THE EFFECTS OF NONCONTINGENT REINFORCEMENT AND RESPONSE INTERRUPTION ON STEREOTYPIC BEHAVIOR MAINTAINED BY AUTOMATIC REINFORCEMENT

by

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Abstract

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Automatically reinforced, stereotypic behaviors are frequently observed in children with autism. Because they are self reinforcing, these behaviors are often difficult to treat. The current study investigated the effects of noncontingent reinforcement using matched sensory stimuli on a fixed-time schedule and response interruption of stereotypic behavior, both in isolation and in combination, on the rates of stereotypic behavior. Four preschool-age students with autism served as participants. A single subject reversal design was used. Rates of appropriate object engagement under these three treatment conditions were also assessed. Functional analysis data is presented showing target behaviors to be automatic in function. Results showed a decrease in stereotypic behavior from baseline within the response interruption and combined treatment phases, however, decreased responding was not achieved when noncontingent reinforcement was implemented in isolation. Substantial increases in appropriate object engagement were not obtained in any treatment phase. Results are discussed in terms of treatment implications, applied behavioral theory and the impact on the field of school psychology.

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Table of Contents

List of Graphs

CHAPTER I

Introduction

Autistic disorder is a life-long, disability characterized by gross deficits in social interaction, communication, and behavior (American Psychiatric Association, 1994). The symptoms of this disorder appear before age 3. According to the American Psychiatric Association (APA), children with autism display "a range of behavioral symptoms, including hyperactivity, short attention span, impulsivity, aggressiveness, self-injurious behaviors, and …temper tantrums" (1994, p. 67). In addition to this, approximately 75% of children with autism have comorbid mental retardation (APA). A study by Filipek and colleagues (2000) found that this debilitating disorder affects 1 in 500 children, and more recent information indicates that approximately 6 children in 1000 births develop autism (Centers for Disease Control (CDC), 2007).

Because of the life-long duration of autism and the debilitating nature of its symptoms, the cost of providing needed services to these individuals can be quite high. Early intervention, however, can reduce these costs substantially (Jacobson, Mulick, & Green, 1998). In a review of the effectiveness of early intervention studies, Ramey and Ramey (1998) concluded that some intervention gains for children as young as age 3 are maintained into adulthood. There is also evidence that early intervention can produce lasting changes in brain functioning associated with behavioral improvements (Shore, 1997).

School psychologists are frequently involved in providing or supervising intensive interventions using applied behavior analysis (ABA) for children with autism or those at risk for developing the disorder. Ramey and Ramey's review indicated that the

most effective behavioral interventions for autism are intensive, long in duration, and delivered directly to children. Lovaas (1987) conducted one of the earlier and most comprehensive ABA intervention studies. Nine of 19 children with autism who received intensive behavioral treatment for at least two years before the age of four demonstrated cognitive and language scores within normal ranges by age six or seven and were able to complete first grade without receiving special services (Leaf & McEachin, 1999). Children with autism in control groups receiving community treatment or just a few hours of behavioral intervention per week demonstrated few gains. A follow-up of the children who made the most gains as a result of intensive treatment showed that these youth functioned normally in adolescence (McEachin, Smith, & Lovaas, 1993).

Other studies using behavioral interventions with children with autism (i.e., Anderson, Avery, DiPietro, Edwards, & Christian, 1987; Birnbrauer & Leach, 1993; Green, 1996, Smith, Groen, & Wynne, 2000) have not achieved the same degree of success as Lovaas did. In general, however, "published studies offer compelling evidence that many children with autism who received early intensive behavioral analytic treatment made substantial gains" (Howard, Sparkman, Cohen, Green, & Stanislaw, 2005, p. 362). The present study was an attempt to determine the superior ABA method to use to reduce stereotypic behaviors in young children with autism. Automatically reinforced, stereotypic behaviors are often observed at a high frequency in children diagnosed with autistic disorder (Charlop, Kurtz, & Greenberg Casey, 1990). A behavior that is maintained by automatic reinforcement occurs independent of variables in the social environment (Wilder & Carr, 1998). When this sort of automatic reinforcement is responsible for maintaining a challenging behavior, treatment strategies are difficult

because the specific maintaining variable of the behavior is unknown or unable to be directly manipulated (Thompson, Fisher, Piazza & Kuhn, 1998).

One treatment strategy that has shown effectiveness in reducing challenging behavior maintained by automatic reinforcement is providing access to preferred stimuli on a noncontingent basis (Britton, Carr, Landaburu, & Romick, 2002). A noncontingent reinforcement (NCR) schedule consists of providing access to reinforcement on a response-independent, fixed time schedule (Tucker, & Sigafoos, 1998). Boe (1977, as cited in Carr, Coriaty, Wilder, Gaunt, Dozier, Britton et al. 2000) was the first published report of using a NCR schedule to treat challenging behavior. In his study, Boe used a variable time delivery of preferred food to reduce aggression in a group of women diagnosed with mental retardation. Since then, NCR schedules have been used to successfully treat challenging behavior maintained by access to preferred tangibles (Vollmer, Ringdahl, Roane, & Marcus, 1997), escape from instructional demands (Kahng, Iwata, DeLeon, & Worsdell, 1997), and automatic reinforcement (Luiselli, 1994; Roscoe, Iwata, & Goh, 1998).

Response interruption is another treatment strategy that has been shown to be effective in treating automatically reinforced stereotypic behavior (Hagopian & Adelinis, 2001). Lalli, Livezey, and Kates (1996) reduced automatically reinforced eye poking in a four-year-old girl with developmental disabilities through the continuous blocking of eye poke attempts. Once reduced to near zero rates, physical blocking was successfully faded.

Carr, Dozier, Patel, Adams, and Martin (2002) investigated the isolated and combined effects of NCR and response interruption on the automatically reinforced object mouthing of a seven-year-old girl with autism. Results indicated that response

blocking in isolation was successful in reducing object mouthing; however, attempts at object mouthing were unaffected. NCR in isolation was also successful in reducing object mouthing; however, rates of behavior returned to baseline levels when an attempt was made to thin the schedule. During the combined intervention phase, object mouthing was successfully reduced to near zero levels and NCR was able to be thinned to 300-seconds while maintaining the behavioral reduction. The authors, however, cited a methodological flaw in their design that warrants a cautious interpretation of the data. Specifically, the ABACABC reversal design did not allow for an experimental test of the effects of the combined intervention that they employed in the last phase of the study.

The current study further investigated the effects of NCR and response interruption in the treatment of automatically reinforced challenging behavior in children with autism. In order to address the design flaw in the Carr et al. (2002) study, the current study used a reversal design where the combined procedure was also reversed back to baseline. Also, the current study was an improvement over Carr et al. (2002) by replicating the treatments across four participants.

The study used a single subject reversal design across four participants. All participants were enrolled in a special education preschool for children with autism. All participants met the DSM-IV diagnostic criteria for Autistic Disorder and engaged in stereotypic behavior throughout the day. Results of brief functional analyses indicated that the behaviors were maintained by automatic reinforcement. Treatment conditions were presented in an ABACADA(D/C/B) format, independently for all four participants. A phases represented baseline conditions. B phases represented response interruption. C phases represented NCR and D represented the combined condition, NCR with response

interruption. The independent variable in the study was the intervention used (response interruption, NCR or their combination). The first dependent variable was percent of 10-second intervals engaged in stereotypic behavior within treatment sessions. The second dependent variable was percent of 10-second intervals engage in appropriate play with objects within treatment sessions. All sessions were conducted during free-play activities either in a separate cubby within the participants' classroom or in the play center of the classroom.

In total, the study contained nine phases for each participant. In phase 1, the maintaining reinforcer behind the stereotypic behavior was assessed through the use of a brief functional analysis. In phase 2, baseline data were collected. Baseline data consisted of 10-second interval recording of stereotypic behavior free of any social contingencies. In phase 3, response interruption was implemented. Each episode of stereotypic behavior was physically interrupted by the investigator within two seconds of onset. In phase 4, the participant was returned to baseline. In phase 5, NCR was implemented. NCR consisted of fixed–time delivery of a matched stimulus to the stereotypic behavior. There were no social consequences for engagement in stereotypic behavior. In phase 6, the participant was returned to baseline. In phase 7, response interruption was implemented in combination with NCR. In phase 8, the participant was once again returned to baseline. The study ended with phase 9, which was a return to the most effective treatment for each participant.

Throughout each phase, data were collected on engagement in stereotypic behavior and appropriate play with objects within 10-second intervals. Interobserver agreement data were collected for a percentage of sessions.

Literature Review

What follows is a detailed literature review of topics associated with the current study. The review begins with a discussion of diagnostic criteria, epidemiology, and associated characteristics of autism. Next, there is a literature review of the nature of stereotypic behavior. Following that, I present a brief review of applied behavior analysis. Although an in depth review of applied behavior analysis is not possible within the scope of the current literature review, I provide general definitions along with a brief historical review and research support for applying ABA procedures with children with autism. The literature review then becomes more focused on the current research question, describing the research findings using noncontingent reinforcement and/or response interruption for treating challenging behaviors, specifically those that are maintained by automatic reinforcement.

Autism

According to the *Diagnostic and Statistical Manual of Mental Disorders Fourth Edition* (DSM-IV; American Psychiatric Association, APA, 1994), autism is a life-long, pervasive developmental disability characterized by deficits in communication, socialization, and behavior. Although the etiology of autism is yet unknown, research indicates that it is most likely a neurological disorder with some form of environmental determinant (Lawler, Croen, Grether, & Van de Water, 2004). Diagnosis is usually made around the age of 18-24 months through behavioral observation including an assessment of spoken language and social skills (Lovaas, 2003). Prevalence rates indicate that approximately 6 children in 1000 births are diagnosable somewhere on the autism spectrum (Lawler et al., 2004; CDC, 2007).

In the DSM-IV, autism falls under the diagnostic category of Pervasive Developmental Disorders. A pervasive developmental disorder is a disorder that occurs before the age of 21, has no known cure, and affects a range of life skills including communication, socialization, and behaviors. Under the heading of pervasive developmental disorders are five separate, yet related, conditions. These conditions include Autistic Disorder, Asperger's Disorder, Childhood Disintegrative Disorder, Rett's Syndrome, and Pervasive Developmental Disorder NOS. Autism is the most classic display of the Pervasive Developmental Disorders and is described in detail below. Individuals diagnosed with Asperger's Disorder show similar characteristics to those found in autism, however verbal speech is age appropriate and cognitive skills are often intact. Deficits lie in the social and behavioral areas (DSM-IV; American Psychiatric Association, APA, 1994). Childhood Disintegrative Disorder is a rare condition in which a child shows typical development for the first 3 years of life and then begins to display autistic characteristics after three. Degeneration can be rapid and can occur relatively late in development (sometimes up until age 8) (DSM-IV; American Psychiatric Association, APA, 1994). Rett's disorder is almost exclusively diagnosed in females and is the only pervasive developmental disorder with physical symptoms including motor degeneration, muscle rigidity, eventual inability to self ambulate and loss of swallowing. These symptoms are displayed as well as the more classic deficits seen in autism (social deficits, lack of communication and stereotypic behaviors) (DSM-IV; American Psychiatric Association, APA, 1994). When an individual meets some criteria for a Pervasive Developmental Disorder, but does not meet all the necessary criteria for

any one disorder, Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) is diagnosed (DSM-IV; American Psychiatric Association, APA, 1994).

Specific criteria for a diagnosis of autism, as listed in the DSM-IV, are broken down into three areas of deficit. The first area of deficit is in social interaction. Children with autism show impairments in social nonverbal behaviors such as eye-to-eye gaze, facial expressions, and social body postures. They often fail to develop age-appropriate peer relationships. Social interaction deficits also include disturbances in social/emotional reciprocity, sharing enjoyment with others, and social referencing of emotions.

The second area of deficit involves communication. Specifically, there is often a significant delay in, or total lack of, the development of spoken language without compensation through forms of nonverbal communication (i.e., sign language, pointing). In individuals that do develop language, the use of language is often not conversational or is limited to stereotyped, repetitive phrases. Speech is also not used to engage in make-believe or social play.

The third area of deficit includes age appropriate behaviors. Specifically, children with autism often engage in stereotyped, repetitive, nonfunctional patterns of behavior. They often have excessive preoccupations with parts of objects or highly restricted patterns of interest. Individuals with autism often display adherence to nonfunctional and inflexible routines. These individuals also exhibit stereotyped, nonfunctional, and repetitive motor mannerisms (i.e., hand flapping, body rocking).

In addition to the aforementioned diagnostic criteria, individuals with autism also show a range of additional behavioral deficits and excesses (Lovaas, 2003). Besides deficits in spoken language, researchers note significant deficits in receptive language

(Lund, 2004; Pelios, 2004). It is reported that children with autism have difficulties in maintaining attention, especially in maintaining focus on pertinent stimuli in the environment (Bradley & Isaacs, 2006; Gadow, DeVincent, & Pomeroy, 2006). This attention deficit may be related to an inability to filter out irrelevant stimuli and sensations in the environment (Lovaas, 2003). Emotional deficits are also apparent. Specifically, children with autism have been found to have less coherent representations of emotional encounters than typically developing children and use "non-emotional" strategies for interpreting emotional situations in others (Losh & Capps, 2006). Close emotional relationships with parents and other caregivers are not clearly apparent in many cases (Lovaas, 2003).

In the area of socialization, children with autism often display toy play that is age inappropriate, idiosyncratic, and nonfunctional (Lovaas, 2003). They seem to have a lack of motivation to engage with toys unless the toy provides immediate sensory feedback (Hine & Wolery, 2006). Where toy play is appropriate, children with autism show a lack of ability to engage in pretend play (Hine et al., 2006). Children with autism show deficits in imitation and modeling of the behaviors of others (Williams, Whiten, & Singh, 2004). This lack of imitation leads to disruptions in socialization as well as in learning. In many, but not all, cases children with autism engage in challenging behaviors such as tantrums, aggression, and self injury. These behaviors are not part of the diagnostic criteria of the disorder, but rather are a direct result of environmental variables and a lack of effective communication (Koegal, Koegal, & Dunlap, 1996). Challenging behaviors lead to a lack of appropriate socialization, learning, and community integration (Lovaas, 2003).

Stereotypic behavior. Children with autism often display stereotypic movements that are characterized by their repetitive, seemingly driven, and nonfunctional nature. Common stereotypic movements include, but are not limited to, hand waving, body rocking, finger play, skin picking, and object twirling (DSM-IV; APA, 1994). Individuals with diagnoses such as mental retardation, autism, hearing impairment and blindness display higher than typical rates of stereotypic behavior (Willemsen-Swinkels, Buitelaar, Dekker, & van Engeland, 1998). This frequent engagement in stereotypic movements by children with autism has been a focus of treatment because it hampers child development. Previous research has shown that stereotypic behavior can interfere with auditory processing, spontaneous appropriate play, discrimination learning, and appropriate social behavior. At a high intensity and frequency, some forms of stereotypic behavior, such as self biting or head banging, may result in self injury (Willemsen-Swinkels et al., 1998).

