al. (1982) demonstrated the use of toys in ways that appeared to provide similar sensory feedback as the self-injurious behavior. Piazza et al. (2000) also showed that stimuli matched to the sensory stimulation resulted in a further reduction of the automatically maintained behavior.

Although the above studies have begun to demonstrate the potential effectiveness of stimuli match in the intervention procedures for automatically maintained behaviors such as stereotypy (Davis et al., 2013; Favell et al., 1982; Rapp, 2006; Piazza et al., 2000), further research is warranted. A single-subject research study that mitigates the implementation constraints, includes response interruption and redirection for reducing motor stereotypy by replacing the target motor stereotypy with a single-step functionally matched or unmatched stimuli that are readily available in the individual repertoire, topographically similar, and prosocial in nature may improve the situation.

The Research Problem

Young children with ASD who engage in high-frequency self-stimulatory behavior lack an effective intervention that may promote prosocial behaviors, create learning opportunities, and improve quality of life (Ledford et al., 2022;

Shahabuddin, 2017; Schmidt et al., 2021; Tereshko et al., 2021). Tereshko et al. noted that motor stereotypy significantly affects an individual's ability to acquire adaptive skills and develop relationships. In the meta-analysis study that was conducted by Melo et al. (2019) and accounted for a rigorous review of 37 research studies, the authors' findings revealed that an average of 52% of individuals with autism exhibit motor stereotypy that is likely to interfere with learning opportunities and social adaptation across environments and individuals.

Methods to reduce the frequency of self-stimulatory behaviors by replacing stereotypy with functionally similar activities has been addressed by Rapp (2006) almost two decades ago. Rapp conducted a research study that looked at the effects of noncontingent matched stimulation and response blocking on stereotypic behavior of a young boy. Results of Rapp's investigation demonstrated that stereotypy was low after noncontingent matched stimulation and high after response blocking. These results suggest that noncontingent matched stimulation might have provided an effect that was similar to the product of stereotypy. Relying on the Rapp's research logic and findings, motor stereotypy, such as hand-flapping, could benefit from an intervention that accounts for noncontingent matched stimuli that are also socially appropriate and immediately available in the individual repertoire. Replacing flapping behavior with clapping may reduce the appearance of the socially maladaptive behavior and replace it with a socially acceptable alternative (Rapp, 2006; Davis et al., 2013; Piazza et al., 2000).

Background and Justification

Existing research has been conducted on methods to reduce the frequency of self-stimulatory behaviors by interrupting stereotyped behaviors and replacing them with functionally similar activities (Rapp, 2006; Davis et al., 2013; Piazza et al., 2000). For example, Rapp's study results demonstrated that providing an individual with a functionally similar activity significantly reduced the occurrence of motor stereotypy following intervention. However, Rapp's research did not include research on specifically reducing hand-flapping by replacing it with a socially appropriate, consistently available replacement, such as clapping. Replacing flapping behavior with clapping could reduce the appearance of the socially maladaptive behavior and replace it with a socially acceptable alternative (Ledford et al., 2022). There are no common barriers to the accessibility of clapping, and it can be a socially functional behavior under certain contexts.

Heathers et al. (2019) found that a common presentation of restricted and repetitive motor movements occur as stereotyped motor movements. Gordon (2006) noted that stereotyped motor movements can present as a variety of socially inappropriate motor movements and if allowed to persist without intervention can become difficult to interrupt. Over time the stereotypic behavior can increase and lead to escalated frustration and aggressive behavior following attempts to interrupt the behavior. The reduction of stereotypic motor movements can increase the individuals access to learning opportunities, whereas its persistence can lead to escalated behaviors and a reduction of learning and social opportunities.

Ryan et al. (2022) showed that response interruption and redirection was an effective method to reduce motor and vocal stereotypy. The authors analyzed data that were collected from the research studies that exclusively used response interruption and redirection in combination with other procedures. The researchers noted that response interruption and redirection as well as other methods produced outcomes that were similar in their effectiveness in reducing stereotypy. Ledford et al.’s (2022) findings also support Ryan and colleagues’ observations in terms of short-term effects. However, Ledford and colleagues also noted that the reduced stereotypy did not maintain post-treatment or generalized across settings. In addition, Ledford et al. expanded the definition of stereotypy by including any automatically reinforced repetitive behaviors.

Pastrana et al. (2013) observed that motor stereotypy, such as hand-flapping, could be effectively reduced using a three-step response interruption and redirection. Pastrana and colleagues examined the immediate and subsequent effects of response interruption and redirection on targeted motor stereotypy and untargeted vocal stereotypy of two participants with autism. The authors used a three-component multiple-schedule research design to demonstrate an immediate reduction in motor stereotypy following the response interruption and redirection. This study also evaluated the effects of vocal stereotypy and whether intervening on one topography of stereotypy might affect the frequency of another topography. Results of the study revealed that vocal stereotypy was slightly less reduced during the interventions than the target motor stereotypy.

In a study utilizing noncontingent matched stimulation and noncontingent unmatched stimulation, Davis et al. (2013) found that noncontingent matched stimulation had a depressing effect on self-injurious behavior. The subject presented with ear-digging which was determined to serve an automatic function following a functional analysis of the behavior. The researchers conducted two interventions, the first of which used noncontingent unmatched stimulation with access to a preferred item, a DVD player. The second intervention utilized noncontingent matched stimulation with acrylic balls. Post-intervention data showed the noncontingent matched stimulation was effective at reducing instances of self-injurious behavior that has an automatic function. The noncontingent nonmatched stimulation did not reduce the self-injurious behavior. Davis et al. (2013) found that matched stimuli that serves the same function is more effective at reducing automatically reinforced behavior in contrast with stimuli that is nonmatched but also serves an automatic function.

In an alternating treatment design by Piazza et al. (2000), researchers aimed to determine whether functionally matched and unmatched stimuli reduce self-stimulatory behavior. The researchers used functional analyses to determine the function of climbing, jumping, saliva manipulation, and mouthing across three participants. All target behaviors were found to have an automatic function and alternative measures were developed for functionally matched and unmatched stimuli. Preference assessments were conducted across participants with the matched and unmatched stimuli to rate their level of engagement. During two 5-min interventions, the participants were given access to the matched and unmatched stimuli on a noncontingent reinforcement schedule. Results showed that all participants showed a greater reduction in self-stimulatory target behaviors when they engaged with functionally matched stimuli. This study effetely utilized functional analysis to assure that the self-stimulatory behaviors serve automatic function and also tested the impact of matched and unmatched stimuli on behavior reduction. The researchers controlled the modes of stimulation during each intervention by blocking mouthing when measuring tactile stimulation and vice versa. This helped isolate the mode of stimulation that was providing the most stimulation to the subject allowing for a more targeted intervention. This research contributes to the current study by further focusing on the different sensory modalities that can present with self-stimulatory behaviors.

Deficiencies in the Evidence

Although there is existing research on the numerous effective ways to reduce stereotypy with the use of response interruption and redirection (Ledford et al., 2022; Ryan et al., 2022; Pastrana et al., 2013), selecting and implementing this intervention for automatically maintained behaviors such as hand-flapping may be difficult because automatically maintained behaviors produce a specific sensory stimulation that serves as reinforcement (Piazza et al., 2000). An alternative form of stimulation that matches the properties of the target stereotypy have been used to reduce levels of automatically reinforced behaviors (Davis et al., 2013; Favell et al., 1982; Rapp, 2006; Piazza et al., 2000). The aforementioned studies demonstrated the use of noncontingent matched stimulation that appeared to provide similar sensory feedback for the target stereotypy behavior. Further research is warranted to further examine the implementation constraints of response interruption and redirection for reducing motor stereotypy by replacing the target motor stereotypy with a single-step functionally matched or unmatched stimuli that are readily available in the individual repertoire, topographically similar, and prosocial in nature.

Audience

Young children with ASD who engage in high frequency motor stereotypy such as hand-flapping are primary beneficiary because the results of this study will potentially introduce the alternative and prosocial treatment options for stereotypy in this population. Behavior analysts, educators, researchers, and therapists may also benefit from the results of this study. In addition, parents are informed of a new approach that can be used at home to help reduce their child's motor stereotypy.

Setting of the Study

The research study was conducted in the home environment of the participants who were young children with ASD that engage in high frequency of motor stereotypy of hand flapping.

Researcher's Role

The researcher is a board certified behavior analyst with 9 years of experience in the field of applied behavior analysis. In the role of a behavior analyst, the researcher identifies an individual's present level of functioning, designs the interventions and treatment plans to meet the individual needs of clients, conducts ongoing supervision of direct service providers, as well as collects and analyzes data to determine the best practices. The researcher possesses direct knowledge and skills in working with young children with ASD who engage in motor stereotypy and a variety of other self-stimulatory behaviors.

Purpose of the Study

The purpose of this single-subject research with the use of an alternating treatment design study is to replicate the findings of Rapp's (2006) study on the effectiveness of reducing motor stereotypy using noncontingent matched stimulation minus the response blocking and assess a relative effectiveness of response interruption and redirection with matched and unmatched stimuli. Because the assessment of the mediums were successful, the researcher hypothesized that the alternatives may be used as the matched stimulation. Relying on Piazza et al. (2000) and Davis et al.'s (2013) studies, the researcher conducted a preference assessment. The highly rated unmatched stimulus along with clapping as a functionally identified matched stimulus were used in the response interruption and redirection intervention.

Chapter 2: Literature Review

This chapter presents a synthesis of literature that has examined diagnostic characteristics and assessment strategies of autism as well as interventions relative to motor stereotypy. The researcher used the Education Resources Information Center database to search for the most recent and seminal research studies with an aim of uncovering the most effective motor stereotypy reduction strategies, noncontingent matched stimulation and response blocking.

Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is marked by distinct genetic underpinnings (Lin et al., 2021) and a widespread of brain alternations on a molecular level throughout the cerebral cortex (Garndal et al., 2022). According to the recent research by Garndal and colleagues, the brain changes are much more pervasive than previously identified and linked to social and emotional deficits. The latter has direct implication on behavioral challenges and difficulties acquiring new skills among individuals with ASD (CDC, 2022). The American Psychiatric Association ([APA], 2013) defined autism as a disorder that is marked by difficulties in communication, social skills, and restricted, repetitive behaviors and interests. Specific levels of severity of autism impact the individual functioning across different environments. As such, ASD is a spectrum disorder. While there is a spectrum, which is unique to everyone with the ASD diagnosis, the levels of autism may range from Level 3, requiring very substantial support, to Level 1, requiring some support. Deficits in communication range from mild impairments in communication to a complete lack of verbal or functional communication abilities. Impairments in the social skills domain can range from socially inappropriate behaviors to a lack of interest in interacting with others. Level 1 restricted and repetitive patterns of behaviors may include inflexibility in interests and difficulty switching focus, whereas Level 3 patterns may significantly affect daily activities and require very substantial support across various environments and developmental stages.

Autism rates have been increasing steadily with the CDC (2023) reporting that 1 in 36 eight-year-olds are now diagnosed with autism. This research shows a significant increase over the last decade with a 1 in 54 children in 2016 (Maenner et al., 2020). Risk factors that have been correlated with the presentation of autism vary with no one risk factor being a determinant to an autism diagnosis. The CDC (2022) reported the most prevalent autism risk factors among which are advanced parental age, a parent or sibling diagnosed with autism, medical complications during birth, and a genetic or chromosomal condition. The diagnostic features of autism can be recognized during early childhood with different presentations across individuals.

In order to diagnose autism, a medical professional or trained clinician uses direct and indirect assessment and diagnostic tools (Crepeau-Hopsin et al., 2022; McDonnell et al., 2019; Sheldrick et al., 2019). Symptoms of ASD are often apparent as early as the first 2 years of life and can be effectively evaluated (Gwynette et al., 2019; Sheldrick et al., 2019). Some of the common diagnostic screening tools include the Autism Diagnostic Observation Screening (ADOS), the Autism Spectrum Rating Scale (ASRS), the Childhood Autism Rating Scale (CARS), the Gilliam Autism Rating Scale (GARS), genetic testing, and Magnetic Resonance Imaging (Gwynette et al., 2019; McDonnell et al., 2019; Sheldrick et al., 2019). For example, the ADOS is a gold standard among various observation measures (Luyster et al., 2009). Its current edition, the ADOS-2, is a semi-structured, four-module assessment tool that is designed to evaluate communication, social interaction, play, imagination, stereotypy, and restricted interests (Gwynette et al., 2019). It incorporates an array of structured activities that are conducted in the interactive environment. The activities vary depending on the language level and chronological age of the participant. It takes 30 to 60 min to administer the ADOS-2. Akshoomoff et al. (2006) examined differences in ASD diagnostic practices and the use of ADOS among school and clinical psychologists. The authors recruited 44 clinical psychologists and 88 school psychologists for the study. Akshoomoff and colleagues addressed ADOS training, experience, placement, diagnostic process, and its targeted use in the survey. Majority of the participants found the ADOS to be a valid and reliable assessment tool. However, high cost of the ADOS kit and time it takes to administer were named among a few limitations of the instrument.

The CARS is another widely adopted ASD assessment instrument for clinical and research settings (Chlebowski et al., 2010; Schopler et al., 2010). It was originally designed for use with individuals with low cognitive abilities. Because of the instrument’s limited inclusion, identification of individuals with high functioning autism was difficult until the CARS-2 appeared as a modified version of the original CARS and was specifically designed for identification of individuals with low and high functioning abilities. The CARS is a comprehensive assessment tool that can be used with children over the age of 2. It is a clinician rating scale that is utilized after a direct observation. High summative CARS’ score correlates to high presentation of autism symptoms.

The ASRS was designed for individuals between 2 and 18 years-of-age and covers domains directly addressed in the Diagnostic and Statistical Manual of Mental Disorders, 5th ed ([DSM-5], Samedi et al., 2022). The GARS-3 also evaluates individuals across six DSM-5 domains and includes 56 items that are grouped into six subscales: restrictive/repetitive behaviors, social interaction, social communication, emotional responses, cognitive style, and maladaptive speech (Samedi et al., 2022). Its interpretation guide provides the GARS' administrator with an easy and efficient method for assessing the ASD probability and severity.

The U.S. Department of Health and Human Services (2021) noted that early intervention can start as early as 18 months of age and can mitigate some of the long-term effects of the disorder. Therapeutic interventions include behavior, speech, occupational, and physical therapies. The interventions target communication, adaptive, and social skills and maladaptive behaviors. A medical professional or trained clinician can refer individuals to these services after the assessments and any follow-up appointments. Intervention approaches are based on the individual needs and target specific deficits. For example, the individual deficient in adaptive skills are addressed by occupational therapy. Motor skill deficits are targeted by physical therapy. Motor and language stereotypy, social-emotional and communication deficits, maladaptive and self-injuries behaviors are addressed by the use of applied behavior analysis.