There are three primary theories of the etiology and maintenance of stereotypic behavior in individuals (Willemsen-Swinkels et al., 1998). The first is the homeostasis theory. According to this theory, engagement in stereotypic behavior compensates for under or over-stimulating environments thereby maintaining the individual in a state of sensory homeostasis or balance. The second theory involves operant conditioning. According to this theory, stereotypy is maintained by internal reinforcement in the form of positive or negative reinforcement. The third theory postulates that stereotypic behavior serves no function for the individual but is a direct result of a pathological condition involving the nervous system. Research suggests that stereotypic behavior in humans may serve multiple functions depending on the individual and the environment (Willemsen-Swinkels et al., 1998). Rapp and Vollmer (2005), in their review of the

stereotypy literature, also found that there is no clear etiology of stereotypic behavior in humans. Stereotypic behavior seems to be maintained by a variety of operant and/or biological factors. Regardless of etiology, research supports the use of behavioral methods, including environmental enrichment and differential reinforcement, in the treatment of stereotypy (Rapp & Vollmer, 2005).

DSM-IV (APA, 1994) lists engagement in stereotypic movements as one of the diagnostic criteria for autistic disorder. With regard to autism, examples of stereotypic behavior include hand clapping, finger flicking, body rocking, body swaying, toe walking, and repetitive object manipulation (APA, 1994). Stereotypic behavior in this population is usually maintained via automatic or internal reinforcement through the sensory stimulation that it provides (Leaf & McEachin, 1999). With automatically reinforced behavior, the behavior itself provides the desired reinforcer irrespective of the actions of others in the environment. This is in contrast to socially reinforced behaviors that require the actions of others to provide the reinforcer (Alberto & Troutman, 2003). Examples of behaviors with a social function include aggression to escape task demands, screaming to get attention, and talking to request cookies. With regard to stereotypic behavior, the automatic reinforcer is likely to be the sensory input that is produced by engagement in the stereotypy. According to Charlop, Kurtz, and Greenberg (1990) sensory reinforcers provided by stereotypic behaviors may be considered primary reinforcers because they serve as some sort of internal stimulation. When this sort of automatic reinforcement is responsible for maintaining problem behavior, treatment strategies are difficult to determine because the specific maintaining variable of the

behavior is unknown or unable to be directly manipulated (Thompson, Fisher, Piazza, & Kuhn, 1998).

Applied behavior analysis. Applied behavior analysis (ABA) is one philosophy that has been used in the treatment of stereotypic behavior. According to Cooper, Heron, and Heward (1987) ABA is defined as, "…the science in which procedures derived from the principles of behavior are systematically applied to improve socially significant behavior to a meaningful degree and to demonstrate experimentally that the procedures employed were responsible for the improvement in behavior" (p. 14).

ABA is rooted in the behavioral theories of researchers such as B.F. Skinner and J.B. Watson. The basic tenet of ABA is that all behavior, both adaptive and problematic, is acquired through the encountering of consequences to behavior (Cooper et al., 1987). Simply stated, behavior that is followed by desired consequences (whatever they may be) will increase in frequency. Likewise, behavior that is followed by undesired consequences will decrease in frequency (Alberto & Troutman, 2003). It is through these principles that we learn to engage in some behaviors and learn to not engage in others.

Due to the deficits characteristic of a diagnosis of autism, children with autism do not learn in the same way that typical children learn (Leaf & McEachin, 1999). According to Janzen (1996), children with autism often focus on small details of a situation rather than on the whole. Therefore, information often has to be introduced in discrete steps and then combined systematically. Information is also often stored as short units of information rather than as interconnected ideas (Janzen, 1996). Children with autism also have difficulty filtering out irrelevant information and background noise. Instruction must be clear and free of distraction (Janzen, 1996). Other atypicalities in

learning style include an inability to understand nonliteral language, the storage of visual information without meaning, abnormalities in auditory processing, an inability to modulate sensory stimulation and deficits in expressive language (Janzen, 1996). Although there is no "cure" for autism, a teaching approach based upon the principles of ABA is currently recognized as the most effective, experimentally tested treatment for individuals with autism (Green, 1999).

According to Lovaas (2003), the methods of ABA are useful for individuals with autism for four main reasons. First, research indicates that the behaviors of children with autism can be accounted for by traditional laws of learning. Second, children with autism show many separate behavioral deficits rather than one main deficit as is seen with other disorders. When these behaviors are treated separately through ABA, broad-based changes in functioning can be noted. Third, repeated applied research has shown that children with autism can learn once a specialized learning environment is constructed for them. Finally, the diagnostic impression of autism is more consistent with theories of specific neurological impairments that can be modified by the environment rather than by medical theories of disease that require a "cure" (Lovaas, 2003).

Researchers have found that teaching procedures based on the theories and techniques of ABA are effective in the reduction of challenging behavior and the acquisition of appropriate behavior in children with autism (Leaf & McEachin, 1999). Some of the most compelling results have come from a series of studies conducted by Dr. Lovaas and his colleagues at UCLA in the late 1980s to early 1990s (Leaf & McEachin, 1999). These studies reported dramatic improvements in language, social skills, self help, play skills, and academics through intensive ABA therapy consisting of 40 hours per

week of structured 1:1 discrete trial teaching with a trained therapist. In fact, at the end of one study, researchers observed that 9 of 19 participants were indistinguishable from age-matched peers on measures of IQ, adaptive skills, and emotional functioning (Leaf & McEachin, 1999).

Although an in depth literature review of the research regarding ABA and autism is out of the scope of the current paper, Lovaas (2003) stated that over 40 years of applied research on ABA and developmental disabilities has yielded consistent favorable outcomes with regard to improvements in intellectual, emotional, social, and educational functioning in individuals with developmental disabilities.

Noncontingent reinforcement. Unlike contingent reinforcement, where a reinforcer is delivered contingent upon a target response, noncontingent reinforcement (NCR) schedules consist of response independent, fixed time delivery of stimuli with known reinforcing properties (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). The main idea of NCR schedules is that reinforcement is delivered irrespective of behavior. Unlike with differential reinforcement schedules, behavior during or at the end of target intervals does not influence the programming of reinforcement (Tucker & Sigafoos, 1998). Although the occurrence of target behaviors does not affect the rate of delivery of reinforcement, the reinforcer that is delivered is usually based on the underlying function of those responses (Carr et al., 2000). In other words, stereotypic behavior can be treated by initiating a noncontingent delivery of stimuli that are matched to the function of the stereotypic behavior.

Behavioral researchers began studying the effects of NCR schedules on responses in the 1960s. Basic research studies consistently found that response-independent

reinforcement schedules produced reductions in target responses (Carr et al., 2000). Boe (1977) was the first published report of using a NCR schedule to treat challenging behavior. In his study, Boe used a variable-time delivery of preferred food to reduce aggression in a group of women diagnosed with mental retardation. Soon thereafter, Thelen (1979) showed the effectiveness of the noncontingent delivery of attention in the reduction of aggressive tantrum behavior in an eight-year-old girl. Although neither of these two early applied works was function-based, they were instrumental in showing that NCR schedules could be used to treat challenging behavior.

With the advancement in functional analysis technology in the early 1990s, researchers were able to show that in order to be optimally effective, the stimuli presented noncontingently should match the maintaining function of the challenging behavior (Tucker et al., 1998). In other words, the treatment procedure must address the response-reinforcer relationship of the stereotypic behavior (Carr et al., 2000). For example, if a student is engaging in stereotypic behavior in order to escape task demands, an appropriate treatment using NCR would be to provide noncontingent reinforcement in the form of timed breaks from instruction. Likewise, if a student is engaging in stereotypic behavior in order to access teacher attention, NCR in the form of timed teacher attention would be delivered.

One of the first studies to use function-based NCR in the treatment of challenging behavior was Vollmer, Iwata, Zarcone, Smith, and Mazaleski (1993). The target behavior of interest was self-injury. After conducting a functional analysis, Vollmer et al. determined that self-injury was maintained by attention. Access to attention was then provided on a fixed-interval 10-second schedule. After achieving significant reductions in

self-injury, the schedule of NCR was systematically faded to a fixed-time 5-minute schedule while maintaining reductions in self injury.

Hagopian, Fisher, and Legacy (1994) replicated the findings of Vollmer et al. with quadruplets diagnosed with autism who engaged in attention maintained destructive behavior. In their study, Hagopian et al. first conducted functional analyses on the challenging behavior in order to discover the maintaining reinforcer. Data from the functional analyses indicated that destructive behavior was maintained in all four children by social attention. Treatment consisted of providing attention on a fixed-time schedule noncontingent of behavior. Two schedules of NCR were implemented, a dense schedule and a lean schedule. The dense schedule consisted of 10 seconds of social attention delivered every 10 seconds, or continuous attention. The lean schedule consisted of 10 seconds of social attention delivered once every 5 minutes. Hagopian et al. found that both schedules produced decreases in destructive behavior, with the dense schedule being the more effective at the onset of treatment. Over the course of treatment, the dense schedule was successfully faded to the rate of reinforcement used in the lean schedule.

Also with regard to behavior maintained by attention, Persel, Persel, Ashley, and Krych (1997) used a noncontingent schedule of social attention in the treatment of aggression and self-injury in a 40-year-old man with traumatic brain injury. Functional analysis data suggested that both topographies of behavior were maintained by social attention. NCR consisted of a fixed-time schedule of attention where attention was provided for 3 minutes every half-hour. Persel et al. found a significant decrease in both aggressive and self-injurious behavior.

Carr and Britton (1999) implemented a noncontingent schedule of attention to reduce attention maintained problematic speech in a 32-year-old male with moderate mental retardation. Problematic speech consisted of excessive talking about topics. After a baseline period, a schedule of noncontingent attention was initiated where the participant would receive 3-5 seconds of attention on a fixed-time schedule beginning at 10 seconds and thinning to 180 seconds. Although significant reductions in behavior were eventually obtained, the authors did not find the rapid reductions in behavior as were found in previous research, despite the initial dense schedule of reinforcement.

NCR has also been used to treat behavior maintained by escape from task demands. Kodak, Miltenberger, and Romaniuk (2003) used a noncontingent schedule of breaks in the reduction of disruptive behavior in two, 4-year-old boys with autism. Noncontingent breaks were first delivered continuously and then gradually faded to a 2-minute schedule. Significant decreases in behavior were obtained across both boys. In addition, compliance to task demands increased.

With regard to behavior maintained by automatic reinforcement, NCR consists of providing noncontingent access to an event or stimulus condition that produces a functionally similar consequence to the stereotypic behavior. Leisure items that are "matched" to the sensory input provided by the stereotypic behavior are often used. Studies have shown the effectiveness of noncontingent schedules of reinforcement with matched sensory items in treating a wide range of automatically reinforced behavior (Roscoe, Iwata, & Goe, 1998; Britton, Carr, Lindaburu, & Romick; 2002; Wilder, Draper, Williams, & Higbee, 1997).

Roscoe, Iwata, and Goh (1998) compared the effectiveness of NCR and sensory extinction in the treatment of automatically maintained self-injury in three participants. Sensory extinction is a treatment strategy whereby the individual is allowed to engage in the target behavior, yet the sensation produced by the behavior is blocked. Like all extinction-based strategies, sensory extinction works by breaking the contingency between the behavior and its naturally occurring reinforcer. In their study, Roscoe at al. implemented sensory extinction by using protective devices such as foam sleeves, boxing gloves, and latex gloves. NCR consisted of giving the participant continuous and free access to sensory items that had been shown to compete with self-injury. Protective devices were not used during the NCR treatment phase and self-injury was not blocked or redirected by the experimenter. Results indicated that both sensory extinction and NCR produced decreases in the target behavior; however, NCR resulted in more rapid and complete behavioral suppression. Other advantages of the NCR intervention were that it required less effort than sensory extinction, did not require the use of restrictive devices, and did not initially result in an extinction burst (i.e., increase) of the target behavior.

Britton, Carr, Landaburu, and Romick (2002) used noncontingent access to sensory-based items in the treatment of three participants who engaged in high rates of stereotypic behavior including head rocking, face rubbing, and repetitive hand movements. Through the use of a functional analysis, Britton et al. determined that the stereotypic behaviors were automatically maintained. The first step in the treatment protocol consisted of conducting individualized stimulus assessments to determine items that reliably competed with the participants' stereotypic behavior. NCR consisted of providing free and continuous access to those competing items. All three participants had

significant reductions in stereotypic behavior. Interestingly, Britton et al. found that participants only obtained reductions in stereotypic behavior when the experimenter prompted the participants to engage in the competing stimuli. They did not independently choose to engage with the items, and, therefore, resorted to stereotypic behavior when not prompted to engage competing items. The authors provided three possible explanations for this latter finding. First, there might have been a differential response effort favoring engagement in stereotypic behavior over the novel stimuli. Second, handing the items to the participants may have acted like a prompt to evoke interaction. Last, the participants may have had a long history of dependent behavior that resulted in overall prompt dependency.

Wilder, Draper, Williams, and Higbee (1997) investigated the effectiveness of three treatments for automatically reinforced rumination in an adult participant with mental retardation and blindness. The first treatment procedure consisted of differential reinforcement in the form of a shower reward after a period of time in the absence of rumination. The second treatment consisted of a decrease in liquid intake before, during, and directly after mealtimes. The third treatment consisted of NCR in the form of access to gelatin or pudding every 20 seconds for 30 minutes after each meal. Although no treatments produced a total elimination of rumination, the NCR treatment produced the most significant and longest duration results. The authors postulated that the effectiveness of the NCR intervention was most likely due to the satiation or oral stimulation that the high frequency access to snacks provided.

Since in an NCR schedule, a stimulus is provided on a fixed-time interval irrespective of behavior, why is it that treatments using NCR reliably result in decreases

in specific target behaviors? In fact, the noncontingent aspect of these schedules seems to be in contrast to traditional theories of stimulus-response-reinforcer relations. Along this line of thinking, Poling and Normand (1999) discussed the idea that NCR schedules do not actually deliver reinforcement at all, but rather they simply deliver access to preferred stimuli. More specifically, reinforcement refers to the process whereby the occurrence of a behavior is followed by a preferred stimulus change resulting in an increase in rate or occurrence of that behavior. In other words, by definition, reinforcement must involve a contingency between a behavior and a reinforcing stimulus. Also, the principle of reinforcement results in an increase in response rate. In contrast, NCR schedules, as traditionally used in the literature, do not involve a contingency between behavior and stimuli. Also, NCR schedules are used as behavior reduction strategies.

For these reasons, Poling and Normand (1999) stated that the term "noncontingent reinforcement" should not be used in the way it is currently being used. Instead, they suggest that researchers should simply refer to the process that they use by the category of stimuli being delivered noncontingently. For example, if you were delivering access to escape on a fixed-time schedule, the procedure would be called noncontingent escape. If, on the other hand, you were delivering attention on a fixed-time schedule, the procedure would be called noncontingent attention. In response to Poling and Normand (1999), Vollmer (1999) reiterated the issues surrounding the term NCR, however, he defended the use of the term on two bases. First, he brought to light the fact that other "reinforcement" procedures, such as differential reinforcement of other behavior (DRO), also do not meet the traditional definition of reinforcement but yet are accepted terms in the field. Second, he supported the use of the term NCR because it has lead to the

recognition of a general class of procedures to be used as treatment across various behavioral functions.

Regardless of the technicalities involved in the correct or incorrect usage of the term reinforcement, why is it that NCR schedules result in decreases in target behaviors? Carr et al. (2000) reviewed three main theories behind the processes that make NCR have a reductive effect on challenging behavior. First, as a result of satiation and environmental enrichment, the reinforcer's establishing operation is eliminated. Second, by disrupting the response-reinforcer relationship, the stereotypic behavior is reduced via extinction. Finally, the reinforcement of other responses increases responses that compete with the stereotypic behavior (Carr et al., 2000). I will now discuss each theory in greater detail.

According to Michael (1993),

> an establishing operation is an environmental event, operation, or stimulus condition that affects an organism by momentarily altering (a) the reinforcing effectiveness of other events and (b) the frequency of occurrence of that part of the organism's repertoire relevant to those events as consequences. (p. 58)

In other words, an establishing operation is an environmental or internal state that influences the momentary effectiveness of a specific reinforcer. The concept of the establishing operation is rooted in Skinner's concept of "third variables" that included conditioning, drive, and emotion (Klatt & Morris, 2001). In non-technical terms, an individual is more highly motivated to obtain a reward when he or she has been deprived of that reward for a period of time. It is the deprivation of the reward that defines the establishing operation.

Using a basic research example, when deprived of food for 48 hours, a rat will find access to food more reinforcing than it would under normal conditions. The rat, therefore, is highly motivated to engage in behaviors that will produce food (i.e., looking around the cage, smelling in and under objects). In addition, environmental stimuli previously associated with food (i.e., dishes, conditioned bars) become highly evocative. Using an applied example, when the temperature drops in a room, an individual will find access to heat more reinforcing than he or she would under normal conditions. The individual is, therefore, more highly motivated to engage in behaviors that will produce heat (i.e., putting on a coat or drinking coffee). In addition, environmental stimuli previously associated with heat (i.e., jackets on the wall, thermostat) become more evocative.

Problem behavior, such as self-injury or stereotypic behavior, may be maintained by the condition of an establishing operation and reinforcement. Specifically, when an individual is under the state of an establishing operation he or she is highly motivated to engage in behavior that will reduce the state of deprivation. Problem behavior that results in a decrease of the establishing operation will be reinforced and thereby increased in frequency. By reducing the state of deprivation through giving access to functionally matched stimuli on a denser schedule than normal, NCR schedules may preempt stereotypic behavior by reducing the establishing operation driving the behavior (Tucker et al., 1998). In other words, once the individual is no longer deprived of a given sensation, the need to seek that sensation through stereotypic behavior is eliminated.

The second theory is that of extinction. By definition, extinction refers to a behavior reduction procedure where the reinforcement of a previously reinforced

behavior is discontinued (Cooper et al., 1987). Extinction can be used to reduce any behavior that is being maintained by either positive or negative reinforcement that is either social or automatic in nature. In an extinction paradigm, once stereotypic behavior is no longer being reinforced, rates of the behavior will gradually decrease. With regard to automatically maintained behavior, it is the sensory experience gained from the behavior that is the functional reinforcer. In an NCR procedure, the original contingency (behavior → sensory reinforcer) is replaced with a fixed-time schedule of reinforcement regardless of behavior. Once the stimulus-reinforcer chain is broken, automatically reinforced behavior will decrease (Carr, 1996).

The final theory is that of differential reinforcement of alternative behavior (DRA). The theory states that reinforcement of alternative behaviors compete with the previously reinforced problem behavior. DRA is a reinforcement procedure whereby problem behavior is reduced by selectively reinforcing time spent on alternative, hypothetically more appropriate, behavior (Cooper et al., 1987). In an NCR procedure, reinforcement is delivered on a fixed-time schedule independent of behavior. It is, therefore, the case that a wide variety of behaviors would randomly be followed by reinforcement. Through increasing the rates of these alternative behaviors, participants will reduce the amount of time that they engage in the problem behavior (Carr, 1996).

There are several advantages associated with NCR interventions that make them preferable to other reinforcement or extinction-based strategies (Vollmer et al., 1993). First, extinction induced stereotypic behaviors are avoided. For example, if a child is receiving oral stimulation from sucking their thumb, they would be likely to seek out alternative means of stimulation (e.g. toy mouthing) if thumb sucking was blocked

without providing for a more appropriate means of gaining oral stimulation (e.g. noncontingent access to lollipops on a fixed-time schedule). Second, NCR schedules are easy to implement given that the individual's behavior does not have to be constantly monitored. With other treatment strategies such as DRO or response interruption, the individual needs to be under constant supervision in order to block responses on a continuous schedule or to deliver reinforcement for total absence of behavior. Finally, NCR schedules avoid conditions of deprivation that result from differential reinforcement schedules (Vollmer et al., 1993). For example, if an individual is engaging in high rates of stereotypic behavior, a DRO schedule, where the total absence of the target behavior is being reinforced, may set up a situation where success is difficult. With repeated failed reinforcement trials, the individual would not receive a reinforcer for an extended period of time, thereby creating a situation where the individual may feel deprived of stimulation.

Three often-cited disadvantages of NCR interventions are that: (a) appropriate behavior is not specifically reinforced, (b) alternate forms of challenging behavior may be inadvertently reinforced, and (c) the procedure may lose effectiveness due to long-term satiation. Marcus and Vollmer (1996) addressed the first disadvantage by implementing a functional communication training intervention simultaneously with the implementation of NCR in the treatment of tangibly maintained disruptive behavior. Specifically, participants were taught how to functionally request desired items while also receiving those desired items on a fixed-time schedule. Results showed a decrease in challenging behavior with a simultaneous increase in adaptive communication.

Addressing the inadvertent reinforcement of alternate forms of challenging behavior, Vollmer, Ringdahl, Roane, and Marcus (1997) superimposed a DRO schedule with a gradually fading hold period built into the NCR interval. In other words, a preferred tangible was delivered noncontingently unless participants displayed alternate challenging behaviors at the end of the fixed-time interval. Results showed a significant decrease in access maintained behavior without inadvertent increases in other forms of challenging behavior.

With regard to the loss of effectiveness of NCR interventions over time due to satiation, DeLeon, Anders, Rodriguez-Catter, and Neidert (2000) showed that satiation can be effectively avoided by rotating sets of possible preferences within the NCR schedule.

Response interruption. Response interruption (RI) is another treatment strategy that has been shown to be effective in treating automatically reinforced stereotypic behavior. RI consists of physically preventing the individual from engaging in the stereotypic behavior, thereby blocking the reinforcing sensation that is maintaining the behavior. Response interruption is either implemented through the use of manual guidance or by the use of an external apparatus, such as eye goggles, to interrupt eye poking.

Lalli, Livezey, and Kates (1996) reduced automatically reinforced eye poking in a 4-year-old girl with developmental disabilities through the continuous blocking of eye poke attempts. Once they had reduced eye pokes to near zero rates, the experimenters faded physical blocking to the participant's wearing protective eye goggles and ultimately to wearing typical eyeglasses. Not only was eye poking reduced in the

presence of the experimenters, but also with only the use of typical eyeglasses, the girl reduced eye poke attempts to one per hour.

McEntee, Parker, Brown, and Poulson (1996) investigated the combined effects of DRO and RI on stereotypic hand mouthing in a 66-year-old male with severe mental retardation. Although DRO procedures have been shown to be unsuccessful in the treatment of long-standing and severe hand mouthing when used in isolation (McEntree et al., 1996), the authors obtained significant reductions in behavior when DRO was combined with continuous RI. Similarly, Rapp et al. (2000) successfully reduced automatically maintained hair pulling in a 19-year-old female with mental retardation through a combination of RI and DRO.

Lerman, Kelley, Vorndran, and Van Camp (2003) investigated the effects of RI and environmental enrichment on stereotypic head and tooth tapping in an 18-year-old student with autism and mental retardation. RI consisted of manually guiding the student's hands to her lap after the first episode of head or tooth tapping. Environmental enrichment consisted of increasing the availability of preferred leisure items in the testing environment. The investigators tested four treatment conditions: RI in isolation, environmental enrichment in isolation, RI combined with environmental enrichment, and RI combined with prompted toy play. Results indicated that environmental enrichment in the absence of RI did not lead to reductions in stereotypic behavior. Although RI in isolation and RI with environmental enrichment produced significant reductions in behavior, appropriate item engagement also decreased. In addition, the authors observed that the participant engaged in a new stereotypic behavior during these conditions, hand wringing. They only obtained successful reductions in head and tooth tapping without the

negative side effect of hand wringing when they combined RI with prompted redirection to toy play following the blocking of head and tooth tapping responses.

There are two primary theories to explain why RI is an effective behavior reduction strategy for automatically maintained behaviors (Lerman & Iwata, 1996). One theory is that RI is a form of punishment. The second theory is that RI is a form of sensory extinction.

Punishment is a procedure whereby a behavior is followed by a nonpreferred stimulus that serves to decrease future occurrences of that behavior (Alberto et al., 2003). According to the punishment theory of RI, the stereotypic behavior that was once followed by a positive reinforcer (i.e., sensory stimulation in the case of an automatically reinforced behavior) is now being followed by a physical interruption of the completion of the stereotypic response. It is the physical contact associated with the procedure that may function as a punishing stimulus (Lerman & Iwata, 1996).

Extinction refers to a behavior reduction procedure where the reinforcement of a previously reinforced behavior is discontinued (Cooper et al., 1987). According to an extinction explanation, RI prevents the automatically reinforced behavior from producing the desired sensory input that was originally maintaining the behavior. The automatically reinforced stereotypic behavior is reduced in rate since it is no longer being reinforced. It is the disruption of the response-reinforcer relationship that serves to extinguish the problem behavior.

According to Lalli et al. (1996), RI differs procedurally from a true sensory extinction intervention because the response cycle is interrupted before sensory reinforcers are possible. In true sensory extinction, the response cycle would continue

uninterrupted, however the sensation produced by the response would be blocked, or interrupted. The response itself, however, would not be blocked. For example, the response cycle of eye poking consists of lifting the hand and poking a finger in an eye. The reinforcer consists of the neurological sensations produced when the finger hits the eyeball. Sensory extinction, by definition, would consist of allowing the finger to hit the eyeball but preventing the response from producing the neurological sensations. Over time, the interruption of the response-reinforcer relationship would lead to decreases in the entire response cycle. In an RI procedure, however, the response cycle is interrupted before the individual gets a chance to poke a finger in his or her eyeball. The person, therefore, never gets to test the contingencies under a sensory extinction condition. Reductions in behavior can, therefore, never be attributable to extinction and are more likely a function of punishment (Lalli et al., 1996).

Lerman and Iwata (1996) were effective in reducing stereotypic hand mouthing in a 32-year-old man with profound mental retardation through continuous blocking (RI) of hand mouthing attempts. According to the authors, rates of responding during the RI condition were consistent with a punishment hypothesis. Specifically, rates of behavior decreased as a greater percentage of hand mouthing responses were blocked. In an extinction paradigm, rates of behavior would not decrease under an intermittent schedule of reinforcement and blocking. Instead, the behavior may have actually become more resistant to extinction as treatment continued.

In contrast to Lerman et al. (1996), Smith, Russo, and Le (1999) obtained a data pattern indicative of a sensory extinction hypothesis when they used RI to treat automatically maintained eye poking. Continuous blocking of eye poking initially

produced a burst in eye poke attempts followed by a gradual reduction to zero rates of behavior. This burst-fade data pattern is what would be expected when using an extinction procedure. Once rates of behavior were maintained at zero, the authors were able to successfully fade the RI procedure.

Whether response interruption is effective due to sensory extinction or punishment, one possible side effect of the procedure is extinction-induced or punishment-induced aggression. In extinction-induced aggression, an individual may display aggressive behavior in an effort to contact a reinforcer that was once available for a previous behavior and is now being contingently withheld. Studies of extinction in humans found aggression to result in nearly 50% of cases in which a behavior was being treated solely through extinction (Pear & Martin, 2002). An example of extinction-induced aggression would be a child hitting another student when a teacher is denying him juice that he is asking for. In punishment-induced aggression, the individual may display aggressive behavior towards another individual after receiving a punisher. The individual who is the target of the aggression may or may not be the individual who delivered the punishment. Punishment-induced aggression has been found in studies with both animals and humans (Pear & Martin, 2002). In addition, RI may lead to an increase in alternative undesirable behaviors as the individual attempts to seek reinforcement through other means (Lerman et al., 2003). Hagopian and Adelinis (2001) encountered an increase in aggression when they attempted to use an RI procedure to treat pica in a 26-year-old man with mental retardation. They successfully reduced his aggression, along with pica attempts, by adding a redirection to alternate edible items into the RI procedure.

Although researchers have shown continuous RI to be effective in the reduction of problem behavior maintained by automatic reinforcement, it is a highly labor intensive procedure. The individual being treated needs continuous monitoring in order for the experimenter to successfully block or interrupt each attempt at the target behavior. In an attempt to reduce the experimenter labor that RI requires, Tarbox, Wallace, and Tarbox (2002) treated stereotypic object mouthing in a 4-year-old boy with autism through the implementation of an intermittent schedule of RI. They hypothesized that an intermittent RI schedule would be easier to implement than a continuous schedule and might perhaps be equally effective. Tarbox et al. found, however, that intermittent RI was ineffective in reducing rates of problem behavior.

NCR combined with RI. Since both RI and NCR have been shown to reduce the occurrence of stereotypic behavior, would combining these two treatments lead to more effective or more rapid behavior reduction? Some researchers have investigated the combined effects of NCR and RI in the treatment of automatically reinforced challenging behavior. Thompson et al. (1998) investigated the separate and combined effects of NCR and RI on automatically reinforced chin grinding in a 7-year-old boy with severe mental retardation and Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS; APA, 1994). NCR consisted of the delivery of chin stimulation using a vibrating toy on a 30-second schedule. The therapist also delivered vibratory chin stimulation whenever the child appropriately requested the vibrating toy. In the RI condition, the therapist blocked chin grinding on other people on a continuous schedule. Results indicated that the percentage of chin grinding was substantially lower when NCR was combined with RI than when either intervention was delivered in isolation.

Fisher, Lindauer, Alterson, and Thompson (1998) initially investigated the effects of NCR on automatically maintained stereotypy and object destruction of two boys diagnosed with mental retardation and autism. NCR access to toys that were matched to the sensory input produced by the problem behavior was used for the intervention. Results indicated a significant reduction in behavior for only one participant. For the other participant, rates of behavior only decreased when NCR was combined with RI and redirection to the matched toys. It is interesting to note that an increase in appropriate toy play was also observed in participant number two when RI and redirection were added to the treatment.

Carr, Dozier, Patel, Adams, and Martin (2002) investigated the isolated and combined effects of NCR and RI on the automatically reinforced object mouthing of a 7-year-old girl with autism. RI consisted of physically blocking each attempt at object mouthing. NCR consisted of a fixed-time delivery of a "matched" stimulus (vibrating toy that the child placed on her mouth). The combined condition consisted of RI on a fixed ratio 2 schedule and NCR to the matched stimulus on a fixed-time schedule beginning at 30-seconds and faded to 300-seconds. RI in isolation successfully reduced object mouthing; however, RI did not affect attempts at object mouthing. NCR in isolation also successfully reduced object mouthing; however, rates of object mouthing returned to baseline levels when an attempt was made to thin the schedule. The combined intervention phase successfully reduced object mouthing to near zero levels, and the researchers were able to thin NCR to 300-seconds while maintaining the object mouthing reduction. Although the results are compelling in their support for the uses of NCR in combination with RI, the authors cited a methodological flaw in their design that warrants

a cautious interpretation of the data. Specifically, the A-B-A-C-A-BC reversal design did not allow for an experimental test of the effects of the combined intervention that was employed in the last phase of the study. An additional reversal followed by a return to the BC condition would have strengthened the findings.