Theoretical Framework

Applied behavior analysis (ABA) is an evidence-based approach that is grounded in a natural science (Cooper et al., 2020). It is well designed to assess human behaviors in a systemic manner and in the context of environmental variables. Relying on the assessment results, various instructional strategies are devised to produce meaningful individual changes that can be generalized across conditions, environments, and individuals. It has become a widely used approach to target socially inappropriate behaviors in individuals with developmental disabilities (National Professional Development Center ([NPDC], 2014). The Individuals with Disabilities Education Act (2004) and NPDC promote the use of evidence-based practices for education and intervention of individuals with developmental disabilities to include ASD. Relying on the science and principles of ABA, the evidence-based strategies and approaches that are often used to address various ASD symptoms are highly effective and widely used (NPDC, 2014). Cooper et al. (2020) noted that ABA offers a structured approach to determine the factors that contribute to a behavior manifestation and applies structured methods to align the target behaviors with socially accepted norms. Fisher et al. (2021) noted that the field of ABA is multifaceted. The first facet accounts for the philosophical foundations of behaviorism; the second facet encompasses the experimental analysis of behavior; and the third facet relies on the methodologies that are ethically appropriate and socially significant. Cooper et al. (2020) noted that the ethical application of ABA requires six guidelines to follow in practice. These areas are scientific inquiry, systematic methods of implementation, basic principles of behavior, socially significant behaviors, behavior improvement, and fundamentals of behavior change. Moreover, Baer et al. (1987) introduced the seven important dimensions of ABA: applied, behavioral, analytic, technological, conceptually systematic, effective, and generality. These dimensions are fundamental to the application of ABA and explain behavior change in a systematic manner with reliance on evidence-based programming.

Historical Foundation of Applied Behavior Analysis

Building on the foundation of behaviorism and the experimental analysis of behavior, ABA emerged as its own branch of science (Cooper et al., 2020). Early researchers that contributed to the evolution of ABA were Ivan Pavlov and John B. Watson who began sharing their findings in the early 1900s. Ivan Pavlov's research with animals led to the discovery of respondent or classical conditioning (Windholz,1995). Moreover, Windholz noted that Ivan Pavlov attributed environmental contingencies to the adaptive responses that cause unconditioned reflexes. Watson's research, on the other hand, focused on an antecedent preceding the behavior of interest (Cooper et al., 2020). He explained the relationship between stimulus and response (S-R) and contributed to the development of methodological behaviorism. In 1938, B. F. Skinner's publication, *The Behavior of Organisms,* expanded upon Ivan Pavlov's findings and explained the concept of antecedent-consequence-based behavior modification or operant conditioning. It is a form of learning that takes place when a naturally elicited stimulus a is paired with a neutral stimulus.

In 1949, Paul Fuller published a breakthrough research study that relied on the principles of ABA (Cooper et al., 2020). Fuller recruited an 18-year-old participant who had significant developmental disabilities and shown no ability to learn prior to the study. Following three rounds of the intervention, the participant mastered simple motor instructions using a sugar-milk solution as a reinforcer. In the following decades, the principles of behavior modification were utilized across multiple settings, expanding the behavior analytic scholarship.

Through environmental modifications and consequence-based behavior strategies, learners with developmental disabilities, such as autism, can learn functional behaviors (Cooper et al., 2020). Motor stereotypy will be targeted using a combination of response interruption and redirection, differential reinforcement of alternative behavior, and replacement with functionally matched stimuli.

Applications of Applied Behavior Analysis

A variety of behavior analytic interventions are used to target motor stereotypy for reduction including response interruption and redirection (RIRD), differential reinforcement, response blocking, functionally matched stimuli (FMS), noncontingent reinforcement (NCR), stimulus control, and various combinations of these interventions (Cividini-Motta et al., 2019; Davis et al., 2013; DeRosa et al., 2019; Dickman et al., 2012; Gould et al., 2018; Ledford et al., 2022; Piazza et al., 2000; Ryan et al., 2022; Schmidt et al., 2021). When these methods are compared to one another, the research results illustrate different levels of efficacy across interventions, and intervention combinations (Briggson, 2019; Cividini-Motta et al., 2019; DeRosa et al., 2019; Rapp, 2006; Schmidt et al., 2019; Tereshko et al., 2021).

RIRD is an evidence-based procedure that aims to reduce the future occurrence of the target problem behavior and increase the future occurrence of the alternative behavior (Cooper et al., 2020). It uses a combination of positive punishment and differential reinforcement of alternative behavior procedures. The former is accomplished by introducing a physical or verbal blocking of an individual's attempt to engage in the undesirable behavior to include motor stereotypy. The latter focuses on promoting the use of incompatible or alternative behavior. Response interruption is contingent upon the engagement in a target behavior. It can be implemented with a physical or verbal blocking such as putting a hand to interrupt the hand flapping movements. Following response interruption, redirection component prompts the individual to engage in an alternative activity such as redirecting to put hands on lap or handing the preferred toy. Pastrana et al. (2013) noted that RIRD prevents engagement in an inappropriate behavior and redirects to an appropriate alternative or incompletable behavior that are part of the same response class and will result in the same consequence as the problem behavior. This way the alternative behavior will successfully compete because it will make the problem behavior ineffective.

Differential reinforcement is a procedure which involves two components: reinforcement and withholding reinforcement (Cooper et al., 2020). Delivery of reinforcement is contingent on the occurrence of an appropriate behavior or a behavior other than the problem behavior. It can be accomplished in a form of attention, access to a desirable item, or a break from demands. The withholding of reinforcement component involves preventing any type of reinforcement for the problem behavior as much as possible. Butler et al. (2020) noted that motor and vocal stereotypy significantly decreased following an intervention with differential reinforcement of other behavior (DRO). DRO is a procedure during which reinforcement is contingent upon the absence of the problem behavior such as stereotypy. Reinforcement is delivered when the problem behavior does not occur for a certain period of time. Buter and colleagues further validated the existing research that supports the efficacy of differential reinforcement protocols in the reduction of vocal and motor stereotypy (Lanovaz & Argumedes, 2010; Rozenblat et al., 2009; Tereshko et al., 2020). Differential reinforcement has also been utilized in combination with RIRD (Cividini-Motta et al., 2019). According to Cividini-Motta and colleagues, the use of differential reinforcement alone may lead to insignificant reductions in stereotypy. In contrast, when differential reinforcement is used in combination with response interruption and redirection, a significant reduction in the target behavior may be attained.

Response blocking is an example of positive punishment procedure that entails physically preventing an individual from engaging in a behavior (Cooper et al., 2020). DeRosa et al. (2019) examined the response blocking efficacy in reduction of motor stereotypy and found that it was more effective than RIRD alone. DeRosa and colleagues' results showed that both methods led to a significant reduction in motor stereotypy. In a study that further expanded on response blocking, Schmidt et al. (2021) demonstrated the efficacy of response blocking in extinguishing the occurrence of stereotypy. Response blocking as a singular intervention has evidence supporting its efficacy, but it is a punishment procedure that fails to offer reinforcement or introduce the opportunity to engage in an appropriate behavior instead. Combining differential reinforcement with response blocking resolves this procedural problem.

Interventions that use FMS are firmly grounded in the science of behaviorism and belief that all forms of life evolve as a result of selection relative to function, and selection by consequences operates during the lifetime of the individuals (Cooper et al., 2020). As such, all behaviors serve function that lead to the best outcome for survival. There are four functions of a problem behavior: automatic, escape, attention, and tangible. By aligning the intervention with the hypothesized function of the target behavior will likely lead to effective results. Vocal and motor stereotypy more often than not serve an automatic function which is sensory in nature and is not socially maintained. Because of the unique and individual nature of sensory stimulated problem behaviors, it is difficult to find an FMS that may serve the same function as the sensory stimulus. However, a successful use of FMS to replace the problem behavior has been proven effective across various environments (Piazza et al., 2000). Piazza and colleagues noted that stimuli that matched the hypothesized function of the behavior showed a greater reduction in motor stereotypy than nonfunctionally matched stimuli. In a study that expanded on the findings of Piazza et al., Rapp et al. (2006) evaluated the efficacy of noncontingent matched stimulation in contrast to response blocking. According to Rapp et al.'s findings, the noncontingent access to matched stimuli led to lower levels of stereotypy as measured during post-intervention. The study outcomes also showed that response blocking showed a post-intervention increase in the rate of stereotypy leading to a deprivation state as a result of response blocking, which increased motivating operations for stereotypy.

Nature and Assessment of Motor Stereotypy

Restricted and repetitive behaviors, which part of the core diagnostic characteristics of ASD, include stereotyped behaviors associated with movements, postures, or utterances (APA, 2013; Lanzarini et al., 2021). Stereotypy produces sensory input which could be vestibular, auditory, tactile, or vestibular in nature (Boyd et al., 2012; Lanzarini et al., 2021). This self-produced sensory input can be self-regulating. Moreover, motor stereotypies are classified into primary (physiological) and secondary that are associated with other neurological conditions (Goldman et al., 2009; Muthugovindan & Singer, 2009). They are further subdivided into suppressible, repetitive, rhythmical, coordinated, purposeless, fixed, and nonfunctional pattern of high-frequency movements that may occur together or several times per day. The physiological nature of motor stereotypy and their pathophysiology in autism are not fully known and require further research (Ghanizadeh, 2010).

DeRosa et al. (2019) stated that motor stereotypy is a common feature of autism which includes repetitive behaviors that can interfere with daily functioning and potentially lead to social stigmatization. According to LeMonda et al. (2012), motor stereotypies are “patterned, repetitive, and purposeless movements” (p. 1099). The presentation of motor stereotypy varies across individuals, as does the frequency and intensity of these behaviors. Common topographical presentations of motor stereotypy include repetitive hand-flapping, rocking, spinning, finger-posturing, tapping, surface rubbing, etc. Motor stereotypy is hypothesized to serve an automatic function, for the individual, and may occur across a variety of settings. Researchers established a positive correlation between the higher occurrence of motor stereotypy and low executive functioning and cognitive impairments among individuals with ASD (LeMonda et al., 2012, Lanzarini et al., 2021).

Motor stereotypy can be assessed with a Repetitive Behavior Scale-Revised (RBS-R) that was developed by Bodfish et al. in 2000. It is a 43-item informant-based rating scale which is used to assess restricted and repetitive behaviors. RBS-R includes six subscales that account for rituals, self-injurious behavior, stereotypy, compulsive behavior, restricted interests, and sameness. Its primary focus is evaluation of the presence and severity of a variety of restrictive and repetitive behaviors as they are exhibited by individuals with neurodevelopmental disorders. RBS-R has been validated with children with ASD and has strong psychometric properties (Hooker et al., 2019). Recently, Luo et al. (2022) further confirmed RBS-R's reliability and validity by testing the instrument among 381 Chinese children with ASD who were 2–4 years of age at the time of the study. Relying on the confirmatory factor analysis, the authors showed the RBS-R's good internal consistency and fit across the indices.

Repetitive and Restricted Behaviour Scale (RRB) is another assessment scale designed for evaluation of stereotypy among individuals with ASD (Bourreau et al., 2009). It comprises of 35 items that are designed to assess a range of stereotypies. The items evaluate the degree of expression of each behavior on a five-level rating scale. The items account for assessment of repetitive body rocking, bizarre gait, and play and leisure rituals to name a few. According to Bourreau and colleagues, RRB has been validated among 145 participants with ASD. The results of the instrument's assessment produced good interrater reliability, internal consistency, and content validity.

Recent Direction in Motor Stereotypy Interventions

A review of the literature provided a vast swath of research related to autism, stereotypy, and interventions that may reduce its frequency. Successful interventions included RIRD (Dickman et al., 2012; Ledford et al., 2022; Ryan et al., 2022), stimulus control (Gould et al., 2018), response blocking (Schmidt et al., 2021), noncontingent matched stimulation (Davis et al., 2013; Piazza et al., 2000), and differential reinforcement (Cividini-Motta et al., 2019).

Ryan et al. (2022) conducted a systemic review of literature on response interruption and redirection. The researchers reviewed 42 studies that included a total of 113 participants with developmental disabilities. In 97% of the reviewed studies, a treatment package that included response interruption and redirection was responsible for reduction of the target stereotypy. When response interruption and redirection was used as an exclusive intervention, vocal stereotypy reductions were noted in 97% of participants and motor stereotypy reductions were noted in 96% of participants. Similarly, to the Ryan and colleagues' systemic review, Ledford et al.'s (2022) systemic review of the studies on the same topic revealed that response interruption and redirection was an effective intervention for reducing automatically maintained stereotypy. To be specific, the researchers reviewed 18 peer-reviewed studies that included 143 participants with autism. The researchers looked at the intervention results' variability between vocal and motor stereotypy and whether the results maintained post-intervention. The authors' data analysis revealed that vocal and motor stereotypy was reduced consistently using response interruption and redirection, but reduction in the target behaviors failed to generalize or maintain following the removal of the intervention. The researchers used the Single Case Analysis and Review Framework (SCARF) to analyze the data in their systemic review. Ledford et al. (2022) noted that the Single Case Analysis and Review Framework measures internal and external validity and provides visual representation of the data analyzed. Ledford et al. (2022) found that 63% of the studies showed results consistent with a functional correlation between the interventions and their results, and more than 25% showing a lack of correlation.

Pastrana et al. (2013) conducted single-subject research designs with two boys with ASD, 6 and 9 years of age. Both participants received applied behavior analytic services to reduce motor and vocal stereotypy. Motor stereotypy presented as hand-flapping in the 9-year-old participant, and the younger participant displayed a surface rubbing behavior as a form of motor stereotypy. The results of the study revealed that response interruption and redirection was an effective method of reducing the frequency of motor stereotypy, including hand-flapping. Pastrana et al. (2013) found that using percentage of time engaged in motor stereotypy, the first component of the intervention engagement for the older participant was 77.3% for no-interaction, and 71.7% with response interruption and redirection. The second component shows a decrease in motor stereotypy to 72.6% for no-interaction, and 32.9% for response interruption and redirection. The third component shows motor stereotypy engagement during no interaction as 69.2% and response interruption and redirection at 66%. The younger participant

DeRosa et al. (2019) found that response blocking produced a more significant reduction in motor stereotypy than response interruption and redirection. The authors conducted a research study with three individuals with ASD who displayed stereotypic behavior. Baseline data was collected for each participant by implementing a 5-min ignore condition wherein each participant was observed without engagement. During a response blocking intervention, a therapist would hover their hand over the participant contingent on the onset of stereotypic behavior with the goal of blocking their motor stereotypy. During the response interruption and redirection intervention, the therapist would give the participant a motor command contingent on engagement in motor stereotypy. The interventions were conducted with an alternating treatment design to measure the post-intervention effects. The results of this study show that both response interruption and redirection and response blocking were effective in reducing stereotypy during intervention and following the interventions. Response blocking emerged as the more effective of the two intervention methods with a greater post-intervention reduction in motor stereotypy. DeRosa et al. (2019) found that Zane's stereotypy occurred 0.9% more frequently when intervening with response blocking versus 49.2% with response interruption and redirection. Similarly, Richard's stereotypy occurred 59.5% more often with response interruption and redirection intervention and 6% more frequent with response blocking. Caden exhibited a 2% increase in stereotypy for response blocking and 14.1% for response interruption and redirection.