Summary and Purpose of the Present Study

As discussed in the above literature review, children with autism frequently engage in stereotypic movements that are maintained by automatic sensory reinforcement. These behaviors may have a negative impact on educational achievement, socialization, and appropriate play. Providing noncontingent access to sensory reinforcement matched to the sensory input provided by the stereotypic behavior (i.e., NCR) has shown to be an effective treatment in reducing those behaviors. Interrupting or blocking stereotypic movements (i.e., RI) has also been shown to be effective in reducing stereotypic behavior. Finally, there is some evidence that combining these two procedures may lead to greater treatment results.

The current study further investigated the effects of NCR and RI, both alone and in combination, in the treatment of automatically reinforced stereotypic behavior in four children with autism. In order to address the design flaw in the Carr et al. (2002) study, the current study used a reversal design where the combined procedure was also reversed back to baseline. Also, in order to strengthen the study, the reversal design was repeated across four participants.

Hypotheses

Hypothesis 1: The combined NCR + RI procedure will result in a greater decrease in the rate of stereotypic behavior than that obtained with either treatment implemented in isolation.

Hypothesis 2: The combined NCR + RI procedure will result in a greater increase in appropriate object engagement than that obtained with either treatment implemented in isolation.

CHAPTER II

Method

Participants

Four preschool-age students with a diagnosis of autism served as participants for the current study (Peter, Davey, Jimmy, and Michael). Participants were between the ages of 2 years, 11 months and 4 years, 10 months at the time of the study. All participants were enrolled in a full-time preschool program that followed an applied behavior analysis (ABA) teaching philosophy. Independent clinicians previously made the diagnoses of autism. Students in this school are enrolled after having received a diagnosis of autism from various professionals including licensed psychologists or neurologists. Initial evaluations are not conducted by clinicians employed by the school. Diagnostic records are included within the students' ancillary records housed within the school. I reviewed these records prior to inclusion of participants in the current study. Diagnoses were confirmed through the Childhood Autism Rating Scale (CARS) that I administered at the initiation of the current study. CARS ratings were obtained through an interview with the participants' teachers at the time of the study's initiation. See below for a description of CARS score interpretation and individual participant results. I selected participants based on the following criteria:

a) Preschool age (2.9-5.0 years of age) at the time of the study,
b) Diagnosis of autism as made by independent clinicians,
c) Characteristics of autism as confirmed by the scores on the CARS,
d) Presence of challenging behavior in the form of stereotypic motor mannerisms observed within free-play settings,

e) Report by teachers that the stereotypic behavior interferes with appropriate play behavior and is a focus of treatment in the school program,

f) Parental consent to participate in the study.

A description of each participant follows:

Peter was 4 years, 10 months of age at the time the study began. At that time, he had been enrolled in the preschool program for 23 months. I preliminarily chose the target behavior based on reports from his teachers. Peter's target behavior was "stereotypic book flipping" defined as holding a book vertically in front of his body while repetitively flipping the pages without focusing on the book's content. According to his teachers, this behavior occurred throughout the day, was difficult to redirect, and prevented appropriate engagement in play materials and peer socialization. Once selected by his teacher, I confirmed the presence of this stereotypic behavior (book flipping) by observing Peter for approximately 2 hours within his typical school routine. Observations confirmed the presence of book flipping and confirmed that the behavior was occurring at a high frequency and was difficult for the teaching staff to redirect. Results of the CARS, administered at the time of the study indicated that Peter was displaying behaviors characteristic of Severe Autism (composite score was 51 out of a possible score of 60). Prior to this study, the classroom teacher had tried several interventions to reduce the target behavior including restricting access to books, supervising Peter at all times when he had access to books, and reinforcing the appropriate use of books through verbal praise. None of these interventions resulted in noteworthy and long-term reductions in book flipping.

Davey was 3 years, 6 months of age at the time that the study began. At that time, he had been enrolled in the preschool program for approximately 6 months. I preliminarily chose his target behavior based on teacher report. Davey's target behavior was "stereotypic object play" defined as holding small toys (usually small plastic character figures such as action figures, Sesame Street figures, cars, trains, boats etc.) in both hands and bouncing the objects while holding them in front of his face, near his eyes, or to his sides. This stereotypic object play was repetitive in nature and was not pretend play. According to his teachers, this behavior occurred whenever his preferred objects were present and interfered with appropriate play and peer socialization. Once selected by his teacher, I confirmed the presence of this stereotypic behavior (object play) through behavioral observations conducted by observing Davey for approximately 2 hours within his typical school routine with the objects used for his stereotypic behavior present in the environment. Observations confirmed the presence of stereotypic object play and confirmed that the behavior was occurring at a high frequency when the objects were present and was difficult for the teaching staff to redirect. Results of the CARS, administered at the time of the study indicated that Davey was displaying behaviors characteristic of Severe Autism (composite score of 48.5 out of a possible score of 60). Prior to the study, the classroom teacher had tried several interventions to reduce the target behavior including restricting access to the objects that prompt stereotypic behavior, modeling appropriate play with objects, and verbally reinforcing appropriate play. None of these interventions resulted in noteworthy or long-term effectiveness.

Jimmy was 4 years, 1 month of age at the time that the study began. At the time of the study, he had been enrolled in the preschool program for approximately six months. I

preliminarily chose his target behavior based on teacher report. Jimmy's target behavior was "repetitive motor movements" defined as nonfunctional and repetitive movements including jumping in place, jumping on his knees, jumping/hopping back and forth in a straight line, and hand flapping. According to his teachers, this behavior occurred on the majority of free-time breaks from instruction and significantly interfered with play behavior and appropriate engagement with objects. Once selected by his teacher, I confirmed the presence of this stereotypic behavior (repetitive motor movements) through behavioral observations conducted by observing Jimmy for approximately 2 hours within his typical school routine making sure that I observed both work sessions and free breaks from instruction. Observations confirmed the presence of repetitive motor movements and confirmed that the behavior was occurring at a high frequency and was difficult for the teaching staff to redirect. Results of the CARS, administered at the time of the study, indicated that Jimmy was displaying behaviors characteristic of Severe Autism (composite score of 50.5 out of a possible score of 60). Prior to the study, the classroom teacher had tried a few interventions to reduce the target behavior including prompting and reinforcing appropriate play, prompting and reinforcing appropriate sitting, and modeling appropriate play with objects. None of these interventions resulted in substantial or long-term reductions in repetitive movements.

Michael was 2 years, 11 months of age at the time that the study began. At that time, he had been enrolled in the preschool program for approximately two months. As with the other participants, I preliminarily chose his target behavior based on teacher report. Michael's target behavior was "repetitive motor movements" defined as repetitive running/jumping in a circle (or around an object) while hand flapping. According to his

teachers, this behavior occurred on the majority of free-time breaks from instruction and substantially interfered with play behavior and appropriate engagement with objects. Once selected by his teacher, I confirmed the presence of this stereotypic behavior (repetitive motor movements) through behavioral observations conducted by observing Michael for approximately 2 hours within his typical school routine making sure that I observed both work sessions and free breaks from instruction. Observations confirmed the presence of repetitive motor movements and confirmed that the behavior was occurring at a high frequency and was difficult for the teaching staff to redirect. Results of the CARS, administered at the time of the study, indicated that Michael was displaying behaviors characteristics of Severe Autism (composite score of 50 out of a possible score of 60). Because Michael was in the school program for only a short period of time, the classroom teacher had tried no formal interventions prior to the study. Incidental reinforcement and modeling of appropriate behavior had not shown treatment results.

Setting

The study was implemented in a nonpublic preschool for children with autism. The preschool was part of a larger program that contained a school program, an adult program, a residential program, and family service programs. The program in the school followed an applied behavior analysis methodology across all treatment domains. The preschool program served approximately 18 students between the ages of 2.9 and 5 years. Classrooms contained six to eight students with one certified special education teacher and approximately five trained assistant teachers. Students spent a good portion of their day involved in one-to-one instruction as per their individualized goals. The students were in school from approximately 8:45 am to 2:40 pm, five days per week. I conducted

all experimental sessions within each participant's typical classroom. For Peter and Davey, I conducted sessions in a cubby area in the back of the classroom that was set up specifically for the current study. The cubby contained a table, chair, and a variety of appropriate play objects. I preferred the use of a separate cubby for experimental sessions because it allowed for the isolation of the independent variable without distractions from the classroom that could have lead to confounding variables. For Jimmy and Michael, I conducted sessions in the regular play area of the classroom that contained a variety of appropriate play objects placed both on the floor and on shelves. Conducting sessions for Jimmy and Michael in a separate cubby within the classroom was not possible due to the nature of their stereotypic target behavior (stereotypic motor movements) that was only present when they were in a large space.

Diagnostic Measure

In order to confirm the existence of behaviors consistent with a diagnosis of autism, I administered the Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Rocher Renner, 1988) at the time of the study via an interview with the participants' teachers. The CARS is a 15-item behavior rating scale developed to identify children that are displaying behaviors characteristic of a diagnosis on the autism spectrum. The CARS was first developed as a tool for evaluating children in the North Carolina TEACCH Program and is now widely used in treatment settings for children with developmental disabilities. The CARS assesses behavior across 15 items. Each item assesses one behavior characteristic of an individual on the autism spectrum. These items include relating to people, imitation, emotional response, body use, object use, adaptation to change, visual response, listening response, taste/smell/touch response, fear/nervousness,

verbal communication, nonverbal communication, activity level, intellectual response and general impressions. Items are responded to via a 1-4 likert scale that produces a composite score. Composite scores may range from 15-60 and are interpreted within three ranges: nonautistic (composite score 15-29.5), mild-moderate autism (composite score 30-36.5), and severe autism (composite score 37-60). Psychometric properties of the CARS are relatively strong. The test manual reports an internal consistency alpha of .94 and test-retest reliability at .88. Validity correlations fall between .80 and .84. Specifically, a .84 correlation between CARS scores and diagnosis was obtained with simultaneous clinical evaluation and a .80 correlation was obtained between CARS scores and diagnoses performed through independent evaluation by evaluators not related to the development of the CARS. A .82 correlation was obtained between ratings based on direct observation, parent interview and records review (Schopler, Reichler, & Renner, 1988).

Dependent Variables

I collected data on two dependent variables for each participant. DV1 (Dependent Variable 1) was percentage of 10-second partial intervals during which each participant engaged in the target stereotypic behavior within each experimental session. Experimental sessions lasted between 5-10 minutes, with the majority of sessions lasting the full 10 minutes. A few sessions were shortened to 5 minutes due to continuous occurrence of the target behavior, a total absence of the target behavior, or unexpected time constraints imposed by the classroom schedule. For those sessions lasting 10 minutes, the session consisted of 60, 10-second intervals. For those sessions lasting only 5 minutes, the session consisted of 30, 10-second intervals. I chose the percentage of 10-

second partial interval as the dependent measure based on previous literature. Past studies of challenging behavior (Charlop et al., 1990; Vollmer et al., 1993; Vollmer et al., 1997; Carr et al., 2002) used percentage of 10-second intervals engaged in stereotypic behavior within a treatment session as a dependent variable.

DV2 (Dependent Variable 2) was the percent of 10-second partial intervals during which each participant engaged in appropriate play with an object. Appropriate play was defined as engagement with an object in a purposeful manner, ideally in the manner in which the object is meant to be used or is typically used by children without autism. A variety of play objects were present in each treatment session. Although I collected data on DV2, there was no treatment component specifically implemented to directly teach appropriate play with specific objects. Although the RI treatment condition directed participants to appropriate play objects, this condition did not teach the children how to play with the objects.

Independent Variables

Types of treatment were the independent variables (IVs) for the study. The current study investigated the effects of three treatments on the frequency of the DVs. Specifically:

IV1 = Response interruption (RI), defined as the physical interruption of the stereotypic behavior by an adult within 2 seconds of the behavior's onset followed immediately by a redirection to an appropriate play object.

IV2 = Noncontingent reinforcement (NCR), defined as fixed-time access to stimuli matched to the target stereotypic behavior.

IV3 = Combined noncontingent reinforcement and response interruption (NCR + RI).

Research Design

The current study used a single subject reversal design repeated across the four participants. I chose a reversal design (also known as a withdrawal design) because it enables the most direct demonstration of experimental control between two variables (Bailey & Burch, 2002). In a reversal design, experimental control is displayed when rates of a dependent variable change reliably by the introduction and withdrawal of an independent variable. In the current study, I presented treatment and baseline conditions in an ABACADA (D/C/B) format, where (A) represents baseline conditions (including return to baseline), (B) represents response interruption in isolation, (C) represents noncontingent reinforcement in isolation, and (D) represents response interruption combined with noncontingent reinforcement. The final phase of the study (D/C/B) indicates a return to a previously initiated condition. I chose the treatment used in the D/C/B phase of treatment individually for each participant based on the results of the treatment phase that had shown the lowest rates of DV1 (stereotypic behavior) for that particular participant.

In a single-subject reversal design, the number of data points necessary in a phase is determined by three factors: trend, variability, and level. Trend is defined as three successive data points heading in the same direction. Trends can either be decreasing, increasing, or absent (i.e., data points not moving consistently in either direction) (Pear & Martin, 2002). With regard to baseline phases, treatment should not be implemented if there is a trend in the data in the hypothesized treatment direction. Treatment can,

however, be implemented in the absence of a trend or when there is a trend in the opposite direction of treatment. Likewise, a treatment phase can be ended when there is a trend in the opposite direction of treatment or in the absence of a trend over successive data points.

Variability refers to the difference in successive data points under the same environmental conditions. Experimental phases should not be discontinued in the face of high variability. High variability decreases the extent to which behavior change is attributable to the independent variable. Stability is the opposite of variability. There is currently no standard definition of stability in data analysis, however, it has been suggested that a therapeutic criterion of stability is when 80%-90% of data points within a phase are within 20% of the mean of data within the phase. Some researchers suggest more stringent criterion and some suggest more lenient criteria (Pear & Martin, 2002; Cooper et al., 1987). For the current study, I defined stability within a phase as 80% of data points falling within 30% of the mean of the phase. Baseline data are considered stable if no data points differ more than 50% from the mean of the baseline (Pear & Martin, 2002).

Level refers to the area of the Y-axis where the majority of data points within a phase converge (Cooper et al., 1987). In combination with variability, an analysis of level yields a determination of difference between two conditions. When data points in one condition do not overlap with data points in an adjacent condition a case can be made that behavior was actually changed from one condition to the next (Cooper et al.).

The total number of experimental sessions across all treatment conditions was 41 for Peter, 38 for Davey, 37 for Jimmy, and 40 for Michael.