Similarly, to DeRosa et al.'s (2019) study, Gould et al. (2018) found that response interruption and redirection was an effective method to reduce the frequency of motor stereotypy. The researchers used a single-subject research design with a 10-year-old boy diagnosed with autism and global developmental delay. In the study, motor stereotypy was broken into two topographies, body and hand stereotypy. Body stereotypy was defined as moving the upper body in a rocking motion exceeding three inches of movement. Hand stereotypy was defined as banging, flicking, twirling and rubbing actions involving the hands. Baseline data was collected on motor stereotypy under work and leisure conditions and paired with a red and green card for stimulus response training. The response interruption and redirection intervention were conducted in a discrete trial teaching format. When the participant engaged in motor stereotypy, the instructor would verbalize "stop," block the motor movement, deliver a 3-step sequence of motor commands, then redirect the participant back to task or leisure activity. Results of the study showed a significant decrease in hand and body stereotypy following intervention. Gould et al. (2018) found that hand stereotypy occurred an average of 89-100% across work conditions in the baseline. The presentation of hand stereotypy decreased to 63% during the RIRD intervention and maintained the baseline levels under leisure conditions. The body stereotypy intervention showed similar decreases in stereotypy during the intervention work phase. A 78–81% average occurrence of body stereotypy during baseline, with a reduction to 16% in the work intervention, and a reduction to 54% during the leisure condition.

Falligant and Dommestrup (2019) also found that response interruption and redirection was an effective intervention when combined with contingent access to stereotypy in leisure contexts. The subject in this study was a 12-year-old boy with ASD who exhibited motor stereotypy along with self-injurious behavior. The baseline sessions lasted for 5 min during which the subject was given access to the preferred items. During the baseline condition, occurrences of motor stereotypy were left untreated. A green card was also displayed to the participant to pair the visual with motor stereotypy being available. During the intervention stage, the researchers let the participant know that he may have a break following work. Moreover, they moved into a position close enough to block and redirect motor stereotypy and placed a red card visible to the participant. Contingent upon motor stereotypy, the participant’s movements were blocked and redirected to task with the use of physical prompting when non-compliant. When the participant failed to engage in motor stereotypy and participated in the activity appropriately for a predetermined length of time, social praise and the opportunity to engage in stereotypic behavior followed. The instructor would move away from the participant and place the green card in view allowing the participant to freely engage in stereotypic behavior. Falligant and Dommestrup (2019) found that their data analysis revealed a statistically significant reduction in motor stereotypy during intervention and post intervention via the Mann-Whitney *U* test (U=16, p<.001). In the baseline stages the average occurrence of motor stereotypy was 94.5% which decrease to 53.4% and increased to 74.5% upon return to baseline.

Shahabuddin's (2017) response interruption and redirection study is important to the field because it involved a larger than anticipated sample size for this type of study. Six children with autism between the ages of 3 and 5 who exhibited motor stereotypy participated in the study. The researcher utilized a changing criterion design across interventions and collected data during demand condition. In the first intervention, response interruption and redirection were contingent on motor stereotypy. The instructor would remove the demand, place three motor commands on the subject, and resume the task once the motor movements had been completed. For the intervals that were free of motor stereotypy, social praise was delivered. Another intervention combined response interruption and redirection with stimulus control and general probing. This intervention added red and green visuals as a visual support to pair when access to motor stereotypy was allowed and when it was prohibited. The researchers probed at various times to determine if generalization of the skills was occurring. The data analysis showed a 50% reduction in motor stereotypy across participants when using response interruption and redirection alone. The intervention using early intensive behavior intervention plus generalization probing lead to a minor reduction in stereotypic behavior of less than 10%. The intervention that combined response interruption and redirection with stimulus control and generalization probing showed a reduction of more than 90% across participants. As a result of this study, the authors noted that response interruption and redirection was effective at reducing motor stereotypy during intervention, but it required stimulus control training in order to effectively generalize.

Following Shahabuddin's (2017) example, Briggson (2019) also found that response interruption and redirection with stimulus control reduced the occurrence of motor stereotypy. Briggson's study used a single-subject research design with a 5-year-old boy with ASD. Using a multi-element design and partial interval data collection approach, the participants had a free access to activities over five 10-min intervals. The intervention was designed to combine response interruption and redirection with stimulus control training. The interruptions were contingent on motor stereotypy. Any instance of motor stereotypy was interrupted, and the participant was directed to view the colored posters on the wall as a reminder that the red poster meant quiet hands. The red poster signed that stereotypy was not allowed whereas the green poster signed that stereotypy was allowed. The results of this study showed that response interruption effectively reduced motor stereotypy and that stimulus control caused post intervention generalization. Stereotypic behaviors occurred 77–100% of the time during the baseline phase. During the first response interruption and redirection with stimulus control intervention stereotypy occurred 90–93% of the time. The second intervention stereotypy occurred about 30% of the time. During the third intervention phase, stereotypy showed a significant decrease to about 18% of the time. Variations in stereotypy were also found to be related to the environment that the participant was in with the highest occurrences taking place in his room, followed by his brother's room, and the lowest occurrences being in the hallway.

Saini et al. (2015) went a step further with their research on response interruption and redirection and noted that response interruption and redirection could be simplified and still produce a significant reduction in motor stereotypy. Saini and colleagues conducted a study with four children with ASD who exhibited stereotypic behaviors. The goal of response interruption and redirection is to give various motor commands following interruption and then redirecting back to task. This study aimed at determining whether simplifying the intervention to one motor command contingent on motor or vocal stereotypy would be as effective as multi-step response interruption and redirection protocols. The intervention consisted of the three-step response interruption and redirection as well as the one-step technique. The one-step intervention was found to be just as effective as the three-step method. Baseline occurrences across participants were scored as moderate to high. Three-step RIRD interventions were run and significantly decreased the occurrence of motor stereotypy across participants. A one-step RIRD intervention was conducted and also showed a significant decrease in motor stereotypy across participants. The return to baseline showed an elevation in motor stereotypy approaching pre intervention levels. The second intervention phase included one-step RIRD exclusively and all participants approached near zero levels of motor stereotypy. This research illustrated that a simplified one-step RIRD intervention can be as effective as a multi-step RIRD approach.

In line with existing research, Cividini-Motta et al. (2019) conducted a study with three children with ASD who exhibited vocal and motor stereotypy. The reversal and multielement designs were used and followed by recording the duration of interventions that was free of stereotypic behavior. Cividini-Motta and colleagues aimed to determine whether response interruption and redirection and differential reinforcement of alternative behaviors were effective at reducing stereotypic behavior and promoting alternative behavior. The authors concluded that both response interruption and redirection and differential reinforcement of alternative behaviors were effective at reducing stereotypic behavior. Cividini-Motta et al. (2019) found that all participants showed a significant decrease in stereotypic behavior during the intervention stages. Intervention phases included differential reinforcement of alternative behaviors (DRA), response interruption and redirection, and a combination of DRA and RIRD. Of the interventions, response interruption and redirection, and response interruption and redirection combined with DRA showed significant reductions in motor stereotypy. DRA showed some reduction in motor stereotypy, but a treatment effect was observed and the researchers could not attribute the reduction to DRA alone due to the treatment effect and prompting.

Unlike the response interruption intervention and redirection studies that were listed above (Briggson, 2019; Cividini-Motta et al., 2019; Falligant & Dommestrup, 2019; Saini et al., 2015; Shahabuddin, 2017), Butler et al. (2021) found that differential reinforcement of other behavior was effective at reducing the occurrence of vocal and motor stereotypy. In this study, Butler and colleagues recruited an adult with autism who was differentially reinforced during intervals that were free of stereotypy. The researchers collected baseline data by observing the participant at work in a variety of demand conditions and did not intervene when the participant engaged in stereotypic behaviors. During the intervention phase, the participant was instructed to pick the item that he selected as reinforcer and keep a calm body for a period of time to earn the reinforcer. The duration of calm body period was set at 1-min intervals and expanded to a 1-hr interval over the course of the study. The data analysis revealed that differential reinforcement of other behavior was effective in reducing vocal and motor stereotypy. In the first intervention the participants stereotypy reduced 96.6% from baseline, in the second intervention it reduced 81.3% from baseline, and the third intervention it reduced 82% from baseline levels. The conclusion of this study is that differential reinforcement of other behaviors (DRO) was effective at reducing the presentation of motor and vocal stereotypy.

Tereshko et al. (2021) also found an effective intervention for motor stereotypy using stimulus control and differential reinforcement. The researchers recruited a 5-year-old boy with ASD and used single-subject research design for this study. Baseline data were collected on the participant's stereotypic behavior prior to implementation of the intervention. The intervention aimed at creating stimulus control for motor stereotypy using a bracelet that was placed on the subject at the beginning of the intervention phase. Partial interval data were collected, and access to an electronic device was contingent upon the absence of motor stereotypy. Once the participant earned access to the device, he could play with it for a predetermined period of time unless there was an occurrence of motor stereotypy. If motor stereotypy occurred, the device was removed. The data analysis demonstrated a significant decrease in motor stereotypy during and following intervention. The bracelet was also shown to maintain the reduction in motor stereotypy post-intervention. Baseline data showed motor stereotypy occurring at an average of 60% and reducing to an average of 3% during intervention and generalization sessions.

With a novel and complex approaches to behavior reduction, Schmidt et al. (2019) conducted a single-subject research design with an adult male with ASD who engaged in high rates of motor stereotypy. The researchers administered a preference assessment to measure and rank the level of the participant's engagement with a variety of competing stimuli and competing tasks. Baseline data was collected in a free access condition during which the percent of engagement in motor stereotypy was recorded. The intervention stages included prompted engagement, prompted engagement with response blocking, and response blocking. The data analysis showed that all interventions significantly reduced motor stereotypy with the response blocking interventions showing the most significant reductions. Prompted engagement combined with response blocking showed a 100% reduction in motor stereotypy from baseline, prompted engagement alone led to a 59% reduction in motor stereotypy from baseline, and response blocking alone led to a 100% reduction in motor stereotypy from baseline.

A study by Davis et al. (2013) found that noncontingent matched stimulation resulted in a decrease in self-injurious behavior. Following a preference assessment, a multielement research design was conducted to measure whether noncontingent access to attention with unmatched stimulation would reduce self-injurious behavior, or if noncontingent matched stimulation would. The results of the study showed that noncontingent unmatched stimulation did not decrease ear-digging and in some instances increased its occurrence. The noncontingent matched stimulation intervention led to a marked decrease in the frequency of ear-digging or self-injurious behavior. In the unmatched stimulation phase stereotypy was recorded with an average of 93.8% per session. In the noncontingent matched stimulation conditions stereotypy reduce to 5.7% reflecting a significant reduction in stereotypic behavior.

In the study by Rapp (2006), the author found that noncontingent matched stimulation reduced post intervention stereotypy and response blocking caused an increase in stereotypy post-intervention. The researcher hypothesized that response blocking led to deprivation of the stereotypy causing it to increase following intervention. The noncontingent matched stimuli was found to give the participant a functionally similar alternative leading to a reduction in the motor stereotypy. The study was conducted with a 9-year-old boy who was diagnosed with autism and mental retardation and who engaged in multiple forms of motor stereotypy. A preference assessment was conducted with items that presented visual, tactile, and auditory stimulation. The baseline intervention was conducted in a no-demand scenario where the observer collected data on the participants stereotypic behavior without intervening. The noncontingent matched stimulation intervention included the researcher delivering continuous access to a variety of items that provided functionally matched stimulation to the participant. The response blocking intervention included no access to toys or other objects, and all instances of stereotypy were blocked by placing the participants hands in his lap. The post-intervention was conducted in the same manner as baseline, stereotypy increased following response blocking and decreased following noncontingent matches stimulation. For the noncontingent matched stimulation intervention, pre-intervention percentage of engagement in motor stereotypy was 72%, during the intervention levels approached near-zero levels at 0.1%, and in the post intervention phase an average of 55% was reported. In the response blocking phase of the experiment pre-intervention levels were 67%, intervention levels were 9%, and post-intervention levels were 84%. The researchers concluded that the matched stimulation stages provided the participant with functionally similar alternatives presented as an abolishing operation for the stereotypy. In the response blocking stage, deprivation of stereotypy occurred causing it to increase post-intervention.

Similarly to Rapp's (2006) findings, Piazza et al. (2000) found that access to functionally matched stimuli led to significantly lower instances of automatically maintained aberrant behavior. In the Piazza and colleagues' study, there were three participants who engaged in automatically reinforced dangerous behavior that included climbing, throwing, saliva play, and mouthing. All target behaviors were found to serve automatic function following a functional analysis. Three interventions were conducted with each participant with the use of baseline, unmatched stimulation intervention, and matched stimulation intervention phases. For one participant who engaged in hand mouthing, two matched interventions were conducted: one intervention for matched tactile stimulation and another one for matched oral stimulation. All participants showed a reduction in automatically reinforced behavior during the unmatched stimulation intervention. Piazza et al. (2000) found that the average of frequency of the automatically maintained behavior across participants during baseline were 2.7, 6.3, and 26.4. In the unmatched stimulation intervention phases the frequency reduced to 1.2, 3.9, and 22.6. For the matched stimulation intervention phase a further reduction of 0.03, 0.3, and 5.5/2.5 was reported.

Favell et al. (1982) found that topographically similar stimulation led to a reduction in the presentation of self-injurious behavior. The researchers conducted a reversal multi-element design study with six individuals with profoundly intellectual disability. The participants' behaviors were hypothesized to serve automatic function. To reduce the target self-injurious behaviors, the intervention was conducted by offering topographically matched toys. The results of the study revealed significant reductions in stereotypy across all six participants when the replacement activity was aligned functionally matched stimuli.