Videotaping

In order to assess inter-rater agreement data on the occurrence or nonoccurrence of the target behavior in baseline and experimental sessions and ease the process of simultaneous treatment delivery and in-vivo data collection, treatment sessions for Peter and Davey were video taped. Video-taping for these participants was possible because treatment sessions were conducted in cubby areas separated from the rest of the classroom. Unfortunately, I could not conduct video-taping for Jimmy or Michael because treatment sessions took place in the play area of the classroom that was frequently used by other students in the classroom. For reasons of student confidentiality and HIPAA regulations, the school prohibited the videotaping of students who were not directly involved in the current study.

Inter-Observer Agreement Data

Interobserver agreement data (IOA) were collected on the occurrence or nonoccurrence of target behaviors for 25% of sessions in total (including both baseline and experimental phases). Target behaviors and their operational definitions are provided in the individual participant descriptions (pages 36 through 39). IOA were collected for 29% of Peter's sessions, 34% of Davey's sessions, 19% of Jimmy's sessions and 15% of Michael's sessions. The smaller percentage of IOA sessions for Jimmy and Michael, as compared to Peter and Davey, was a result of not having videotaped their sessions. IOA data were collected for Peter and Davey by having their teachers and/or assistant teachers review the videotaped sessions. IOA data were collected for Jimmy and Michael by having a teacher or teacher assistant collect data simultaneously with the experimenter during the actual session. I calculated the percent of agreement by dividing the number of

intervals during which teachers and experimenter ratings agreed within a session by the total number of intervals within a session and multiplying by 100 (Cooper et al, 1987).

The average total interobserver agreement was 94.63%, indicating that agreement occurred during approximately 95% of data intervals. IOA data for individual sessions ranged from 65% to 100% with 89% falling above 90%. The lower percents were attributed to confusion in the operational definition of Jimmy's target behavior for the first couple of IOA sessions. Agreement for Peter (over 12 sessions) occurred during 96.53% of intervals, indicating a strong agreement. Agreement for Davey (over 13 sessions) occurred during 96.03% of intervals, also indicating strong agreement. Agreement for Michael (over 6 sessions) was equally as strong at 97.08% agreement. IOA data for Jimmy (over 7 sessions) showed less agreement at 83.33%. Initially, there was confusion over the operational definition of the dependent variable for Jimmy. Whereas Michael would hand/arm flap while engaging in stereotypic movements, Jimmy would frequently engage in repetitive movements without the presence of hand/arm flapping. The presence or absence of hand/arm flapping seemed to be the difficulty in originally establishing reliability in observing the presence of the target behavior. By the second session of IOA data collection, I had revised the operational definition of Jimmy's target behavior to specify that repetitive motor movements in the presence or absence of hand/arm flapping would be considered the target behavior. Once the operational definition was revised, IOA data showed some increase in agreement, however, there tended to be more confusion over the presence or absence of Jimmy's target behavior as compared to the target behaviors of the other participants. I collected treatment data for Jimmy following the revised definition from the first session.

Treatment Integrity

Treatment integrity refers to the degree to which a treatment or independent variable was implemented as intended. Reporting of treatment integrity is important in order to establish a functional relationship between the independent variable and the dependent variable in a study. Treatment integrity is also important for the purposes of external validity of the data and to provide a means of replication of the procedures (Wheeler, Baggett, Fox, & Blevins, 2006). The current study ensured treatment integrity by providing clear operational definitions of the target behaviors under treatment, outlining the treatment parameters and procedures, videotaping sessions for two of the four participants, and having all treatments conducted by the principle investigator.

I also calculated data on the percent of correct treatment implementation across all experimental sessions. Across all four participants, I obtained 100% treatment integrity for the RI condition. The experimenter initiated the RI procedure for all instances in which the target behaviors were observed. It is important to note that I did not obtain 100% IOA data for all experimental sessions in which I calculated IOA. This indicates that, despite 100% treatment integrity for the behaviors I observed, there may have been some occurrences of the target behavior that I did not interrupt. I also calculated treatment integrity for implementation of the NCR procedure for 30 seconds each minute. I implemented NCR on the proposed schedule for 100% of treatment sessions in the NCR and RI + NCR phases. It is important to note that the duration of NCR was sometimes cut short for Davey and Michael due to a lack of engagement in the matched stimuli that I presented.

Procedures

Each participant was exposed to nine experimental phases. The phases were as follows and each will be described in detail below.

Phase 1 = brief functional analysis

A1 = initial baseline

RI = response interruption (IV1)

A2 = return to baseline 1

NCR = noncontingent reinforcement (IV2)

A3 = return to baseline 2

NCR + RI = noncontingent reinforcement plus response interruption (IV3)

A4 = final return to baseline

Final Phase = return to most effective treatment condition

Phase 1 - Brief functional analysis. Before finalizing the choice of the DV1, I assessed the maintaining reinforcer behind each participant's stereotypic behavior to ensure that the behavior was being maintained by automatic reinforcement and not a social reinforcer (i.e., escape, attention, or access to preferred tangibles). I used only those stereotypic behaviors that were automatically maintained as target behaviors in the current study. Behaviors maintained by social functions were not appropriate for the current study, because the focus of the current investigation was to assess the treatment effects of RI and NCR on the rate of automatically reinforced (nonsocial) behaviors. I subjected all four participants to an individual, brief functional analysis using methods based on those described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994).

A functional analysis is an experimental procedure to assess the maintaining reinforcer of a behavior through the systematic manipulation of environmental variables

within analogue assessment sessions (Iwata et al., 1994). Iwata et al. refined functional analysis procedures in their assessment of self-injury behavior. The authors assessed the function of self-injury behavior using four different assessment conditions. The first condition isolated the possibility of social attention as a reinforcer. In this condition, they removed attention from the participant for the duration of the session; however, a brief period of social attention was made contingent upon engagement in self-injury. The second condition isolated the possibility of escape from demand as a reinforcer. In this condition, the participant was required to engage in instructional tasks throughout the session, however, breaks from these tasks were made contingent upon self injury. The third condition was called the "unstructured play" condition and served as an experimental control. In this condition, the participant was not required to do work and had free access to preferred toys and social attention. Engagement in self-injury was simply ignored. In the final condition, the participant was observed while alone in a playroom. This "alone" condition served to mimic an impoverished environment that may lead to an increase in self-stimulatory behavior. Experimental sessions each lasted for 15 minutes and were run two times per day for each condition. The total number of sessions across participants averaged 30. Experimenters charted rates of self-injury across each condition. Because self-injury was systematically reinforced differently in each condition, the differential rates of behavior point to the likely maintaining reinforcers. If rates of behavior were highest in the social attention condition, social attention may have been the maintaining function. If rates of behavior were highest in the demand condition, escape from demands may have been the maintaining function. Finally, if rates of

behavior were highest within the alone condition or were equal across all conditions, the behaviors may have been automatically reinforced (Iwata et al.).

The general procedures used by Iwata et al. (1982/1994) are now regarded as the standard format for conducting experimental functional analyses (McComas & Mace, 2000). Researchers often test four experimental conditions. These include attention, demand, access to tangibles, and play (control) conditions (McComas & Mace, 2000). Recently, researchers have devised a method of brief functional analysis where they conduct each condition only a limited number of times and for session lengths as short as 5 minutes (Hanley, Iwata, & McCord, 2003). Research indicates that the findings from brief functional analyses correlate highly and positively with the findings from full functional analyses and brief functional analyses are easier and more practical to implement (Hanley et al.).

In the current study, brief functional analysis conditions consisted of attention, demand, access to tangibles, and control conditions. I did not include an alone condition in the analysis because it was against the policy of the treatment setting to leave the student alone in a classroom without direct observation. Also, being left in a classroom without teachers and other students would have seemed highly abnormal to the participants and therefore could have introduced variables into the analysis (such as attention) beyond those being testing within the alone condition. In the attention condition, I allowed the participant to walk around a cubby area of the classroom that was filled with various play objects. I denied the participant access to attention and briefly engaged in 15 seconds of verbal attention with the participant contingent on engagement in the target behavior. In the escape condition, I required the participant to sit at a table

placed within a cubby of the classroom and was given academic instructions by the examiner who was sitting across the table. I used prompting to maintain task engagement. I delivered minimal verbal reinforcement for correct responding. I provided fifteen-second instructional breaks upon engagement in the target behavior. In the access to tangible condition, I allowed the participant to walk around a cubby area of the classroom filled with various play objects. I gave him 15 seconds of free access to a highly preferred tangible (chosen by his classroom teacher). After the 15 seconds, I removed the tangible item and denied him access to it for the remainder of the session. I returned the tangible item for 15 seconds following each instance in which I observed the target behavior. In the control condition, I allowed the participant to walk around a cubby area of the classroom filled with various play objects. I also gave him free access to a highly preferred reinforcer and experimenter attention on a dense schedule. I did not present any task demands. There were no scheduled consequences for engagement in the target behavior. Functional analysis sessions lasted 5 minutes each and were repeated twice for consistency. I recorded ten-second partial interval data on engagement in target behaviors and calculated and graphed percents per session. I displayed data from the functional analyses graphically and I review these data in the results section.

A1 – Initial baseline. I collected initial baseline data for each participant. Baseline data were collected on both DV1 (stereotypic behavior) and DV2 (appropriate engagement with objects). Baseline sessions lasted 10 minutes each and were repeated for 5 sessions for Davey, Jimmy, and Michael and for 3 sessions for Peter. Approximately five sessions of baseline are necessary in order to establish a stable rate of responding before treatment is introduced (Cooper et al., 1987). The decision was made

to discontinue baseline after three sessions for Peter because all three sessions revealed 100% engagement in DV1within each of the 10-minute sessions. DV2 for Peter maintained at zero or near zero. During baseline, the participants were placed within the treatment setting that would be used for all experimental sessions. For Peter and Davey, this consisted of a cubby in the back of their classroom containing a table, chair, and various play objects. A separate cubby was preferred for all sessions in order to limit distractions from the classroom that could potentially lead to confounding variables. Also, the use of the separate cubby allowed for videotaping of sessions. For Jimmy and Michael, the setting consisted of the regular play area in their classroom with various play objects on the floor and on shelves. A separate cubby area was not used for Jimmy and Michael because their stereotypic behavior was only present at high rates in larger, less restrictive settings. During baseline, there were no scheduled consequences for engaging in the target behavior. As in all experimental sessions, I collected data on DV1 and DV2 through 10-second partial interval recording.

Response interruption. RI followed this baseline. Data collection procedures were identical to those used in the initial baseline. During this phase, I interrupted each episode of stereotypic behavior within 2 seconds of the behavior's onset. Interruption consisted of my physically stopping the participant by holding him in place with his hands to his sides for a count of 2 seconds. I also provided a verbal direction of "stop". If necessary, I removed objects from the participants' hands as part of the interruption (i.e., books with Peter and character figures with Davey). After I provided the interruption, I directed the participant to an appropriate play object. I placed all challenging behavior that resulted from the RI (i.e. brief screaming, minor aggression) on an extinction

schedule by not discontinuing the interruption based on the challenging behavior. If the challenging behavior had resulted in a discontinuation of the interruption, the challenging behavior would have been reinforced by allowing engagement in the stereotypic behavior. The participant was moved onto the next experimental phase when stable responding was established. As mentioned earlier, stable responding was defined as 80% of data points falling within 30% of the mean of the phase.

A2 – Return to baseline 1. The setting, procedures, and data collection methods for this baseline phase were the same as in the initial baseline. The participant was moved onto the next experimental phase when stable responding was established.

Noncontingent reinforcement. This phase consisted of NCR in isolation. Data collection procedures were identical to those used in the initial baseline. During this phase, the participant was given the opportunity to freely engage in a matched stimulus for 30 seconds, once every minute, for a 10-minute session. A matched stimulus is a stimulus that provides the same form of sensory stimulation as the stereotypic behavior, yet is more socially appropriate and adaptive. As explained in the literature review, noncontingent engagement in a matched stimulus should reduce an individual's motivation to engage in matched stereotypic behavior at other times. Originally, I set the schedule density of matched stimulus presentation at a 30-second fixed interval schedule as used by Carr et al. (2002). After trying this schedule with Peter and Davey for one session each, I increased the schedule to a 1-minute fixed interval because a 30-second schedule was difficult to implement accurately and maintain for the full 10 minutes. I discarded data from these original NCR sessions for Peter and Davey and did not include these data in the analysis.

For Peter, the matched stimulus consisted of flipping pages to a magazine in place of flipping pages to a book. For Davey, the matched stimulus consisted of playing with trains instead of engaging in stereotypic play with character figures. For both Jimmy and Michael, the matched stimulus consisted of jumping on a trampoline instead of engaging in repetitive gross motor movements. Although I did not conduct data-based preference assessments, I chose these individually matched stimuli based on my observations that showed these particular stimuli to at least partially compete with engagement in the chosen target stereotypic behaviors. I did not collect data during these observations to determine matched stimuli. For the observations, I made short lists for each participant containing objects and activities that may serve the same sensory function as the stereotypic behavior. During the observations, I presented these objects one by one and prompted the student to engage with the object if needed. Based on what I observed, I made a determination as to which object or activity was the most effective in competing with the stereotypic behavior. I assumed that those objects and activities were matched stimuli and used them in the remainder of the study. I had intended to systematically fade the schedule density of the NCR once engagement in the target stereotypic behavior dropped to less than 10% of 10-second intervals. None of the participants, however, reduced his stereotypic behavior to less than 10%.

A3 – Return to baseline 2. This baseline phase followed the same procedures and data collection methods as previous baseline.

Response interruption plus noncontingent reinforcement (RI + NCR). In this phase, I used RI of the stereotypic behavior, as described above, while providing an NCR schedule, also as described above. Once again, the participant was moved onto the next

phase once a stable pattern of responding was established. I intended to use a fading procedure for the NCR schedule if engagement in stereotypic behavior dropped to below 10%. This did not occur for any of the four participants, however.

A4 – Final return to baseline. Phase 8 followed the same procedures and data collection methods as all baseline phases.

Final Phase – Return to most effective treatment condition. In order to end the study with the target behavior showing a decreased frequency, this final phase consisted of a return to the treatment that had shown the best outcome with the least needed treatment components for each participant. The treatment procedures were identical to those described above for the treatment chosen. For all four participants, the final phase consisted of RI alone. The decision to use this condition was made for Peter because data were equal for the last four days of both the RI and the NCR + RI conditions. This indicated that NCR did not add to the treatment effectiveness of response interruption, making it possible to use the simpler procedure (i.e., RI) alone as the more effective treatment. For Davey, I chose RI alone because adding NCR as a treatment did not result in less stereotypic responding than did RI in isolation. Also, Davey did not show a preference to engage in the chosen matched stimulus. For both Jimmy and Michael, rates of behavior during RI and NCR + RI were relatively equal, however, I chose RI for Phase 9 due to the lower means in the RI alone condition for both.

Results

Functional Analyses

Figure 1 shows the frequency of stereotypic responding for all four participants during functional analysis sessions. Data suggest that stereotypic behaviors across all

participants were being maintained through automatic reinforcement, because, for all participants, rates of stereotypic behavior were elevated in the attention, access to tangible, and control conditions. Rates of stereotypic behavior were low in the escape condition, indicating that stereotypic behaviors did not serve as a means of escape. The low rate of stereotypic behavior in this condition was most likely due to the highly controlled environment in the escape condition where the participant was seated at a desk while being given task demands from the examiner. Undifferentiated patterns of responding across multiple social conditions can either indicate a behavior being controlled by multiple functions (Iwata et al., 1994) or a behavior being controlled by automatic reinforcement (Roscoe et al., 1998; Iwata et al., 1994). Because, in the present analysis, I evaluated rates of behavior in the control condition as well as in the attention and access conditions, I concluded that target behaviors for all participants were automatically reinforced.