The literature review on reducing motor stereotypy illustrates that there are multiple effective methods to curb the behavior (Briggson, 2019; Butler et al., 2021; Cividini-Motta et al., 2019; Falligant & Dommestrup, 2019; Saini et al., 2015; Schmidt et al., 2019; Shahabuddin, 2017; Tereshko et al., 2021). A large portion of the scholarship on reducing motor stereotypy includes response interruption and redirection interventions (Briggson, 2019; Cividini-Motta et al., 2019; Falligant & Dommestrup, 2019). Some studies combined response interruption and redirection with noncontingent matched stimuli to deliver functionally similar, socially appropriate alternatives to participants as a replacement for stereotypy (Davis et al., 2013; Favell et al., 1982; Piazza et al., 2000; Rapp et al., 2006). Additional methods, such as stimulus control, can assist with generalizing the skills outside of an intensive intervention environment (Schmidt et al., 2019; Tereshko et al., 2021). Differential reinforcement also has evidence behind its efficacy with motor stereotypy reduction but may not be an effective method for all learners (Butler et al., 2021). There are many effective interventions and combinations of interventions that allow for multiple options when determining the best intervention for a specific learner.

Research Questions

1. Is response interruption and redirection with matched stimulation or response interruption and redirection with unmatched stimulation more effective in reducing instances of motor stereotypy in children with autism?
2. Is matched stimulation effective in reducing instances of motor stereotypy

children with autism?

3. How do caregivers perceive the effectiveness of response interruption and redirection with matched and unmatched stimulation as measured by the Behavior Intervention Rating Scale?

Chapter 3: Methodology

Participants

Participants for the study were two children diagnosed with autism who received ABA services at the ABA service facility in Nebraska. To qualify for the study, potential participants were officially diagnosed with ASD, between the ages of 3–5, presented with frequent hand flapping motor stereotypy, and received ABA services. Potential participants with diagnostic comorbidities and motor stereotypy that is other than hand flapping were excluded from this study. The participants' ABA treatment plans as well as the completed Motor Stereotypy Questionnaire were used to collect demographic and performance information that accounted for diagnosis, age, gender, ethnicity, and presentation of hand flapping motor stereotypy. Written informed consent was obtained from the participants' caregivers prior to the student's enrollment in the study.

The researcher used the purposive sampling technique to recruit the participants (Creswell & Guetterman, 2018; Edmonds & Kennedy, 2017). This sampling approach was designed to help with alignment of the potential participants to the objectives of the research study. It allowed for the researcher’s selection freedom and non-random sampling that were necessary to fulfill the goals of the study and answer the research questions.

Instruments

In the field of ABA, tools used to collect data are often unique to the research study and aligned with the measures of interest (Cooper et al., 2020). Multiple data collection forms were created for this research study including a questionnaire on the topography and frequency of motor stereotypy.

The Motor Stereotypy Questionnaire (see Appendix A) is a 10-question survey that was designed to ascertain the frequency, topography, antecedents, and response to interruption of motor stereotypy. The questionnaire was developed to collect additional information on motor stereotypy in combination with a functional behavior assessment. The survey expanded on the data collected pre-intervention related to the presentation and hypothesized maintaining variables of hand flapping motor stereotypy. The primary aim of the questionnaire was to gather information to understand the scope of the hand flapping motor stereotypy and to assure safe intervention. The questionnaire consisted of eight closed questions, a Likert scale, and multiple-choice questions. Questions asked about the likelihood of motor stereotypy, whether it occurred consistently under demand and no-demand scenarios, and the response to interruption of the behavior. The questionnaire was designed to be completed by the caregivers of potential participants. Completion time for the questionnaire did not exceed 5 min.

The Motivation Assessment Scale ([MAS], Durand & Crimmins, 1992) was implemented by the researcher to determine the hypothesized function of hand flapping motor stereotypy for each participant (See Appendix B). It was an open source widely used instrument that was designed to identify the motivation behind the target problem behavior in individuals with developmental disabilities. Durand (as cited in Haim, 2002) created a revised version of MAS in 2002. While the Durand's expanded version of MAS was enhanced to address the important characteristics of individuals with developmental disabilities, it is a 51-item long and takes time to complete. As such, it was not practical for this study. The researcher adapted the original 16-item MAS, which comprises of four subscales that each represent a possible function of behavior: sensory, escape, attention, and tangible. The MAS items describe specific situations, and the parent respondent rates the likelihood of the behavior to occur on a 6-point Likert scale ranging from 0 = *never* to 6 = *always*. For example, if a child with ASD demonstrated low motivation for sensory activities as reported by parents, but a high motivation for attention, this information can assist with understanding why the child is engaging in the hand flapping motor stereotypy and its potential function. Scoring was completed by assigning the selected points value from each question into the scoring grid which is divided into the four functions of behavior: sensory, escape, attention, and tangible. The total and mean score for each category were calculated and ranked in order from the highest number to the lowest. The highest scoring domain delivered the hypothesized function of the behavior. The completion of MAS took no longer than 10 min.

To expand upon the potential findings that resulted from the MAS assessment and the hypothesized sensory function of hand flapping motor stereotypy among the potential participants, the researcher created the Sensory Modality Assessment ([SMA], see Appendix C). Because there are six sensory systems which are auditory, visual, touch, movement, body position, and oral (Alsaedi et al., 2023; Dunn, 2014), the researcher created a two-column blank table to collect observational data on the potential sensory input that corresponded to a specific activity. The participant's high frequency of engagement in the motor stereotypy that corresponds to the specific sensory modality was observed, recorded, and calculated using the tally method. The latter was a simple way of recording data and counting the amount of the observed behavior that occurs frequently (Cooper et al., 2020). The Child Sensory Profile-2 (CSP-2) is a widely used sensory processing measure that was initially created by Dunn in 1999 (Alsaedi et al., 2023; Dunn, 2014). It served as a foundation for SMA. While CSP-2 could be used to assess the participants' sensory processing patterns, it was not suited for this study because it consisted of the 86-item 5-point Likert-type scale that could take approximately 20 min to administer. The results of the CSP-2 were based on the parental perception of the child's sensory profile and were subjective in nature. Because SMA was designed to collect information by the trained practitioner, it was likely to produce accurate data that identified the participant specific sensory modality and lead to the targeted intervention that accounted for a reduction of the sensory input.

To track the duration of engagement in motor stereotypy for each participant during each intervention phase, the researcher created a simple Data Sheet (see Appendix D). The purpose of this data collection instrument was to record instances of hand flapping motor stereotypy and to collect additional information on its presentation. The data collection sheet included six columns labeled: name/code of participant, intervention phase, duration of interval, topography of motor stereotypy, duration of engagement in motor stereotypy, and whether other behaviors were present during the interval. The data sheet reflected data collection methods that were typically assigned to behavior reduction goals in ABA therapy (Cooper et al., 2020). The data collection sheet helped to determine whether there were combined phenotypes of motor stereotypy that might benefit from additional and/or separate interventions.

Measurement of social validity and acceptability of a treatment is an important aspect of the ABA applied dimension (Cooper et al., 2020). A social validity instrument is typically designed to evaluate the outcomes of the treatment and its social acceptance (Ledford & Gast, 2019). There are numerous effective social validity instruments that have been developed to assess the acceptability of interventions. Some examples include Treatment Evaluation Inventory by Kazdin (1980), the Behavior Intervention Rating Scale by Elliott and Von Brock Treuting (1991), and the Scale of Treatment Perceptions by Berger et al. (2016). Relying on research conducted by Elliott and Von Brock (1991), the researcher adapted an open source the Behavior Intervention Rating Scale (See Appendix G). The rating scale includes 24 questions that are answered using a Likert scale that measures agreement from strongly disagree to agree. The questions were designed to determine the responder's agreement with the intervention goals, methodologies, and likely impact on the participant.

Measures Materials

Materials that were utilized during the research include a stopwatch, timer, pencils, paper, toys, and a calculator.

The dependent variable under study was duration of hand flapping motor stereotypy. Rapp (2006) noted that motor stereotypy is a repetitive motor movement that can present as hand-flapping, rocking, or other rhythmic movements. Engagement in hand flapping motor stereotypy was measured using duration of engagement during all phases of the experiment. A stopwatch timer was started when a subject began to engage in a hand flapping motor stereotypic behavior and stopped when the behavior ceased. All additional presentations of motor stereotypy were recorded and added to the duration for each intervention phase.

The independent variable in the experiment was response interruption and redirection with matched stimulation (RIRD-MS) and RIRD with unmatched stimulation (RIRD-NMS). RIRD and MS are two interventions that have been demonstrated to be effective in reducing the occurrence of motor stereotypy with participants with ASD (Davis et al., 2013; Favell et al., 1982; Rapp et al., 2006; Piazza et al., 2000). The combination of MS and RIRD were assessed for potential reduction of hand flapping motor stereotypy in comparison to RIRD-NMS.

Design

The researcher used an alternating treatment design (ATD) for this study. It allowed for a rapid manipulation of two or more conditions or interventions across multiple sessions (Ledford & Gast, 2018). Because the researcher collected data to empirically compare the RIRD-MS and RIRD-NMS' effectiveness in reducing motor stereotypy, it was well suited for this study. While ATD typically calls for the four experimental phases: baseline (Phase 1), comparison of independent variables (Phase 2), use of the best treatment alone (Phase 3), and follow-up (Phase 4), the researcher carried out the first three phases without the follow-up. In addition, while the baseline and best alone conditions are optional, the researcher felt strongly the need to include the baseline condition because it revealed the participant's pre-intervention performance. The two treatment conditions —RIRD-MS and RIRD-NMS—were alternated during Phase 2 in an alternating across multiple sessions (Ingelsoll, 2011).

To apply ATD with fidelity, the researcher followed Ingersoll's (2011) study that compared the effects of responsive interaction, milieu teaching, and a combined intervention on the type and communicative function of expressive language in two preschool children with autism. In contrast to the Ingersoll's approach to the ATD application, the researcher added the baseline and the best alone conditions for the reasons described above.

The ATD was well suited for this study because it relied on a practical nature of the proposed treatment in the applied setting such as home or treatment facility (Ledford & Gast, 2018). It efficiently allowed the researcher to assess RIRD-MS and RIRD-NMS at the same time and reduced the amount of resources and time that was otherwise needed for the study. It also lessened typical threats to internal validity such as testing, maturation, history, and attrition. There were limitations to ATD, which included multi treatment interference and limited information regarding the effects of the intervention. Because of the rapid alternation of conditions, it was difficult to maintain procedural fidelity. The duration of time engaged in motor stereotypy was collected using a stopwatch and the RIRD data collection sheet. Duration of time engaged in motor stereotypy was further converted into percent of engagement following data analysis.

Procedures

Data Collection Procedures

1. The researcher sought approval from the ABA treatment facility where the study was conducted.

2. When approval was granted, the researcher sought approval from the university's Institutional Review Board (IRB).

3. After the IRB approval was secured in writing, the researcher began the participant recruitment process.

4. Relying on the purposive sampling technique and collaboration with the ABA facility administration, the researcher recruited potential participants via a recruitment flyer that was physically displayed on the announcement board of the ABA facility and electronically sent to parents of children with ASD.

5. Parents who expressed interest in the study were prompted to complete the parent consent form. The researcher either met in person, or virtually, with parents or guardians to review the form and obtained their written approval.

6. To ascertain the potential participants' qualification for the study, the researcher administered the Motor Stereotypy Questionnaire and reviewed the collected data.

7. Relying on the Motor Stereotypy Questionnaire results and a brief direct observation of the potential participants in the natural environment, the researcher drafted a clear operational definition of the hand flapping motor stereotypy behavior.

8. Relying on Lomar and Horner's (2014) approach, the researcher conducted a brief functional assessment that consisted of two components: descriptive assessment and indirect assessment. Descriptive assessment involved direct observation of the participant's target motor stereotypy in the natural environment and collection of the antecedent-behavior-consequence data using an ABC data sheet. Indirect assessment entailed the completion of MAS and evaluation of the collected data according to the MAS guidelines.

9. If the functional assessment results indicated the hypothesized sensory function of hand flapping motor stereotypy, the researcher administered MSA to the participant and identified the specific sensory modality.

10. Relying on the MSA results, stimulus preference assessment was conducted using the approach described by Piazza et al. (2013). Items and activities that were included in the preference assessment were selected based on the extent to which they match or do not match the hypothesized sensory consequences of the hand flapping

motor stereotypy. Items or activities that were hypothesized to be a stimulus match were selected by the researcher. Unmatched items and activities were selected based on the parent nomination or direct observation of the participant's preferences in the natural environment.

11. Each participant engaged with all selected matched and unmatched stimuli one at the time in random order. The highest selected matched stimuli were used for the RIRD-MS intervention and the highest selected unmatched stimuli were used for the RIRD-NMS intervention.

12. The researcher collected baseline data (A) on the hand flapping motor stereotypy for all participants simultaneously using the duration of engagement methods per 5-min interval across five intervals.

13. The researcher introduced the RIRD-MS intervention (B1) to the participants only after data stability was established in the baseline (A) condition. The target behavior data were collected during the B1 intervention for a minimum of five consecutive 5-min intervals.

14. After five consecutive sessions under the B1 condition, the researcher introduced RIRD-NMS intervention (B2) to the participants for a minimum of five consecutive 5-min intervals.

15. After completion of the initial data collection for both interventions (B1 and B2), the researcher engaged in visual analysis of data and evaluated whether a functional relation existed and whether additional data collection might be needed.

16. Upon completion of the study, the researcher administered the Behavior Intervention Rating Scale to the participants' parents.

17. Throughout the study, two trained observers recorded reliability and fidelity data for 30% of sessions across all phases of the study.

The baseline phases encompassed a no-demand scenario where the participant engaged in free-play in an enriched environment. During the baseline phase, no one interacted or interfered with the participants motor stereotypy. The first intervention (B1) included RIRD with MS where the researcher interrupted motor stereotypy and redirected the participant to functionally equivalent alternative stimuli each time hand flapping motor stereotypy occurred. The alternative intervention phase (B2) included RIRD with NMS during which the researcher interrupted motor stereotypy and redirected the participant to non-matched stimuli each time stereotypy occurred. The researcher conducted two RIRD-MS interventions and two RIRID-NMS interventions in alternating order. Data on any other socially inappropriate behaviors exhibited during the intervals were also collected for analysis.

The research was conducted at homes of the participants during the first hour of their ABA session. The environments were enriched with a variety of functionally matched and non-matched stimuli during the baseline phase. The participants were given no instructions, and observation on the duration of motor stereotypy was recorded. During the first intervention phase (B1), the environment was enriched with functionally matched stimuli. Each time the participant engaged in motor stereotypy, the researcher interrupted this behavior by handing the participant a functionally matched item to engage with. Differential reinforcement was provided in the form of social praise for each engagement with functionally matched item in lieu of hand flapping motor stereotypy. During the alternative intervention phase (B2), the environment was enriched with non-matched stimuli. Each time the participant engaged in motor stereotypy, the researcher interrupted this behavior by handing the participant a non-matched item to engage with. Differential reinforcement was provided in the form of social praise for each engagement with non-matched item in lieu of motor stereotypy. Upon cessation of the experiments across participants, the data were analyzed visually. Line graphs were created and percentages of engagement in the target behavior was calculated.

Internal Validity

There are several specific threats to internal validity when using ATD. Maturation, instrumentation, procedural infidelity, testing, attrition, adaptation, Hawthorne Effect, multiple treatment interference, and instability were among a few threats that are commonly found in other research designs (Gast & Ledford, 2018). The most important threats to consider and address were procedural infidelity, multitreatment interference, and adaptation. These threats can be observed by engaging in visual and formal analysis of the collected data. The researcher looked for shallow trend lines, reported differences between the two observers, changes in the participants' behaviors, and delays in behavior changes. The researcher controlled for the common threats to internal validity by providing practical training to all observers who were involved in the data collection or administration of procedures.

Reliability of Measurement

Interobserver agreement (IOA) was collected during all three phases of the study (see Appendix E). It was used to measure the quality of measurement in ABA and degree to which the trained observer assigns the same observed values to the dependent variables when collecting data (Cooper et al., 2020). Total count IOA data was used in this study.

Total count IOA was calculated by taking the smaller of the two recorded counts by each observer, dividing it by the larger of the two recorded counts, and multiplying by 100. In addition, session-by-session IOA data were also taken and represented visually reported as an average for each phase of the study across all phases.

Treatment Fidelity

Treatment fidelity ensured that researchers adhered to preconstructed guidelines of the research (Cooper et al., 2020). The National Autism Center ([NAC] as cited in Cooper et al., 2020) addressed treatment fidelity as one of the dimensions for establishing the scientific merit of the research study. The highest score for treatment integrity on the NAC's Scientific Merit Rating Scale is 80% accuracy during a minimum of 25% of the sessions. Relying on the NAC's recommendations, the researcher created or adapted a variety of checklists, questionnaires, and data collection instruments to obtain uniform data collection approach across participants. Systematic steps for the accurate implementation of this research study were turned into a treatment fidelity checklist item which, in turn, will encourage compliance with the methodological approach to the interventions (see Appendix F).

Data Analysis Procedures

The collected data were exported into Microsoft® Excel and formatted into a line graph. Each participant's data were evaluated through a separate line graph and depict the A, B, and C phases of the study. The x-axis of the graph showed the progression of time, and the y-axis represented the duration of engagement in the hand flapping motor stereotypy during 5-min intervals. Visual analysis of trend, variability, and level was performed to assess the comparative effects of RIRD-MS and RIRD-NMS.

A percentage of non-overlapping data (PND) was also calculated to determine the degree to which data was similar across participants. The PND was evaluated by identifying the highest baseline data point, counting the number of intervention data points that are higher than that number, and dividing by the total number of intervention points times 100 (Ledford & Gast, 2018).

Chapter 4: Results

Introduction

This research study was conducted to determine whether RIRD-MS is more effective than RIRD-NMS. Pre-intervention data were collected on the topography, frequency, and intensity of the participants hand-flapping using a motor stereotypy questionnaire. The researcher conducted a functional behavior assessment to determine the function of the stereotypy. A sensory modality assessment was conducted along with a free operant preference assessment to determine matched and unmatched reinforcers to utilize in the intervention phases of the study. Relying on the reversal research design, the researcher applied an A-B-A-C design with the use of 5-min intervals. A treatment fidelity checklist was completed throughout the experiment and an interobserver agreement was conducted following the interventions. The caregivers completed a behavior intervention rating scale to determine social validity of the RIRD intervention.

Demographic Characteristics

Two children with autism participated in the study: Lee is a 7-year-old boy with high-functioning autism and Jay is a 3-year-old boy with low-functioning autism. Both participants were receiving ABA-based therapy in the home environment at the time of the study. Lee received 10 hrs of ABA services per week, while Jay received 35 hrs of ABA services per week. Both participants exhibit hand-flapping motor stereotypy daily, most commonly, during low-demand and highly preferred activities.

Data Analysis

Following data collection, the researcher used Microsoft Excel to organize data and create a line graph of the results. Visual analysis of the results was conducted by the researcher to determine whether a functional relationship exists between the variables.

Research Question 1

Is RIRD-MS or RIRD-NMS more effective in reducing instances of hand-flapping motor stereotypy in children with autism? Lee's motor stereotypy questionnaire showed that his hand-flapping behavior occurred "a lot of the time," and the antecedents were access to preferred items and activities, such as access to his toys and tablet. Lee's functional behavior assessment results showed that hand-flapping was maintained by automatic reinforcement. The sensory modality assessment results showed that Lee's hand-flapping provided tactile and visual stimulation. The preference assessment results identified Lee's preference for an expandable ball and a stress ball. The sensory modality assessment indicated the expandable ball and stress ball had the potential to satisfy the need for tactile and visual stimulation. The stress ball and expandable ball were assigned as functionally matched stimuli while the remaining items including a Game Boy, toy phone, vibrating ball, and cheese puffs were assigned as non-matched stimuli.

Analysis of the baseline (A_1) data revealed that Lee engaged in hand-flapping for 8.84s in the first 5-min interval with a percent of engagement of 27% and 7.46s in the second 5-min interval with 22% of engagement per interval. In the RIRD-MS intervention phase (B_1), Lee engaged in hand-flapping for 4.15s during the first 5-min interval with 12% of engagement and 3.69s during the second 5-min interval with 11% of engagement per interval. In the alternating baseline phase (A_2), the participant engaged in no hand-flapping stereotypy. During RIRD-NMS intervention phase (C_1), Lee engaged in hand-flapping for 7.19s for the first 5-min interval with 22% of engagement and 8.72s for the second 5-min interval with a percent of engagement of 26%. During the third baseline phase (A_3), the participant engaged in hand-flapping for 1.31s for the first 5-min interval with 4% of engagement per interval and 2.83s for the second 5-min interval with a percent of engagement of 8%. During the following RIRD-MS intervention phase (B_2), Lee engaged in hand-flapping for 5.07s per the first 5-min interval with 15% of engagement per interval and 4.97s for the second 5-min interval with a percent of engagement of 15% as well. During the fourth baseline phase (A_4), the participant engaged in hand-flapping 0.47s for the first 5-min interval with 1% of engagement per interval and 0.43s for the second 5-min interval with the same percent of engagement. In the alternating RIRD-NMS intervention phase (C_2) that followed, Lee engaged in hand-flapping for 1.87s per the first 5-min interval with 6% of engagement per interval and 1.27s with a percent of engagement of 4%. The percent of nonoverlapping data for Lee's data was 0.00% (p=1.000).

Table 1

RIRS With FMS and NMS (Lee)

Phase	Behavior duration interval 1	Percent of engagement interval 1	Behavior duration interval 2	Percent of engagement interval 2	Percent of nonover lapping data
Baseline (A_1)	8.84s	2.95	7.46s	2.49	-
RIRD-MS (B_1)	4.15s	1.38	3.69s	1.23	0
Baseline (A_2)	0s	0	0s	0	-
RIRD-NMS (C_1)	7.19s	2.4	8.72s	2.91	0
Baseline (A_3)	1.31s	0.44	2.83s	0.94	-
RIRD-MS (B_2)	5.07s	1.69	4.97s	1.66	0
Baseline (A_4)	0.47s	0.16	0.43	0.14	-
RIRD-NMS (C_2)	1.87s	0.62	1.27s	0.42	0

Jay's motor stereotypy questionnaire showed that his hand-flapping behavior occurred "most of the time," and the antecedents occurred across environments and activities. Jay's functional behavior assessment results showed his hand-flapping stereotypy was maintained by automatic reinforcers. The sensory modality assessment showed that hand-flapping served as a potential tactile and visual stimulatory modality. The preference assessment identified Jay's preference for a spinning wheel and a vibrating ball. Results of the sensory modality assessment indicated that the spinning wheel and vibrating ball had the potential to satisfy the need for tactile and visual stimulation. The items were assigned as functionally matched stimuli with the remaining items including a Game Boy, cheese puffs, and an expandable ball assigned as non-matched stimuli.

Analysis of the baseline phase (A_1) showed that Jay engaged in hand-flapping for 64.74s during the first 5-min interval with a percent of engagement of 21.58% and 105.12s during the second 5-min interval with 35.04% of engagement. In the initial matched stimuli phase (B_1), the participant engaged in hand-flapping for 34.22s during the first 5-min interval with a percent of engagement 11.4% and for 31.77s during the second 5-min interval with a percent of engagement 10.59%. In the second baseline (A_2), the participant engaged in hand-flapping for 115.91s during the first 5-min interval with a percent of engagement of 38.64% and for 121.56s during the second 5-min interval with a percent of engagement of 40.52%. In the initial unmatched stimuli phase (C_1), the participant engaged in hand-flapping for 33.17s per the first 5-min interval with a percent of engagement of 11.06% and for 30.98s during the second 5-min interval with a percent of engagement of 10.33%. In the third baseline phase (A_3), the participant engaged in hand-flapping for 130.52s during the first 5-min interval with a percent of engagement of 45.51% and for 130.53s during the second 5-min interval with a percent of engagement of 43.51%. In the alternating matched stimuli phase (B_2), the participant engaged in hand-flapping for 15.41s during the first 5-min interval with a percent of engagement of 5.14% and for 13.12s during the second 5-min interval with a percent of engagement of 4.37%. In the fourth baseline phase (A_4), the participant engaged in hand-flapping for 94.79s during the first 5-min interval with a percent of engagement of 31.6% and for 128.19s during the second 5-min interval with a percent of engagement of 42.73%. In the alternating unmatched stimuli phase (C_2), the participant engaged in hand-flapping for 50.05s during the first 5-min interval with a percent of engagement of 16.68% and for 48.57s with a percent of engagement of 16.19%. The percent of nonoverlapping data for Jay was 0% (p=1.000).

Table 2

RIRD With FMS and NMS (Jay)

Phase	Bx Duration Interval 1	Percent of Engagement Interval 1	Bx Duration Interval 2	Percent of Engagement Interval 2	Percent of Nonoverlapping Data
Baseline 1 (A_1)	64.74s	21.58	105.12s	35.04	-
RIRD-MS 1 (B_1)	34.22s	11.4	31.77s	10.59	0
Baseline 2 (A_2)	115.91s	38.64	121.56s	40.52	-
RIRD-NMS 1 (C_1)	33.17s	11.06	30.98s	10.33	0
Baseline 3 (A_3)	130.52s	43.51	130.53s	43.51	-
RIRD-MS 2 (B_2)	15.41s	5.14	13.12s	4.37	0
Baseline 4 (A_4)	94.79s	31.6	128.19s	42.73	-
RIRD-NMS 2 (C_2)	50.05s	16.68	48.57s	16.19	0

Research Question 2

Is clapping or any other specific form of matched stimulation effective in reducing instances of hand-flapping motor stereotypy in children with autism?

Results of the data from Lee's initial 5-min baseline (A_1) phase showed that he engaged in motor stereotypy for 8.84s during the first 5-min interval and 7.46s in the second 5-min interval. The initial RIRD-MS intervention (B_1) phase showed a reduction in the target behavior engagement by 4.69s for the first 5-min interval and 3.77s during the second 5-min interval. It is a 53% reduction in engagement time in the first interval and 51% reduction in the second interval. On the return to baseline (A_2) phase, the target behavior did not occur. It may or may be a spillover effect from (B_1) phase. Lee's engagement in motor stereotypy during the RIRD-NMS intervention (C_1) phase in comparison to the first baseline phase (A_1) showed reduction by 1.65s (23%) in the first 5-min interval and an increase by 1.26s (14%) in the second 5-min interval. A comparative analysis of the target behavior's duration between RIRD-MS (B_1) phase and RIRD-NMS (C_1) phase revealed that RIRD-MS produced a greater reduction of 3.04s in engagement in comparison to RIRD-NMS in the first 5-min interval and a greater reduction of 5.03s in the second 5-min interval. To compare the return to baseline (A_3) results with the immediately preceding RIRD-NMS intervention (C_1) phase, the researcher noted a 5.88s reduction in behavior during the first and the second 5-min of A_3 phase. It is 18% reduction that may or may not be attributed to the RIRD-NMS intervention spillover effect. The participant's engagement in motor stereotypy during the alternating RIRD-MS (B_2) phase showed reduction by 3.77s (11%) in the first 5-min interval and 2.49s (7%) in the second 5-min interval in comparison to the initial baseline (A_1). However, a comparative analysis of data between RIRD-MS (B_2) phase and the preceding baseline (A_3) phase revealed increased in the target behavior by 3.76s (11%) in the first interval and 2.14 (6%) in the second interval. Lee's engagement in motor stereotypy during the return to baseline (A_4) showed a reduction in the target behavior by 8.37s (25%) in the first interval and 7.03s (21%) in the second interval from the initial baseline (A_1). The participant's engagement in motor stereotypy during the RIRD-NMS (C_2) phase showed reduction in behavior by 6.97s (21%) in the first interval and 6.19s (19%) in the second interval from the initial baseline (A_1). A comparative analysis of C_2 phase to A_4 phase results revealed an opposite effect wherein the researcher noted slight increase in the target behavior during RIRD-NMS intervention by 1.4s (4%) in the first interval and 0.84s (2%) in the second interval. Final analysis of data between RIRD-MS (B_2) phase and RIRD-NMS (C_2) phase demonstrated decreased in motor stereotypy by 3.2s (9%) in the first interval and 3.7s (11%) in the second interval in favor of RIRD-UMS intervention.