For Peter, the rate of stereotypic behavior in the attention condition was 100% of the 10-second observation intervals from both sessions. In the access to tangibles condition, Peter obtained a mean of 93.5% for stereotypic behavior across both sessions.

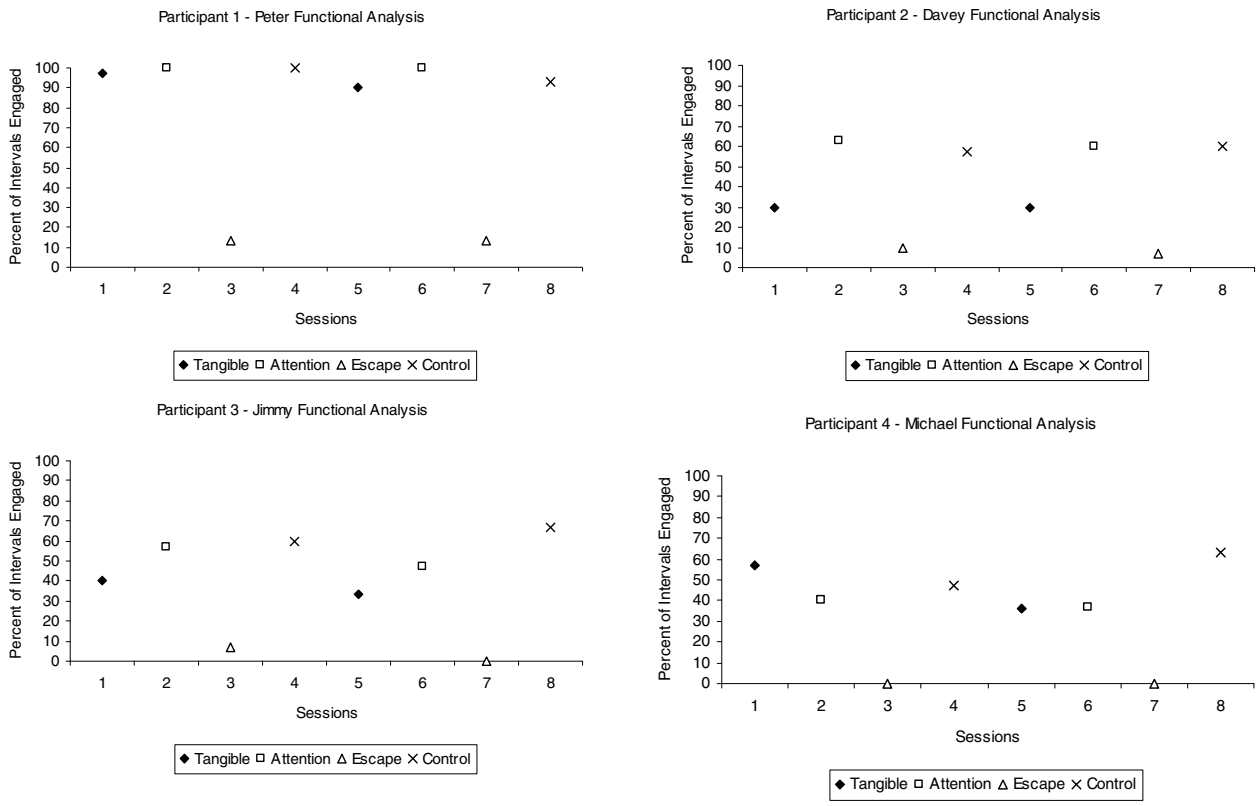

Figure 1. Functional analysis data for all four participants.

In the control condition, he obtained a mean of 96.5% and in the escape condition, he obtained a mean of 13%.

Davey achieved a mean rate of stereotypic behavior of 61.5% in the attention condition and a mean of 30% in the access to tangibles condition. Davey had a mean of 58.5% in the control condition and a mean of 8.5% stereotypic behavior in the escape condition. Although rates in the access to tangible condition were somewhat lower than those observed in the attention and control conditions, the target behavior was still observed on a regular basis within that condition. I therefore interpreted rates as undifferentiated across the three conditions (attention, access, and control).

Jimmy obtained a mean rate of stereotypic behavior of 52% in the attention condition and a mean of 36.5% in the access to tangibles condition. He achieved a mean of 63.5% in control condition and a mean of 3.5% in the escape condition. As with Davey, rates of behavior were somewhat lower in the access to tangibles condition compared to the control and attention conditions. Since rates of behavior were still elevated, I interpreted the data as undifferentiated across the three conditions (attention, access, and control).

Michael obtained a mean rate of stereotypic behavior of 38.5% of the observation intervals in the attention condition and a mean of 46.5% in the access to tangibles condition. He obtained a mean of 55% in the control condition and a mean of 0% in the escape condition.

Initial Baseline

Figure 2 (page 60), Figure 3 (page 63), Figure 4 (page 65), and Figure 5 (page 67) present baseline data for each participant during A1. I recorded baseline data for DV1 as the percentage of 10-second partial intervals during which the participant engaged in stereotypic behavior.

For Peter, I collected A1 baseline stereotypic data on book flipping and appropriate object engagement data for a total of three sessions. Peter book flipped (DV1) during all of the 10-second baseline intervals for a baseline mean of 100% for DV1. DV2 was the percentage of 10-second partial intervals during which Peter engaged in appropriate play with an object. He obtained a mean of 1.11% of baseline intervals for DV2.

For Davey, I collected baseline data on stereotypic object play and appropriate object engagement for a total of four sessions. I stopped baseline sessions after four sessions because data stabilized for the last three sessions at the criteria of less than 50% deviation from the mean of the last three. Davey obtained a mean of 50% engagement for stereotypic object play (DV1). Davey obtained a mean of 21% of intervals for appropriate object engagement (DV2).

For Jimmy, I collected baseline data on stereotypic motor movements and appropriate object engagement for a total of five sessions. Jimmy obtained a mean of 38.8% engagement for stereotypic motor movements (DV1) and a mean of 5.9% of intervals for appropriate object engagement (DV2).

For Michael, I collected baseline data on stereotypic motor movements and appropriate object engagement for a total of five sessions. Michael showed a mean of 41.4% for stereotypic motor movements (DV1) and a mean of 8.8% of intervals for appropriate object engagement (DV2).

Treatment Results

I evaluated treatment data through visual analysis of the single-case data and Mean Percent Decrease between baseline and treatment phases. I made these evaluation decisions after a review of current research discussing the benefits and concerns associated with using statistical procedures to analyze single-subject data. Visual analysis of graphs is the traditional method used for interpreting data from single-subject research designs (Kromrey & Foster-Johnson, 1996). Visual analysis of data is appropriate in single-subject research because of the strong internal validity of properly constructed designs (Olive & Smith, 2005). Kazdin (1982) also suggested that single-case designs

often violate some of the assumptions on which statistical procedures depend. Specifically, he stated that visual analysis of data results in less chance of making a type I error (concluding that a treatment effect existed when in fact it did not) than relying on statistical interpretations of significance. In other words, visual analysis is a more conservative method than statistical analysis when it comes to declaring treatment effects that were not actually present. Investigators have also avoided statistical analysis in single-subject research because the designs often violate experimental assumptions (i.e., random selection, independence of data etc.) on which statistical interpretation depends (Olive et al., 2005).

Recently, however, the American Psychological Association has suggested that all research manuscripts include the reporting of effect size calculations to support conclusions based on data (Olive et al., 2005). Although suggested by APA, an investigation of the current literature shows that examiners conducting single-subject research do not use effect size calculations. Parker et al. (2005) reviewed the results of 124 articles that employed single-case study designs from counseling, clinical, and school psychology journals to assess the methods that the authors of theses studies used to make their interpretations of the data. They found that over 65% of the studies used only visual analyses of the data to state findings. Of the remaining 35%, most used nonstatistical comparisons of means or medians (reporting mean increases or decreases between phases) to support visual analysis. Less than 11% of the studies used any form of effect size calculations or statistical procedures.

With regard to effect size calculations in single-subject research, there is no standard formula that has yet been adopted in the field, however many researchers state

that it is beneficial to use effect sizes to supplement visual analysis (Parker et al., 2005). Recent research, however, states that effect sizes, when they are used, should be used with extreme caution (Olive et al., 2005) and are not warranted in many cases (Parker et al., 2005). In their study, Olive et al. (2005) found that effect sizes (regardless of the formula used to calculate the effect size) masked pertinent characteristics of the data. They found evidence of both type I, as noted by Kazdin (1982), and type II errors (concluding that a treatment effect did not exist when in fact it did) when basing interpretations on effect size calculations. The authors concluded that effect sizes, if used at all, should only be used in combination with visual analysis of graphed data. Parker et al. (2005) found that the magnitude of the effect size depended more on the formula that was used than on the actual data. They therefore concluded that some calculations of effect size are "relatively meaningless unless constrained by information on their reliability" (p.128).

Due to the cautions noted above, in addition to the lack of agreement as to the appropriate formula to use when calculating effect sizes, I made the decision to interpret the current data through visual analysis, along with nonstatistical interpretation of mean difference by reporting percent decrement between baseline and treatment phases. Although they are not traditionally conducted in ABA studies, I also calculated mean percent decreases (or increases) between baseline and treatment data. This latter procedure has been used as a supplement to visual analysis in single-subject studies published within school psychology journals (Jones & Wickstrom, 2002; Clarke, Bray, Kehle, & Truscott, 2001).

Peter. Figure 2 displays the session-by-session data for Participant 1 – Peter. I will discuss results for engagement in stereotypic behavior (book flipping; DV1) first followed by presentation of the results for appropriate object engagement (DV2). After three session of initial baseline, I initiated RI in isolation (IV1). Data, signified by closed squares in Figure 2, indicate an overall mean of 38.75% engagement in DV1across the eight sessions of RI in isolation. This is a 61.25% decrease in DV1 from baseline. I calculated percent decrease as follows: D% = 100(X2-X1)/X1 ("Percent increase/percent decrease", n.d.). It is important to note that Peter obtained a mean of only 15.75% for DV1 for the last four sessions of RI (IV1).

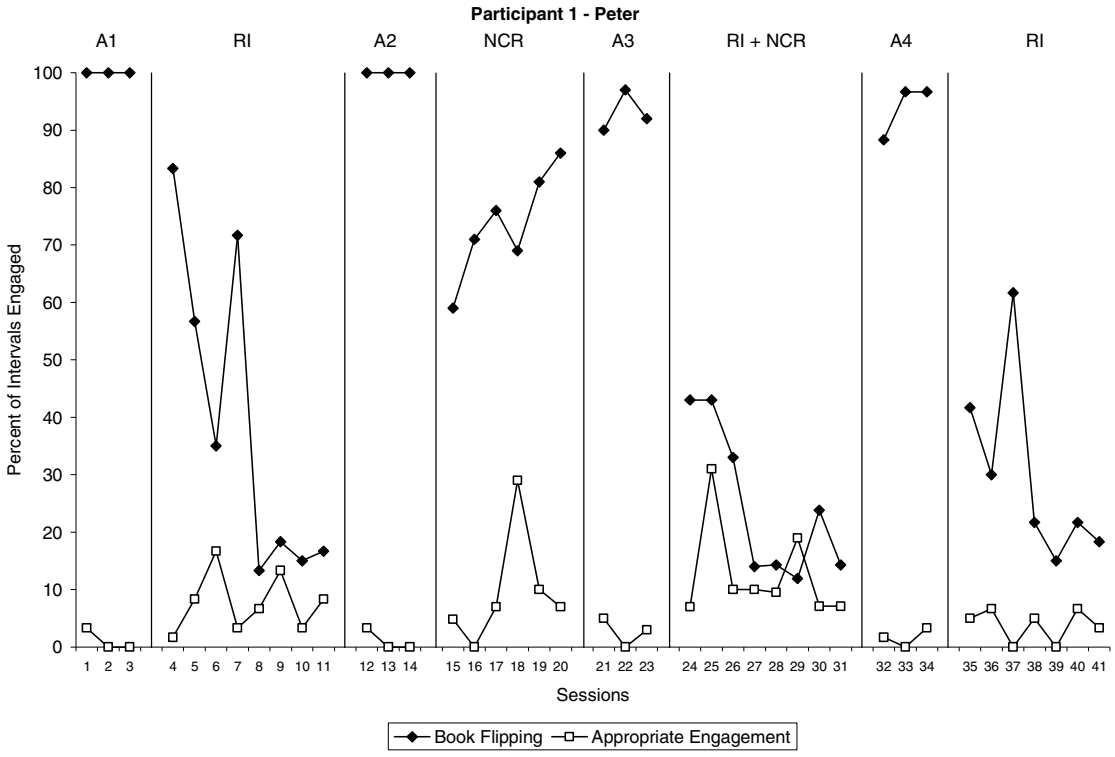

Figure 2. Session by session data for participant 1 – Peter.

Thus, during the last four sessions of RI (IV1), there was an 84.25% decrease in stereotypic behavior from baseline. Data were shown to stabilize at this rate, as the last

four sessions showed an absence of trend with all data points falling within 30% of the mean of those four points. The reason that Peter's behavior did not decrease more quickly may have been a product of the novelty of RI as an intervention for book flipping. This treatment had not been used consistently with Peter in the past.

The A2 portion of Figure 2 represents the first return to baseline condition. Peter's stereotypic behavior of book flipping returned to a mean of 100% during A2. I then implemented NCR to magazine flipping (IV2). As indicated previously, magazine flipping was the matched stimulus that provided the same form of sensory stimulation as Peter's stereotypic behavior of book flipping (see page 52). The NCR intervention resulted in a mean of 73.67% engagement DV1, a 26.33% decrease from baseline. I discontinued the NCR treatment after six sessions, because, as shown in Figure 2, after an initial decrease from baseline, there appeared to be an increasing trend in Peter's engagement in stereotypic behavior.

The A3 portion of Figure 2 represents the second return to baseline condition. Peter's stereotypic behavior quickly returned to a mean of 93%. The next treatment phase consisted of RI + NCR to magazine flipping (IV3). Results indicate a mean of 24.63% engagement in DV1 across eight sessions. This is a 73.51% decrease from the previous baseline rate. Once again, there was a delayed decrease to a stable rate. Taking the data only from the last five sessions of this condition, Peter obtained a mean of 16% engagement in DV1. The data from the last five sessions are more interpretable because of their stability at a particular level. This is an 82.79% decrease from baseline and is consistent with the decrease in stereotypic behavior that was obtained in the RI in isolation condition.

Peter's stereotypic behavior returned to 94% during the final return to baseline condition A4. During the final phase, I initiated RI in isolation once again. Peter's stereotypic behavior returned to a mean of 30.1%. His stereotypic behavior stabilized at a mean of 19.25% across the last four sessions.