Results of the data from Jay's initial 5-minute baseline (A_1) phase showed that he engaged in motor stereotypy for 64.74s during the first 5-min interval and 105.12s in the second 5-min interval. The initial RIRD-MS intervention (B_1) phase showed a reduction in the target behavior engagement by 30.52s for the first 5-min interval and 73.35s during the second 5-min interval. It is 47% reduction in engagement time in the first interval and 70% reduction in the second interval. Results of the return to baseline (A_2) phase showed an increase in the target behavior engagement by 81.69s for the first 5-min interval and 89.79s during the second 5-min interval. It is 239% increase in engagement time in the first interval and 283% in the second interval. Jay's engagement in motor stereotypy during the RIRD-NMS intervention (C_1) phase in comparison to the first baseline phase (A_1) showed a reduction by 82.74s in the first 5-min interval and by 1.26s (4%) in the second 5-min interval. A comparative analysis of the target behavior's duration between RIRD-MS (B_1) phase and RIRD-NMS (C_1) phase revealed that RIRD-MS produced 3.04s (9%) reduction in comparison to RIRD-NMS in the first 5-min interval and 5.03s (15%) in the second 5-min interval. To compare the return to baseline (A_3) results with the immediately preceding RIRD-UMS intervention (C_1) phase, the researcher noted 5.88s reduction in behavior during the first and the second 5-min of A_3 phase. It is 18% reduction that may or may not be attributed to the RIRD-NMS intervention spillover effect. The participant's engagement in motor stereotypy during the alternating RIRD-MS (B_2) phase showed reduction by 3.77s (11%) in the first 5-min interval and 2.49s (7%) in the second 5-min interval in comparison to the initial baseline (A_1). However, a comparative analysis of data between RIRD-MS (B_2) phase and the preceding baseline (A_3) phase revealed an increase in the target behavior by 3.76s (11%) in the first interval and 2.14 (6%) in the second interval. Lee's engagement in motor stereotypy during the return to baseline (A_4) showed a reduction in the target behavior by 8.37s (25%) in the first interval and 7.03s (21%) in the second interval from the initial baseline (A_1). The participant's engagement in motor stereotypy during the RIRD-NMS (C_2) phase showed a reduction in behavior by 6.97s (21%) in the first interval and 6.19s (19%) in the second interval from the initial baseline (A_1). A comparative analysis of C_2 phase to A_4 phase results revealed an opposite effect wherein the researcher noted a slight increase in the target behavior during RIRD-NMS intervention by 1.4s (4%) in the first interval and 0.84s (2%) in the second interval. Final analysis of data between the RIRD-MS (B_2) phase and the RIRD-NMS (C_2) phase demonstrated a decrease in motor stereotypy by 3.2s (9%) in the first interval and 3.7s (11%) in the second interval in favor of RIRD-NMS intervention.

Figure 1

Percent of Engagement in Motor Stereotypy per 16 Intervals

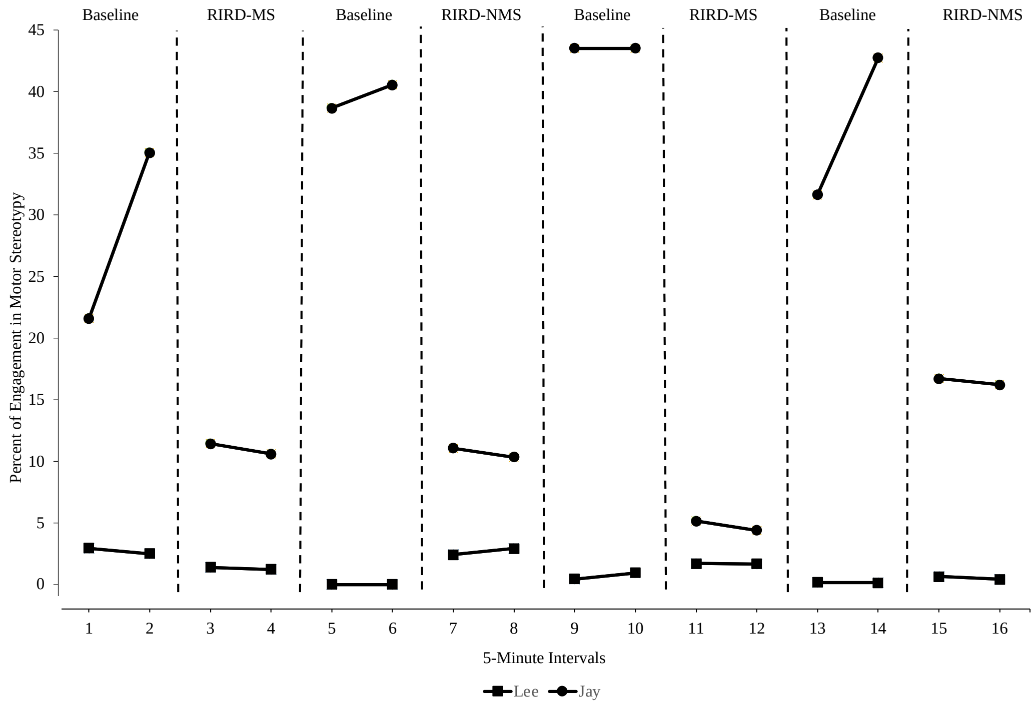


Figure 1 shows that Lee's engagement in motor stereotypy occurred at low levels (range = 0–5 percent) with a slightly decelerating trend in baseline. In contrast, Jay's engagement in motor stereotypy occurred at high levels (range = 20–35 percent) with accelerating trend in baseline. In the B_1 phase, Lee's engagment in motor stereotypy occurred at low levels (range = 0–5 percent) with a decelerating trend. Jay's motor stereotypy occurred at medium-high levels (range = 10–15 percent) with decelerating trend in B_1 phase. In the A_2 phase, Lee's engagment in motor stereotypy occurred at the lowest possible levels whereas Jay's motor stereotypy occurred at high levels (range = 35–45 percent) with an accelerating trend. In the C_1 phase, Lee's engagement in motor stereotypy occurred at low levels (range = 0–5 percent) with an accelerating trend whereas Jay's motor stereotypy occurred at low levels (range = 10–15 percent) with a decelerating trend. In the A_3 phase, Lee's engagement in motor stereotypy occurred at low levels (range = 0–5 percent) with an accelerating trend whereas Jay's motor stereotypy occurred at high levels (range = 40–45 percent) with a flat trend. In the B_2 phase, Lee's engagement in motor stereotypy occurred at low levels (range = 0–5 percent) with an accelerating trend whereas Jay's motor stereotypy occurred at low levels (range = 5–10 percent) with a deccelerating trend. In the A_4 phase, Lee's engagement in motor stereotypy occurred at the lowest levels whereas Jay's motor stereotypy occurred at high levels (range = 30–45 percent) with an accelerating trend. In the C_2 phase, Lee's engagement in motor stereotypy occurred at low levels (range = 0–5 percent) with a deccelerating trend whereas Jay's motor stereotypy occurred at medium levels (range = 15–20 percent) with a deccelerating trend.

Research Question 3

How do caregivers perceive the effectiveness of response interruption and redirection

with matched and unmatched stimulation as measured by the Behavior Intervention Rating Scale?

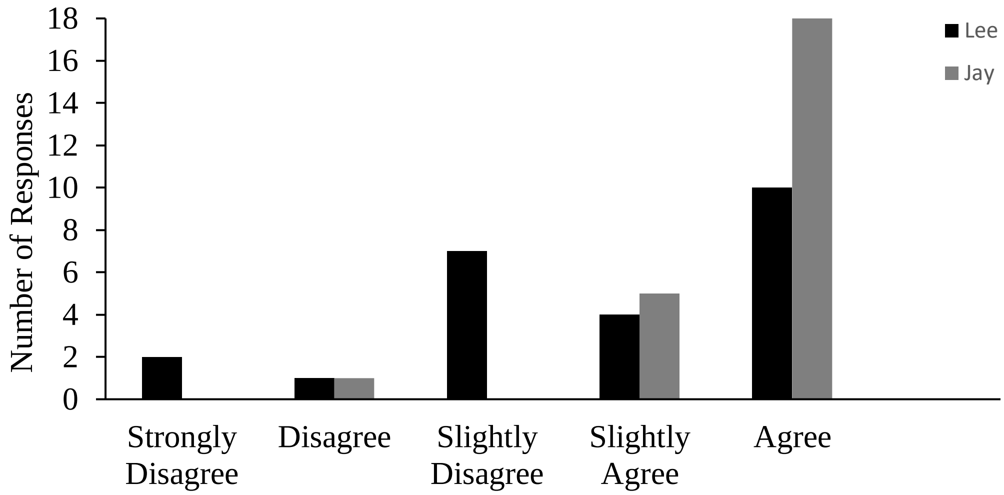
For each of the 24 statements on the Behavior Intervention Rating Scale, there was a sum of the responses as an indicator of the strength of the social validity measure per the participant's caregiver along the continuum of (1) *strongly disagree*, (2) *disagree*, (3) *slightly disagree*, (4) *slightly agree*, and (5) *agree* in response to each statement. The highest level of agreement was calculated by the caregiver's selection of 5 points for each of the 24 statements or 5x24=120. If the caregiver selected (1) *strongly disagree* across all statements, then the score was calculated as 1x24=24, which indicates the weakest level of social validity.

The results of the behavior intervention rating scale for Lee showed a predominantly agreeable response rating from the caregiver. Lee's caregiver agreed across 75% of the questions receiving a score of 90. Slight agreement was expressed across 21% of the questions earning a score of 20. Lee's caregiver disagreed with one question regarding the maintenance of motor stereotypy reduction following the intervention.

In contrast to Lee's assessment of the intervention, Jay's caregiver agreed across 42% of the questions receiving a score of 50, and slightly agreed across 12.5% of questions earning a score of 12. Jay's caregiver expressed slight disagreement across 29% of questions earning a score of 21. The caregiver disagreed with one question related to whether the intervention would lead to negative consequences for the child. They also strongly disagreed with two questions relating to the speed of skill acquisition, and retention of skills following the intervention, earning a score of 4 across all three questions. Overall, the caregivers selected the same responses across 50% of the questions, reflecting a common expectation across interventions.

Figure 2

Caregivers' Responses to Behavior Intervention Rating Scale



To evaluate the procedural fidelity of the study, interobserver agreement was conducted alongside the researcher, via direct observation, by a registered behavior technician. The registered behavior technician collected duration data during each phase of the study. The interobserver agreement for Lee during the A_1 baseline phase was 84.39%, B_1 – 88.92%, A_2 – 86.38%, C_1 –82.45%, A_3 – 46.29, B_2 – 98.03%, A_4 – 91.49, and C_2 – 67.91%. The total IOA across Lee's intervention was 98.34% showing a high percentage of agreement. The interobserver agreement for Jay during the A_1 baseline phase was 61.59%, B_1 – 92.84%, A_2 – 95.35%, C_1 – 93.40%, A_3 –99.99%, B_2 – 85.14%, A_4 –73.95%, and C_2 – 97.04%. The total IOA across Jay's intervention was 88.35%. showing a high percentage of agreement.

Chapter 5: Discussion

Introduction

This study evaluated the effectiveness of RIRD-MS vs. RIRD-NMS in reducing instances of motor stereotypy in children with autism. Because social validity of an intervention is important to the ABA practitioners and general public, the researcher also assessed the caregiver's perception of the effectiveness of RIRD-MS and RIRD-NMS as measured by the Behavior Intervention Rating Scale. In preparation for the intervention, the function and topography of the participant's motor stereotypy were determined using a functional behavior assessment, and the sensory modality of the stereotypy was assessed using a sensory modality assessment. The function of motor stereotypy was found to be automatic for both participants and the sensory modality of the motor stereotypy for both participants was found to be tactile and visual stimulation.

Summary of Findings

The first research question was answered by analyzing the data collected during each stage of the research study. Lee's data showed that RIRD-MS and RIRD-NMS both significantly reduced his overall engagement in motor stereotypy from the initial baseline. The first RIRD-MS intervention showed a significant reduction in motor stereotypy which was reduced even further upon the return to baseline. The first RIRD-NMS intervention showed a significant increase in motor stereotypy, returning to levels approaching the initial baseline phase. The following RIRD-MS subsequent phase revealed a reduction in motor stereotypy which continued to reduce over time and until the return to baseline and second RIRD-NMS phase.

Jay's results similarly showed a significant reduction in motor stereotypy engagement during the initial RIRD-MS phase. Jay's motor stereotypy increased significantly, nearly doubling, from the initial baseline upon the return to baseline possibly from the deprivation of motor stereotypy during the RIRD-MS phase. During the RIRD-NMS phase, the stereotypy duration was significantly reduced to the level that matched the RIRD-MS phase. Upon the second return to baseline, the duration of motor stereotypy again increased to more than double the initial baseline duration. Upon return to the RIRD-MS phase the engagement in motor stereotypy again reduced significantly. On the return to baseline motor stereotypy increased significantly exceeding the initial baseline duration. On the return to the RIRD-NMS phase, motor stereotypy was reduced to lower levels than in the initial baseline. This data analysis demonstrates that RIRD-MS resulted in greater reductions in motor stereotypy engagement in comparison to RIRD-NMS.

To answer the second research question, the researcher reviewed the overall reduction in the duration of motor stereotypy during the initial baseline phase in contrast to the RIRD-MS intervention phases across both participants. The results showed a significant reduction in the duration of engagement for both participants during the RIRD-MS intervention phases. The first RIRD-MS intervention phase showed a greater reduction in motor stereotypy to the second RIRD-MS for Jay, but not for Lee. Both RIRD-MS phases showed a significant reduction in engagement from the initial baseline demonstrating its superior effectiveness for reducing engagement in the target behavior.

Analysis of the behavior intervention rating scale results showed high rates of agreement between the caregivers on the efficacy of the RIRD intervention for both participants. However, the caregivers found the RIRD application to be laborious. The caregivers also reported a concern relative to the long-term maintenance of the intervention results for both participants. The results illustrate an overall caregiver satisfaction with the intervention, but uncertainty about its long-term efficacy.

Interpretation of Findings

Analysis of the collected data supports the RIRD's effectiveness in reducing motor stereotypy in both participants. The individual results of both participants differed across the two interventions and baseline phases. A review of the diagnostic and behavioral characteristics of Lee revealed that the participant was mildly impacted on the autism spectrum, engaged in low levels of motor stereotypy, and exhibited flexibility with reinforcement. Lee's intervention data showed a significant initial reduction in motor stereotypy which persisted across all returns to baseline and was reduced to a near zero level across two of the phases. There was no significant difference in the reduction of motor stereotypy with the use of RIRD-MS vs. RIRD-NMS yielding inconclusive results on whether RIRD-MS was a final winner. This could be due to the overall RIRD's effectiveness in the participant irrespective of the alternative replacement activities. No signs of deprivation were detected from Lee's data analysis.

A review of Jay's diagnostic and behavioral characteristics indicated the participant was severely impacted on the autism spectrum, engaged in persistent motor stereotypy, and exhibited rigidity with reinforcement. RIRD as an overarching intervention approach was found to be effective in reducing motor stereotypy with a significantly larger effect during the RIRD-MS vs. RIRD-NMS administration. Jay showed signs of motor stereotypy deprivation on the return to baseline with the second and third returns to baseline exceeding the initial baseline duration of motor stereotypy.