All participants had access to appropriate play objects throughout the intervention and baseline phases. I anticipated that as during the intervention periods, participants' play with these objects should increase as their stereotypic behavior decreased. The open squares in Figure 2 indicate appropriate object engagement for Peter. Appropriate object engagement consisted of any use of an object or play with an object as that object was designed to be used (i.e., banging a drum, looking at pictures in a book, etc.). Peter did not achieve a noteworthy increase in appropriate object engagement in any treatment condition, however, Peter's results do indicate a slight increase in DV2 during each treatment condition compared to baseline rates. He obtained the highest percentage of appropriate object engagement in the RI + NCR condition (12.63%), followed by the NCR condition (9.64%), RI condition (7.63%), and the return to RI condition (3.86%).

Davey. Figure 3 displays the session-by-session data for Participant 2 – Davey. I will first discuss his engagement in stereotypic behavior (i.e., stereotypic object play, DV1) followed by a discussion of appropriate object engagement. After four sessions of initial baseline (A1), I initiated RI in isolation (IV1). Baseline sessions were stopped after four because data stabilized for the last three sessions at the criteria of less than 50% deviation from the mean of the last three points. Data (closed boxes in Figure 3) indicate an overall mean of 20.14% for DV1 across the seven sessions of RI. The average decrease of DV1 from baseline during RI was 59.72%.

A2 represents the first return to baseline condition. Davey obtained a mean of 48.33% engagement in stereotypic object play during A2. This is similar to the initial baseline rate of 50%. I then implemented NCR to trains (IV2) for six sessions. Play with toy trains was the matched stimulus that I had chosen (see page 52) to provide the same form of sensory stimulation as Davey's stereotypic behavior of object play. Although stereotypic behavior data did not stabilize at the criterion of less than 30% deviation from the mean, I made the decision to discontinue the phase after six sessions because rates of stereotypic behavior were similar to the initial and preceding baselines, no data points

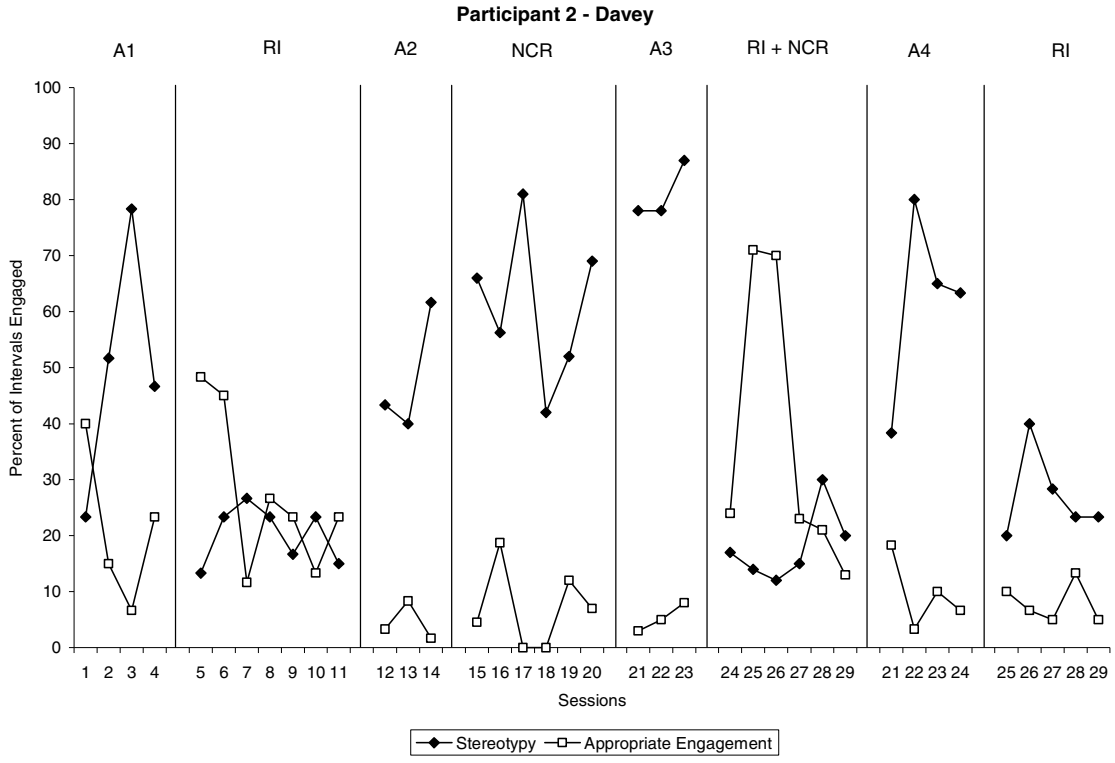

Figure 3. Session by session data for participant 2 – Davey.

overlapped between the NCR and RI conditions (indicating a change in level), and the possibility of an increasing trend across the last three data points of the phase (indicating

the absence of a treatment effect). Results indicate a mean of 61% engagement in DV1. This is a 26.21% increase from A2 indicating no positive treatment effect.

A3 represents the second return to baseline condition. Davey's engagement in stereotypic behavior increased to a mean of 81%. This is above the rate of the initial baseline of 50%. The next treatment phase consisted of RI + NCR (IV3). Davey's stereotypic behavior decreased to a mean of 18% across six sessions. This was a 77.78% decrease from the previous baseline (A3). Davey's stereotypic behavior returned to 61.5% during the final return to baseline condition (A4). During the final phase, I once again initiated RI in isolation, and Davey's stereotypic behavior returned to a mean of 26.8%. I chose RI as the final condition because adding NCR to RI did not result in less stereotypic responding than did RI in isolation. Also, Davey did not show a preference to engage in the use of the chosen matched stimulus.

The open squares in Figure 3 show appropriate object engagement (DV2) for Davey. Appropriate object engagement consisted of any use of an object or play with an object as that object was designed to be used. (i.e., banging a drum, looking at pictures in a book, etc.). Davey showed a mean of 21.25% for DV2 during the initial baseline (A1). This mean was higher than those obtained in the remaining baseline conditions (A2, 4.33%; A3, 5.33%; and A4, 9.5%). I compared treatment data in all conditions to the combined mean from all baseline phases of 10.1%.

In the RI in isolation condition (IV1), Davey engaged in appropriate object play a mean of 27.29%. This is a 170.19% increase in appropriate play from the combined baseline. The RI mean was inflated by two high percents obtained during the first two treatment sessions. Data stabilized at a mean of 19.66% across the last five sessions of

RI, indicating a 94.65% increase from baseline. In the NCR in isolation condition (IV2), Davey's mean for DV2 was 7.17%, indicating no increase in this behavior from the combined baseline. When RI was implemented in combination with NCR (IV3), Davey achieved a mean of 37% appropriate object engagement. Although this is a 266.33% increase from baseline, it is important to note that the mean is inflated by two sessions with elevated data. Data dropped to baseline levels within the last three sessions. In fact, data for the last three sessions indicate a decreasing trend in appropriate engagement with play objects. When I initiated RI in isolation once again in the final phase, Davey did not display appropriate engagement with play objects at the same level that he had in the original RI condition. Results indicated a stable 8% engagement in appropriate object play in the final phase of the study. This is actually lower than the original baseline rate of behavior of 21.25%.

Jimmy. Figure 4 displays the session-by-session data for Participant 3 – Jimmy. I will first discuss Jimmy's engagement in stereotypic behavior (repetitive motor movements, DV1, indicated by closed boxes in Figure 4), followed by a discussion of Jimmy's appropriate object engagement (DV2). After five sessions of initial baseline (A1), I initiated RI in isolation (IV1). RI data indicate an overall mean of 14.33% engagement in repetitive motor movements across six sessions. This is a 63.06% decrease in stereotypic behavior from baseline. I discontinued the RI procedure after six sessions because all six data points fell within 30% of the mean of this phase, indicating stability.

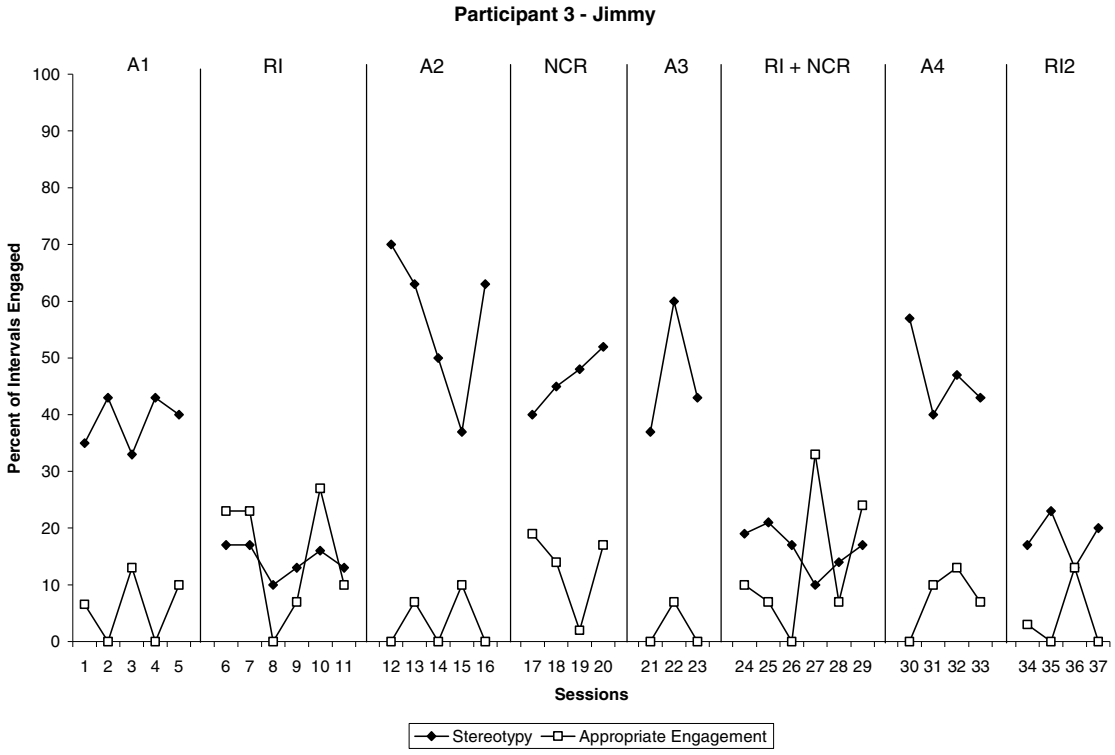

Figure 4. Session by session data for participant 3 – Jimmy.

A2 represents the first return to baseline condition. Jimmy obtained a mean of 56.6% engagement in repetitive motor movements during A2. This is a slight increase over the initial baseline rate in A1. I then implemented NCR to a trampoline (IV2) for four sessions. Jumping on a trampoline was the matched stimulus that I had chosen (see page 52) to provide the same form of sensory stimulation as Jimmy's stereotypic repetitive movements. During this NCR phase, Jimmy showed a mean of 46.25% engagement in stereotypic repetitive motor movements. This is an 18.28% decrease from the second baseline (A2), indicating little positive treatment effect. I discontinued NCR after only four sessions due to an increasing trend in Jimmy's repetitive motor movements across the sessions.

A3 represents the second return to baseline condition. During A3, Jimmy's engagement in stereotypic behavior was 46.67%. The next treatment phase consisted of RI in combination with NCR (IV3). Jimmy engaged in stereotypic behavior for a mean of 16.33% of the 10-second intervals across the six sessions. Jimmy's behavior reached stability after six sessions with 80% of data points falling within 30% of the mean of the data. This is a 65% decrease in stereotypic behavior from A3 and is similar to results obtained in the RI in isolation condition. Jimmy's stereotypic behavior returned to 46.75% engagement during the final return to baseline condition (A4). Because it produced the lowest mean rate of stereotypic behavior, I initiated RI in isolation in the final treatment phase and stereotypic behavior returned to a mean of 18.25%.

The open squares in Figure 4 give data concerning Jimmy's appropriate object engagement (DV2). Appropriate object engagement consisted of any use of an object or play with an object as that object was designed to be used. (i.e., banging a drum, looking at pictures in a book, etc.). Jimmy demonstrated only slight increases in appropriate object engagement during treatment conditions (RI, NCR, and RI + NCR) compared to baseline (A1, 2, 3, and 4). Jimmy obtained the highest percentage of DV2 in the RI in isolation condition (15%), followed by the NCR + RI condition (13.5%), NCR in isolation condition (13%), and the return to RI condition (4%).

Michael. Figure 5 displays the session-by-session data for Participant 4 – Michael. I will first discuss Michael's engagement in stereotypic behavior (repetitive motor movements; DV1) that is represented by the close boxes in Figure 5, followed by a discussion of appropriate object engagement (DV2). After five sessions of initial baseline (A1), I initiated RI in isolation (IV1). Michael demonstrated an overall mean of 11.43%

engagement in DV1 across the seven sessions of RI, a 72.39% decrease in stereotypic behavior from baseline. RI data were relatively stable across sessions, with some high and low variations.

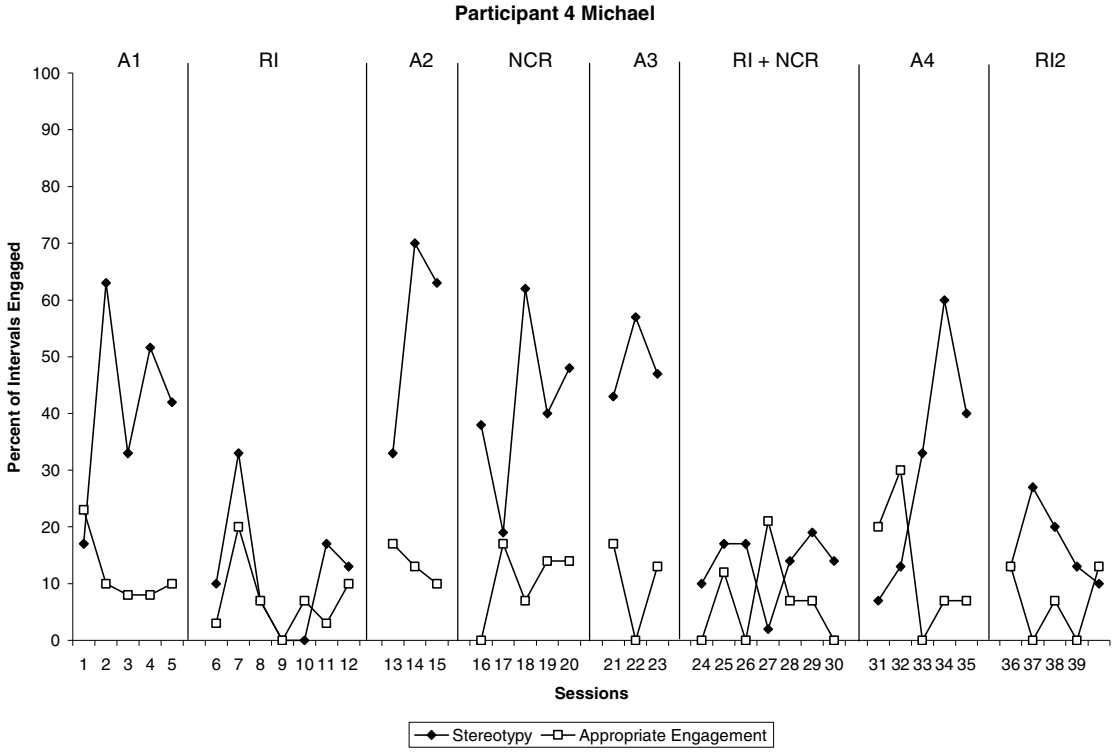

Figure 5. Session by session data for participant 4 – Michael.