The interpretation of the behavior intervention rating scale results contributes to the social validity of the RIRD intervention. The caregivers reported that the intervention successfully reduced the participants' engagement in motor stereotypy. These findings align with the collected data on the effectiveness of RIRD in reducing motor stereotypy. In contrast, the caregivers gave low ratings for the perceived maintenance of the intervention following the study. This observation highlights the caregivers' apprehension with the long-term results and need for further evaluation. While the overall results of the behavior intervention rating scale point to an the immediate efficacy of the RIRD intervention, maintenance and generalization of newly acquired skills should be incorporated and assessed as an equally important application components.

Context and Implication of Findings

The findings of this research study align with the previous research that attested to the RIRD's effectiveness as a means to reducing motor stereotypy (Davis et al., 2013; Dickman et al., 2012; Ledford et al., 2022; Piazza et al., 2000; Ryan et al., 2022; Schmidt et al., 2021). Davis et al. (2013) conducted the research study that addressed the effects of NMS and MS in the reduction of the automatically maintained self-injurious behavior (SIB). The authors determined that NMS can dramatically reduce the engagement in automatically maintained behavior when sensory induction stimulus is replaced by delivery of noncontingent reinforcement in an enriched environment. The researchers ascertained that a variety of activities with unmatched stimuli may provoke the participant's engagement in alternative behavior, and therefore reduce SIB. Results of the current study report similar findings that the availability of alternative matched or unmatched stimuli may reduce motor stereotypy. Unlike the Davis et al.'s study outcomes that reported a significant reduction in SIB using NMS, the current study found a greater reduction in motor stereotypy with the use of MS rather than NMS. Davis and colleagues also demonstrated success of intervention due to a learned behavior of anticipated blocking during SIB. The current study showed a reduction in engagement in motor stereotypy as soon as RIRD-MS or RIRD-NMS were introduced over the course of the study. Lee's motor stereotypy was reduced with each RIRD-MS intervention phase. Jay's motor stereotypy was reduced with the introduction of the first sets of RIRD-MS and RIRD-NMS intervention phases and then increased in the final intervention and during baseline phases of the study. Jay's results could be attributed to a deprivation effect associated with Jay's high rate of motor stereotypy.

Rapp's (2006) study results echo Davis et al.'s (2013) findings. In contrast to Davis and colleagues, Rapp applied response blocking and MS both of which led to significant decreases in stereotypic behavior of participants. Rapp further hypothesized that the increase in stereotypic behavior following response blocking without MS was due to a deprivation effect. While the current study did not use the response blocking strategy, it relied on the application of RIRD-MS that proved to be successful for both participants, and the slight increase in Jay's motor stereotypy could also be attributed to a deprivation effect. Moreover, success of RIRD-MS and RIRD-NMS without the blocking strategy promotes noninvasive approaches to evidence-based interventions for stereotypy.

Piazza et al. (2000) also studied the impact of MS and NMS use on aberrant stereotypic behavior and, similarly to the current study, took into account the sensory modality of the behavior as well as the participants' relative preference for alternative stimulatory items. Piazza and colleagues' results aligned with the current research relative to the greater effectiveness of MS vs. NMS on the reduction of motor stereotypy. A significant difference between the Piazza et al.'s study and the current study is associated with isolation of each sensory modality to discern which had a higher impact on the stereotypic behavior. The current study utilized replacement stimuli that satisfied multiple sensory modalities that were determined by the sensory modality assessment conducted prior to the intervention.

This study further contributes to the scholarship on RIRD-MS and RIRD-NMS as an effective intervention for the reduction of stereotypy. To be specific, the study results demonstrated that RIRD-MS may be an effective intervention for individuals who are severely affected by autism and engage in persistent motor stereotypy. Both RIRD-MS and RIRD-NMS may be effective for individuals who exhibit mild-to-moderate autism symptoms and engage in moderate motor stereotypy. The social significance and impact of the motor stereotypy should be taken into consideration prior to targeting the behavior for reduction. Intervention goals to reduce and/or replace stereotypic behaviors should be considered when the behavior impedes access to social and learning opportunities, or when its presentation can lead to elevated risk of social stigmatization.

Limitations of the Study

Limitations of the study include a small number of participants, difference in the participants' age, difference in manifestation characteristics of participants' autism symptoms, and the timeline of the intervention. Because of the limited number of participants, the scope of the study and its outcomes may not generalize to other individuals with autism. A discernable difference between RIRD-MS and RIRD-NMS with one of the participants serves as evidence of the study limitations. The age difference between the participants may explain a gap in the individual abilities, speed of skill retention, and tolerance across the developmental timeline. The participants' autism severity may also attribute to differences in flexibility and the function of self-stimulatory seeking behavior. The use of an alternating treatment design might have led to multiple treatment interferences with anticipation of motor stereotypy interruption.

Future Research Directions

Future research efforts should involve a large sample of participants with similar manifestations of autism symptoms. Delivery of the intervention calls for a prolonged period of time with assessment of maintenance and generalization of skills. When using ATD, an introduction of brief breaks between the interventions may lessen the effect of carryover and multiple interferences. To further discriminate between the RIRD-MS and RIRD-NMS, it may be necessary to recruit potential participants who are of the same age and with similar presentation of ASD characteristics. Individuals with high frequency of motor stereotypic behaviors could benefit from an exclusive evaluation of the RIRD-MS intervention alone.

References

Akshoomoff, N., Corsello, C., & Schmidt, H. (2006). The role of the Autism Diagnostic

Observation Schedule in the assessment of autism spectrum disorders in school and community settings. *California School Psychologist*, *11*, 7–19.

Alsaedi, R. H., Carrington, S., & Watters, J. J. (2023). Caregivers' Assessment of the Sensory Processing Patterns Exhibited by Children with Autism in the Gulf Region. *Journal of Autism and Developmental Disorders*, 1–17.

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). American Psychiatric Publishing.

American Psychological Association. (2022, August). Autism spectrum disorder. https://www.apa.org. https://www.apa.org/topics/autism-spectrum-disorder

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

Berger, N. I., Manston, L., & Ingersolll, B. (2016). Establishing a scale for assessing the social validity of skill building interventions for young children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 46,* 3258–3269. https://doi.org/10.1007/s10803-016-2863-9

Bodfish, J. W., Symons, F. J., Parker, D. E., & Lewis, M. H. (2000). Varieties of repetitive behavior in autism: Comparisons to mental retardation. *Journal of autism and developmental disorders*, *30*, 237–243.

Bourreau, Y., Roux, S., Gomot, M., Bonnet-Brilhault, F., & Barthélémy, C. (2009). Validation of the repetitive and restricted behaviour scale in autism spectrum disorders. *European Child & Adolescent Psychiatry, 18,* 675–682.

Boyd, B. A., McDonough, S. G., & Bodfish, J. W. (2012). Evidence-based behavioral interventions for repetitive behaviors in autism. *Journal of Autism and Developmental Disorders, 42,* 1236–1248.

Briggson, S. (2019). *Decreasing stereotypy through response interruption and redirection (RIRD) and stimulus control* (1583024). [Master's thesis]. ProQuest Dissertations and Theses Global.

Butler, C., Kobylarz, A., Zaki-Scarpa, C., LaRue, R. H., Manente, C., & Kahng, S. (2020). Differential reinforcement to decrease stereotypy exhibited by an adult with autism spectrum disorder. *Behavioral Interventions*, *36*(1), 261–270. https://doi.org/10.1002/bin.1760

Centers for Disease Control and Prevention. (2022, March 31). What is autism spectrum disorder? https://www.cdc.gov/ncbddd/autism/facts.html

Centers for Disease Control and Prevention. (2023, February 3). Screening and Diagnosis of Autism Spectrum Disorder for Healthcare Providers. https://www.cdc.gov/ncbddd/autism/hcp-screening.html#DiagnosticTools

Cividini-Motta, C., Garcia, A. R., Livingston, C., & MacNaul, H. L. (2019). The effect of response interruption and redirection with and without a differential reinforcement of alternative behavior component on stereotypy and appropriate responses. *Behavioral Interventions*. https://doi.org/10.1002/bin.1654

Cooper, J. C., Heron, T. E., & Heward, W. L. (2020). *Applied Behavior Analysis.* (3rd ed.). Pearson.

Crepeau-Hobson, M. F., Leech, N., & Russell, C. (2022). CLEAR Autism Diagnostic

Evaluation (CADE): Evaluation of reliability and validity. *Journal of Developmental and Physical Disabilities, 34*(5), 853.

Creswell, J.W., & Guetterman, T. C. (2018). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (6th edition). Pearson.

Davis, T. N., Dacus, S., Strickland, E., Machalicek, W., & Coviello L. (2013). Reduction of automatically maintained self-injurious behavior utilizing noncontingent matched stimuli. *Developmental Neurorehabilitation*, *16*(3), 166–171. https://doi.org/10.3109/17518423.2013.766819

DeRosa, N. M., Novak, M. D., Morley, A. J., & Roane, H. S. (2019). Comparing response blocking and response interruption/redirection on levels of motor stereotypy: Effects of data analysis procedures. *Journal of Applied Behavior Analysis*, *52*(4), 1021–1033. https://doi.org/10.1002/jaba.644

Dickman, S. E., Bright, C. N., Montgomery, D. H., & Miguel, C. F. (2012). The effects of response interruption and redirection (RIRD) and differential reinforcement on vocal stereotypy and appropriate vocalizations. *Behavioral Interventions, 27*(4), 185–192. https://doi.org/10.1002/bin.1348

Dunn, W. (2014). *Sensory profile 2 User's Manual*. Pearson

Durand, V. M., & Crimmins, D. B. (1992). *The Motivation Assessment Scale (MAS) administration guide*. Monaco and Associates.

Edmonds, W. A., & Kennedy, T. D. (2017). *An applied guide to research designs: Quantitative, qualitative, and mixed methods* (2nd ed.). Sage.

Elliott, S. N., & Von Brock Treuting, M. (1991). Behavior intervention rating scale. PsycTESTS Dataset. https://doi.org/10.1037/t07574-000

Falligant, J. M., & Dommestrup, A. K. (2019). Decreasing motor stereotypy in leisure contexts: Analysis of stimulus control with response interruption and redirection. *Behavioral Interventions*, *35*(2), 306–314.

Favell, J. E., McGimsey, J. F, Schell, & R. M. (1982). Treatment of self-injury by providing alternate sensory activities. *Analysis and Intervention in Developmental Disabilities*, *2*, 83–104.

Gandal, M. J., Haney, J. R., Wamsley, B., Yap, C. X., Parhami, S., Emani, P. S., Chang, N., Chen, G. T., Hoftman, G. D., de Alba, D., Ramaswami, G., Hartl, C. L., Bhattacharya, A., Luo, C., Jin, T., Wang, D., Kawaguchi, R., Quintero, D., Ou, J., Wu, Y. E., et al., (2022). Broad transcriptomic dysregulation occurs across the cerebral cortex in ASD. *Nature*, 1–8.

Ghanizadeh, A. (2010). Clinical approach to motor stereotypies in autistic children. *Iranian Journal of Pediatrics*, *20*(2), 149.

Goldman, S., Wang, C., Salgado, M. W., Greene, P. E., Kim, M., & Rapin, I. (2009). Motor stereotypies in children with autism and other developmental disorders. *Developmental Medicine & Child Neurology*, *51*(1), 30–38.

Gordon, C. T. (2000). Considerations on the pharmacological treatment of compulsions and stereotypies with serotonin reuptake inhibitors in pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, *30*(5), 437–438.

Gould, K. M., Harper, J. M., Gillich, E., & Luiselli, J. K. (2018). Intervention, stimulus control, and generalization effects of response interruption and redirection on motor stereotypy. *Behavioral Interventions*. https://doi.org/10.1002/bin.1652

Gwynette, M. F., McGuire, K., Fadus, M.C., Feder, J. D., Koth, K. A., & King, B. H. (2019). Overemphasis of the Autism Diagnostic Observation Schedule (ADOS) evaluation subverts a clinician's ability to provide access to autism services. *Journal of the American Academy of Child and Adolescent Psychiatry*, *58*(12), 1222–1223.

Haim, A. (2002). *The analysis and validation of the Motivation Assessment Scale-II Test Version: A structural equation model*. State University of New York at Albany.

Heathers, J. A., Gilchrist, K. H., Hegarty-Craver, M., Grego, S., & Goodwin, M. S. (2019). An analysis of stereotypical motor movements and cardiovascular coupling in individuals on the autism spectrum. *Biological Psychology*, *142*, 90–99. doi.org/10.1016/j.biopsycho.2019.01.004

Hooker, J. L., Dow, D., Morgan, L., Schatschneider, C., & Wetherby, A. M. (2019). Psychometric analysis of the repetitive behavior scale-revised using confirmatory factor analysis in children with autism. *Autism Research*, *12*(9), 1399–1410.

Ingersoll, B. (2011). The differential effect of three naturalistic language interventions on language use in children with autism. *Journal of Positive Behavior Interventions*, *13*(2), 109–118.

Kazdin, A. E. (1980). Acceptability of alternative treatments for deviant child behavior. *Journal of Applied Behavior Analysis*, *13*(2), 259–273.

Lanovaz, M. J., Robertson, K. M., Soerono, K., & Watkins, N. (2013). Effects of reducing stereotypy on other behaviors: A systematic review. *Research in Autism Spectrum Disorders, 7*(10), 1234–1243. https://doi.org/10.1016/j.rasd.2013.07.009

Ledford, J. R., & Gast, D. L. (2018). *Single-case research methodology: Applications in special education behavioral services* (3rd edition). Routledge.

Ledford, J. R., Trump C., Chazin, K. T., Windsor, S. A., Bennett Eyler, P., & Wunderlich, K. (2022). Systematic review of interruption and redirection procedures for autistic individuals. *Behavioral Interventions*, 1–21. https://doi.org/10.1002/bin.1905

Lin, P. I., Moni, M. A., Gau, S. S. F., & Eapen, V. (2021). Identifying subgroups of patients with autism by gene expression profiles using machine learning algorithms. *Frontiers in Psychiatry, 12*, 637022.

Loan, A., Leung, J. W., Cook, D. P., Ko, C., Vanderhyden, B. C., Wang, J., & Chan, H. M. (2023). Prenatal low-dose methylmercury exposure causes premature neuronal differentiation and autism-like behaviors in a rodent model. *iScience, 26*(3), 106093. https://doi.org/10.1016/j.isci.2023.106093

Loman, S. L., & Horner, R. H. (2014). Examining the efficacy of a basic functional behavioral assessment training package for school personnel. *Journal of Positive Behavior Interventions, 16*, 18–30.

Luyster, R., Gotham, K., Guthrie, W., Coffing, M., Petrak, R., Pierce, K., Bishop, S., Esler, A., Hus, V., Oti, R., Richler, J., Risi, S., & Lord, C. (2009). The Autism Diagnostic Observation Schedule-toddler module: A new module of a standardized diagnostic measure for autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *39*(9), 1305–1320.

Maenner, M. J., Shaw, K. A., & Baio, J. (2020). Prevalence of autism spectrum disorder among children aged 8 years—Autism and Developmental Disabilities Monitoring Network, 11 sites, United States, 2016. MMWR Surveill Summ, *69*(4), 1–12.

Muthugovindan, D., & Singer, H. (2009). Motor stereotypy disorders. *Current Opinion in Neurology*, *22*(2), 131–136.

Pastrana, S. J., Rapp, J. T., & Frewing, T. M. (2013). Immediate and subsequent effects of response interruption and redirection on targeted and untargeted forms of stereotypy. *Behavior Modification*, *37*(4), 591–610. https://doi.org/10.1177/0145445513485751

Piazza, C. C., Adelinis, J. D., Hanley, G. P., Goh, H., & Delia, M. D. (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. *Journal of Applied Behavior Analysis*, *33*(1), 13–27. https://doi.org/10.1901/jaba.2000.33-13

Rapp, J. T. (2006). Toward an empirical method for identifying matched stimulation for automatically reinforced behavior: A preliminary investigation. *Journal of Applied Behavior Analysis*, *39*(1), 137–140. doi.org/10.1901/jaba.2006.37-05

Ryan, J., Rosales, R., & Rowe, E. (2022). A review of response interruption and redirection: 2007–2021. *Behavioral Interventions, 37*(4), 1206–1236. https://doi.org/10.1002/bin.1886

Saini, V., Gregory, M. K., Uran, K. J., & Fantetti, M. A. (2015). Parametric analysis of response interruption and redirection as treatment for stereotypy. *Journal of Applied Behavior Analysis*, *48*(1), 96–106. https://doi.org/10.1002/jaba.186

Samadi, S. A., Noori, H., Abdullah, A., Ahmed, L., Abdalla, B., Biçak, C. A., & McConkey, R. (2022). The psychometric properties of the Gilliam autism rating scale (GARS-3) with Kurdish samples of children with developmental disabilities. *Children*, *9*(3), 434. https://doi.org/10.3390/children9030434

Schmidt, J. D., Falligant, J. M., Goetzel, A., Hardisty, S., & Hagopian, L. P. (2021). Decreasing motor stereotypy with competing stimuli and tasks: Analysis of prompted engagement and response blocking. *Behavioral Interventions.* https://doi.org/10.1002/bin.1786

Schopler E., Van Bourgondien M..E, Wellman, G.J., & Love S.R. (2010). *Childhood Autism Rating Scale* (2nd Ed). Western Psychological Services

Shahabuddin, A. (2017). *The use of response interruption and redirection (RIRD) with stimulus control training for motor stereotypy in children with autism spectrum disorder (ASD;* 10622811). [Doctoral dissertation]. ProQuest Dissertations and Theses Global.

Sheldrick, R. C., Frenette, E., Vera, J. D., Mackie, T. I., Martinez-Pedraza, F., Hoch, N., Eisenhower, A., Fettig, A., & Carter, A. S. (2019). What drives detection and diagnosis of autism spectrum disorder? Looking under the hood of a multi-stage screening process in early intervention. *Journal of Autism and Developmental Disorders*, *49*, 2304–2319.

Skinner, B. F. (1931). The concept of the reflex in the description of behavior. *The Journal of General Psychology*, *5*(4), 427–458. https://doi.org/10.1080/00221309.1931.9918416

Tereshko, L., Ross, R. K., & Frazee, L. (2021). The effects of a procedure to decrease motor stereotypy on social interactions in a child with autism spectrum disorder. *Behavior Analysis in Practice, 14*(2), 367–377. https://doi.org/10.1007/s40617-020-00516-w

U. S. Department of Health and Human Services. (2021, April 19). Early intervention for autism. National Institute of Health. https://www.nichd.nih.gov/health/topics/autism/conditioninfo/treatments/early-intervention

Appendix A

Motor Stereotypy Questionnaire

Motor Stereotypy Questionnaire

Name of subject:

1. Does motor stereotypy occur?
2. Does motor stereotypy frequency/duration/intensity impede access to learning opportunities?
3. Does motor stereotypy occur:

   Rarely   Sometimes   A lot of the time   Most of the time   All of the time

4. Does motor stereotypy occur under demand scenarios?
5. Does motor stereotypy occur under no-demand scenarios?
6. Does the subject appear to enjoy engaging in motor stereotypy?
7. Does the subject respond positively if the motor stereotypy is interrupted?
8. Does the subject respond negatively if the motor stereotypy in interrupted?
9. Does the subject engage in maladaptive behaviors when the motor stereotypy is interrupted?
10. Circle all topographies of motor stereotypy the subject engages in:

    Hand-flapping   Rocking   Finger/hand play

    Spinning   Swinging   Surface swiping

    Mouthing   Licking   Rubbing items on skin

    Jumping   Climbing   Hanging from hands

    Hanging upside down   Placing items/hands in front of eyes

    Rolling/dropping   Running   Pacing   Pica

    Picking   Pulling   Pushing   Biting   Kicking

    Squeezing/Hugging   Shaking legs   Shaking arms   Shaking head

    Grinding teeth   Spitting/Drooling   Staring   Hitting

Appendix B

Motivation Assessment Scale

MOTIVATION ASSESSMENT SCALE

Name: ______________________ Rater: ______________________ Date: ___ / ___ / ______

Behaviour Description:
____
____

Setting Description
____
____

Instructions: The Motivation Assessment Scale (MAS) is a questionnaire designed to identify those situations in which an individual is likely to behave in certain ways. From this information, more informed decisions can be made concerning the selection of appropriate rein forcers and treatments. To complete the MAS, select one behaviour that is of particular interest. It is important that you identify the behaviour ***very specifically.*** For example, '***aggressive'*** is not as good a description as ***'hits his sister'.*** Once you have specified the behaviour to be rated, read each question carefully and circle the one number that best describes your observation of this behaviour.

Questions	Never	Almost Never	Seldom	Half the time	Usually	Almost Always	Always
1. Would the behaviour occur continuously, over and over, if this person was left alone for long periods of time? (for example, several hours)	0	1	2	3	4	5	6
2. Does the behaviour occur following a request to perform a difficult task?	0	1	2	3	4	5	6
3. Does the behaviour seem to occur in response to your talking to other persons in the room?	0	1	2	3	4	5	6
4. Does the behaviour ever occur to get a toy, food, or activity that this person has been told that they can't have?	0	1	2	3	4	5	6
5. Would the behaviour occur repeatedly, in the same way, for very long periods of time, if o-one was around? (For example, rocking back and forth for over an hour)	0	1	2	3	4	5	6
6. Does the behaviour occur when any request is made of this person?	0	1	2	3	4	5	6
7. Does the behaviour occur whenever you stop attending to this person?	0	1	2	3	4	5	6
8. Does the behaviour occur when you take away a favourite toy, food or activity?	0	1	2	3	4	5	6

Questions	Never	Almost Never	Seldom	Half the time	Usually	Always	Always
9. Does it appear to you that this person enjoys performing the behaviour? (It feels, tastes, looks, smells and/or sounds pleasing)	0	1	2	3	4	5	6
10. Does this person seem to do the behaviour to upset or annoy you when you are trying to get them to do what you ask?	0	1	2	3	4	5	6
11. Does this person seem to do the behaviour to upset or annoy you when you are not paying attention to them? (For example, if you are sitting in a separate room, interacting with another person)	0	1	2	3	4	5	6
12. Does the behaviour stop occurring shortly after you give this person the toy, food or activity he has requested?	0	1	2	3	4	5	6
13. When the behaviour is occurring does this person seem calm and unaware of anything else going on around him or her?	0	1	2	3	4	5	6
14. Does the behaviour stop occurring shortly after (one to five minutes) you stop working or making demands of this person?	0	1	2	3	4	5	6
15. Does this person seem to do the behaviour to get you to spend some time with them	0	1	2	3	4	5	6
16. Does the behaviour seem to occur when this person has been told that he or she can't do something they wanted to do	0	1	2	3	4	5	6

	Sensory	Escape	Attention	Tangible
	1	2	3	4 ....
	5	6	7	8 ....
	9	10	11	12 ....
	13	14	15	16 ....
Total Score =	....	....	....	....
Mean Score =	....	....	....	....
Relative Ranking	....	....	....	....

Appendix C

Sensory Modality Assessment

Sensory Modality Assessment

Activity	**Perceived modality**
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Score: 1 point per presentation. Highest points = hypothesized sensory modality

Modality	**Total points**
Light/Visual	
Sound/Auditory	
Taste	
Temperature	
Smell	
Pressure/Tactile/Touch	

Appendix D

Data Sheet

RIRD with FMS/NMS Data Sheet

Name/Number	Intervention phase	Duration of interval	Topography of motor stereotypy	Duration of engagement in MS	Other bxs present during interval

Appendix E

Interobserver Agreement

Interobserver Agreement (IOA)

DOE = Duration of engagement

	Subject 1 Researcher 1	Subject 1 Researcher 2	IOA % Agreement	Subject 2 Researcher 1	Subject 2 Researcher 2	IOA % Agreement	Subject 3 Researcher 1	Subject 3 Researcher 2	IOA % Agreement
A DOE									
B DOE									
A DOE									
C DOE									
A DOE									
B DOE									
A DOE									
C DOE									
Total DOE									
Total IOA % Agreement									

Appendix F

Treatment Fidelity Checklist

Treatment Fidelity Checklist (A-B-A-C-A-B-A-C)

1. ☐ Enrich environment with FMS and NMS stimuli.
2. ☐ Start timer for 2 mins (Baseline A)
3. ☐ Use stopwatch to record duration of engagement in motor stereotypy.
4. ☐ When 2 min timer ends, document total duration of engagement in motor stereotypy.
5. ☐ Remove NMS stimuli from the environment.
6. ☐ Start timer for 2 mins (Intervention B RIRD w/FMS).
7. ☐ Use RIRD and replace motor stereotypy with FMS.
8. ☐ Record duration of engagement in motor stereotypy
9. ☐ Enrich environment with FMS and NMS stimuli.
10. ☐ Start timer for 2 mins (Baseline A).
11. ☐ Use stopwatch to record duration of engagement in motor stereotypy.
12. ☐ When 2 min timer ends, document total duration of engagement in motor stereotypy.
13. ☐ Remove FMS stimuli from the environment.
14. ☐ Start timer for 2 mins (Intervention C RIRD w/NMS).
15. ☐ Use RIRD and replace motor stereotypy with NMS.
16. ☐ Record duration of engagement in motor stereotypy.
17. ☐ Enrich environment with FMS and NMS stimuli.
18. ☐ Start timer for 2 mins (Baseline A).
19. ☐ Use stopwatch to record duration of engagement in motor stereotypy.
20. ☐ When 2 min timer ends, document total duration of engagement in motor stereotypy.
21. ☐ Remove NMS stimuli from the environment.
22. ☐ Start timer for 2 mins (Intervention B RIRD w/FMS).

23. ☐ Use RIRD to replace motor stereotypy with FMS.
24. ☐ Record duration of engagement in motor stereotypy.
25. ☐ Enrich environment with FMS and NMS stimuli.
26. ☐ Start timer for 2 mins (Baseline A).
27. ☐ Use stopwatch to record duration of engagement in motor stereotypy.
28. ☐ When 2 min timer ends, document total duration of engagement in motor stereotypy.
29. ☐ Remove FMS stimuli from the environment.
30. ☐ Start timer for 2 mins (Intervention C RIRD w/NMS).
31. ☐ Use RIRD to replace motor stereotypy with NMS.
32. ☐ Record duration of engagement in motor stereotypy.
33. ☐ Enrich environment with FMS and NMS stimuli.

Appendix G

Behavior Intervention Rating Scale

Behavior Intervention Rating Scale
BIRS

You have just read about a child with a classroom problem and a description of an intetvention for improving the problem. Please evaluate the intervention by circling the number which best describes your agreement or disagreement with each statement. You must answer each question.

		Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree
1.	This would be an acceptable intervention for the child's problem behavior.	1	2	3	4	5
2.	Most teachers would lind this intervention appropriate for behavior problems in addition to the one described.	1	2	3	4	5
3.	The intervention should prove effective in changing the child's problem behavior.	1	2	3	4	5
4.	I would suggest the use of this intervention to other teachers.	1	2	3	4	5
5.	The child's behavior problem is severe enough to warrant use of this intervention.	1	2	3	4	5
6.	Most teachers would find this intervention suitable for the behavior problem described.	1	2	3	4	5
7.	I would be willing to use this in the classroom setting.	1	2	3	4	5
8.	The intervention would not result in negative side-effects for the child.	1	2	3	4	5
9.	The intervention would be appropriate intervention for a variety of children.	1	2	3	4	5
10.	The intervention is consistent with those I have used in classroom settings.	1	2	3	4	5
11.	The intervention was a fair way to handle the child's problem behavior.	1	2	3	4	5
12.	The intervention is reasonable for the behavior problem described.	1	2	3	4	5
13.	I like the procedures used in the intervention.	1	2	3	4	5
14.	This intervention was a good way to handle this child's behavior problem.	1	2	3	4	5
15.	Overall, the intervention would be beneficial for the child.	1	2	3	4	5
16.	The intervention would quickly improve the child's behavior.	1	2	3	4	5
17.	The intervention would produce a lasting improvement in the child's behavior.	1	2	3	4	5
18.	The intervention would improve the child's behavior to the point that it would not noticeably deviate from other classmates' behavior.	1	2	3	4	5
19.	Soon after using the intervention, the teacher would notice a positive change in the problem behavior.	1	2	3	4	5
20.	The child's behavior will remain at an improved level even after the intervention is discontinued.	1	2	3	4	5
21.	Using the intervention should not only improve the chid's behavior in the classroom, but also in other settings (e.g., other classrooms, home).	1	2	3	4	5
22.	When comparing this child with a well-behaved peer before and after use of the intervention, the child's and the peer's behavior would be more alike after using the intervention.	1	2	3	4	5
23.	The intervention should produce enough improvement in the child's behavior so the behavior no longer is a problem in the classroom.	1	2	3	4	5
24.	Other behaviors related to the problem behavior also are likely to be improved by the intervention.	1	2	3	4	5