A2 represents the first return to baseline condition (A2). Michael had a mean of 55.33% of 10-second intervals with stereotypic behavior in this phase. This is a slight increase over the initial baseline rate (A1). I then implemented NCR to a trampoline (IV2) for five sessions. Jumping on a trampoline was the matched stimulus that I had chosen (see page 52) to provide the same form of sensory stimulation as Michael's stereotypic repetitive movements. During NCR, Michael demonstrated a mean of 41.4% engagement in DV1, a 25.17% decrease from the second baseline data (A2), but a 0% decrease from the initial baseline (A1). Due to the lack of change in level between the

NCR phase and the initial baseline, noted by 5 overlapping data points, I made the decision to stop the NCR phase after 5 sessions.

A3 represents the second return to baseline condition where Michael showed a mean of 49% engagement in stereotypic behavior that is consistent with previous baseline conditions (A1 and A2). The next treatment phase consisted of RI in combination with NCR to a trampoline (IV3). Michael's stereotypic behavior achieved stability after seven sessions, with 85% of the data points falling within 30% of the mean. Michael achieved a mean of 13.29% engagement in stereotypic behavior across the seven sessions of the RI + NCR condition. This is a 72.87% decrease from A3 and is consistent with the data obtained in the RI in isolation condition.

During the final baseline (A4) Michael engaged in 30.6% stereotypic behavior. This mean percentage was lowered by the first two sessions of the A4 condition, which immediately followed the last two sessions of the RI + NCR condition. Engagement in repetitive motor movements in A4 stabilized at a rate of 44.33% during the last three sessions. During the final phase, I once again initiated RI in isolation, and Michael's stereotypic behavior returned to a mean of 16.6% DV1 engagement, a 62.55% decrease from the adjusted A4 baseline rate. I implemented RI in isolation in the last phase of treatment because it had previously produced the lowest rate of stereotypic behavior compared to the other treatment phases.

The open squares in Figure 5 show appropriate object engagement (DV2) for Michael. Appropriate object engagement consisted of any use of an object or play with an object as that object was designed to be used. (i.e., banging a drum, looking at pictures in a book, etc.). Michael did not obtain increases in DV2 over baseline during any treatment

condition (RI, NCR, and RI + NCR). He had a mean appropriate object engagement of 11.98% across the four baseline conditions (A1, A2, A3, and A4). Michael's percent of engagement with appropriate objects was 7.14% for the RI condition, 10.4% for the NCR condition, 6.7% for the RI + NCR condition, and 6.6% for the return to RI condition. No positive treatment effects were observed.

Overall results summary. When presenting single-subject research data, researchers typically compare treatment effects to within-subject baseline rates of behavior, such as those presented above. I also have compiled the data across subjects in order to discuss overall trends. These data are represented in Figures 6 and 7.

Figure 6 represents mean rates of stereotypic behavior (DV1) combined across all four participants. Thus, Figure 6 presents bar graphs of the mean data within each condition. All participants combined had a mean over all baseline phases (summarizing A1, A2, A3, and A4) of 62.05% engagement in stereotypic behavior. Collectively, participants demonstrated a mean of 21.16% engagement in stereotypic behavior for the RI in isolation condition (IV1). This represents a 65.89% decrease from participants'

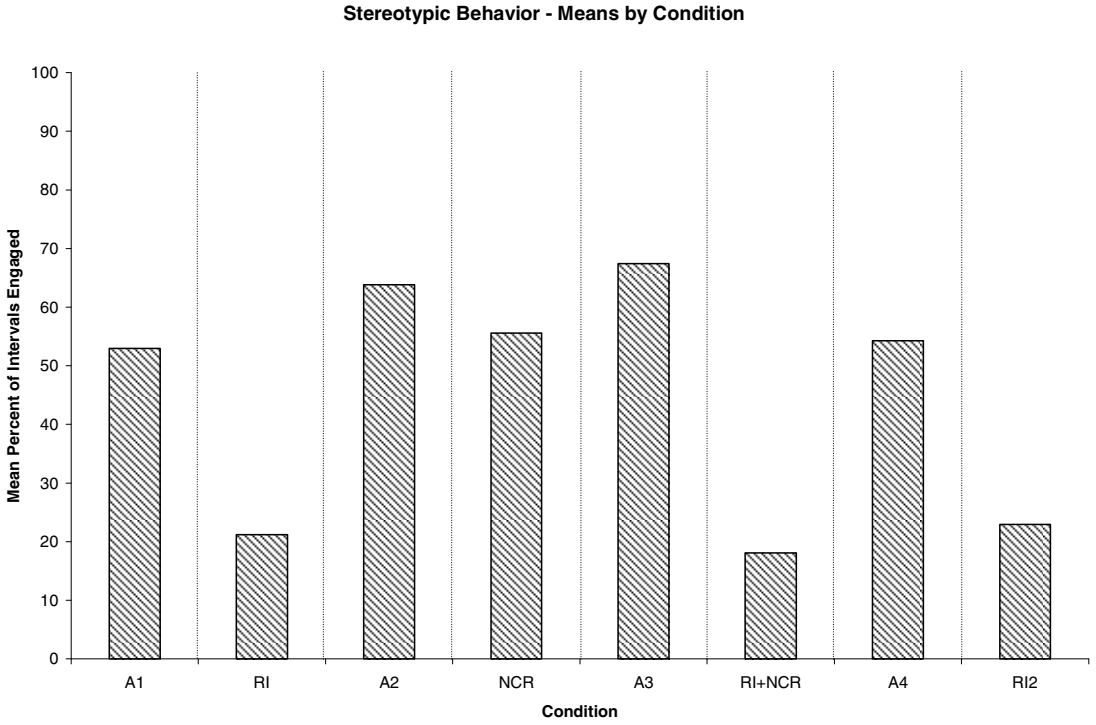

Figure 6. Stereotypic behavior summary means based on data from all participants combined across conditions.

collective baseline. Participants obtained a mean of 55.58% engagement in stereotypic behavior in the NCR in isolation condition (IV2). This represents a 10.42% decrease from baseline. It is important to note that one of the participants showed an increase in stereotypic behavior during NCR. Participants obtained a mean of 18.06% engagement in stereotypic behavior in the RI + NCR condition. This represents a 70.89% decrease from baseline and is relatively similar to the 65.89% decrease from baseline when RI was implemented in isolation. Participants obtained similar rates of engagement in stereotypic behavior during the final phase of return to RI in isolation condition, where they collectively obtained a mean of 22.93% engagement in stereotypic behavior. Overall results indicate that the combined treatment of RI+NCR was effective in reducing rates of

stereotypic behavior, but no more effective than was RI when implemented in isolation. The NCR condition, when implemented in isolation, did not result in decreases in stereotypic behavior from baseline.

Thus, the data did not support the first hypothesis, that the combined RI + NCR procedure would produce a greater decrease in stereotypic behavior than either RI or NCR alone. Both individual and collective results indicated a relatively equal decrease in stereotypic behavior for RI both alone and in combination with NCR with stimuli matched to stimuli associated with participants' stereotypic behaviors. Both individual and collective results also showed only slight decreases (or an increase for one participant) in stereotypic behavior when NCR was implemented in isolation.

Figure 7 represents mean rates of appropriate object engagement across all conditions across all four participants. Participants' had a collective baseline (from A1, A2, A3, and A4) mean of 7.13% engagement in appropriate object play (DV2). Although data show individual variation across the participants (see Figures 2 – 5), they collectively displayed only a slight increase in appropriate object engagement within the treatment conditions (except for the final return to RI). A mean of 14.26% engagement was obtained in the RI in isolation condition. Although this represents a 100% increase in the behavior compared to the collective baseline, I do not believe that it reflects a socially important increase in appropriate play behavior.

Participants obtained a mean of 10.05% engagement with appropriate objects in the NCR in isolation condition. This represented a 40.95% increase in the behavior over the collective baseline. Participants obtained a mean of 17.45% appropriate engagement in the RI + NCR condition. This represents a 144.74% increase in appropriate object

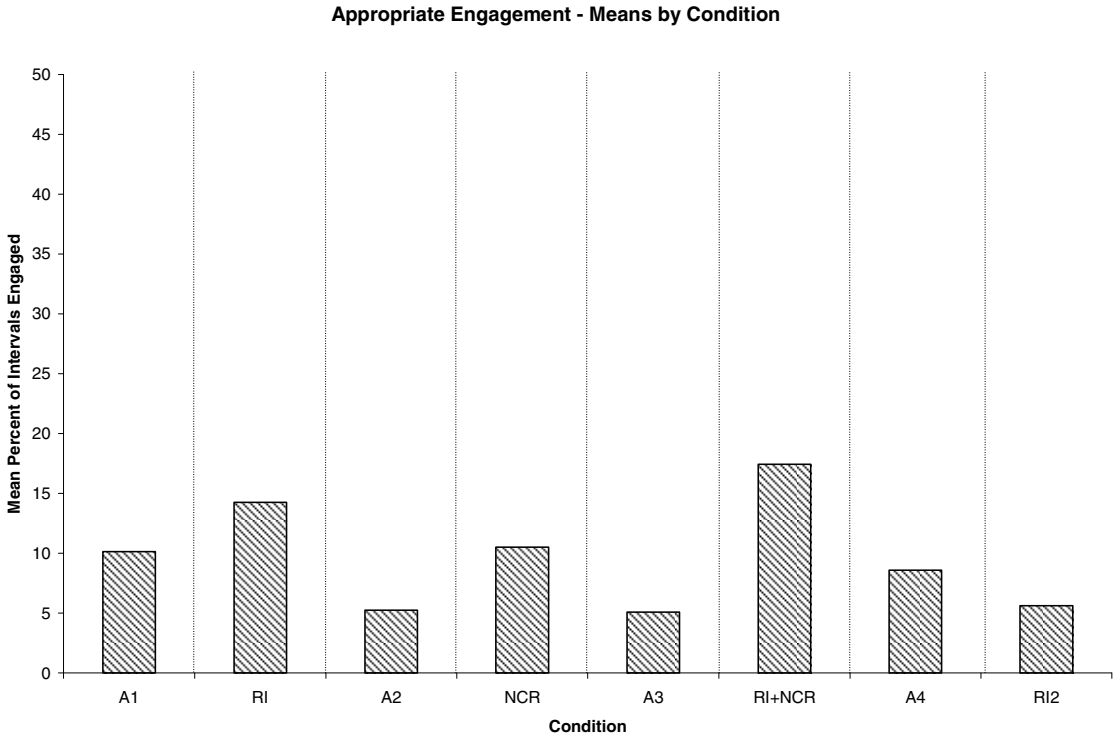

Figure 7. Appropriate engagement summary means based on data from all participants across conditions.

engagement as compared to the collective baseline. Although this is a large increase from baseline, engagement with appropriate objects for only 17.45% of 10-second intervals in a 10-minute session is far from ideal. In the final phase RI in isolation condition, participants obtained a mean of 5.61% engagement with appropriate objects. This figure is lower than participants' collective baseline of 7.13% engagement and only about half of the engagement with appropriate objects percentage obtained during the first RI condition. Overall results indicate that providing either treatment for stereotypic behavior in isolation or in combination resulted in only slight increases in appropriate object engagement. The amount of increase may or may not be considered socially important

and may not be replicable (as indicated by the different results achieved in the two RI only conditions).

The data do not provide support for the second hypothesis, that appropriate object engagement would be greatest during the combined RI+NCR condition. I did not engage in direct teaching of appropriate object play; instead, I hypothesized that appropriate object engagement would increase naturally as a by-product of decreasing stereotypic behavior. Rates of appropriate object engagement, between conditions, differed for each participant, although no participant showed socially meaningful increases during any treatment condition.

Discussion

This section summarizes and discusses the results. It also presents the implications of this research for school psychologists. I discuss the limitations of the present study and make suggestions for future research.

Discussion of Results

Current study results did not support either of the hypotheses. The RI+ NCR combined procedure did not produce a greater decrease in the rate of stereotypic behavior than did either treatment in isolation. The results contrast with those obtained by Carr et al. (2002) that supported the use of the combined procedure over either treatment implemented in isolation. In the current study, RI in isolation produced rates of reduction in stereotypical behaviors that were equal to the reductions produced by the combined procedure. This suggests that the stereotypic behavioral reductions found using the combined procedure may have been due solely to the RI component of the combined procedure. This suggestion is further supported by the failure of the NCR procedure in

isolation to produce reductions in stereotypic behavior. This finding implies that behavior reduction programs for stereotypic behavior maintained by automatic reinforcement may be effective when using only an RI strategy. It is interesting to note that rates of behavior did not drop to zero (indicating complete suppression) for any of the participants. It could be that the interruption of responses within two seconds of onset produced a pattern of brief reinforcement that was potent enough to maintain responding. A response blocking procedure, whereby the reinforcer was completely avoided, potentially would have prevented brief contact with the automatic reinforcer. Response blocking, however, would have been impossible with Jimmy and Michael since their target behaviors could not be blocked prior to it being observed. Although potentially possible, response blocking would have been highly impractical to use with Peter and Davey as well.

With regards to the behavioral principle underlying the effectiveness of RI, participants' data patterns seem to indicate that RI was most likely effective through a punishment paradigm with Participants 2, 3, and 4 (Davey, Jimmy, and Michael). Data for these participants showed a rapid reduction in stereotypic behavior from the first session of each condition in which I implemented RI (including the combined phase). This data pattern is consistent with what would be observed when a punishment paradigm is in effect under a continuous schedule of blocking (Lerman et al., 1996). If extinction were the principle behind the decrease in stereotypic behavior, the data would have shown an initial extinction burst followed by a gradual decline in rates of behavior (Smith et al., 1999). It is interesting to note that Davey showed an increase in aggressive behavior when I implemented RI. This aggressive behavior is also supportive of a punishment hypothesis to explain the effectiveness of the current RI procedure. Others in

the behavioral literature have reported punishment-induced aggression (Cooper et al., 1987), and Hagopian et al. (2001) also found punishment-induced aggression in their attempt to reduce pica through the use of RI. Davey's aggression was, however, low in intensity and easily redirected. It is interesting to note that Davey also behaved aggressively during the combined RI+NCR procedure, but not when NCR was implemented in isolation.

In contrast to the other participants, Participant 1 (Peter) displayed a lag in stereotypic behavioral reduction during each RI condition. This lag may be more consistent with an extinction paradigm than a punishment paradigm. Under extinction, a behavior would initially show a burst in responding followed by a gradual reduction in rates of behavior (Smith et al., 1999). The absence of an extinction burst could be attributed to the extreme high rates of Peter's stereotypic behavior during baseline, often reaching 100% of intervals engaged. No participant achieved full suppression of stereotypic behavior (zero rates) in any condition. This may be more of a reflection of the short duration of the experimental phases than of the overall effectiveness of treatment.

NCR using matched stimuli in isolation did not produce a significant decrease in stereotypic behavior with any of the participants. This may indicate an inability to satiate automatically reinforced behavior, at least with regard to stereotypic behavior in children with autism. Because the NCR schedule did not produce a behavioral reduction, I did not fade the schedule gradually as planned. This finding is in contrast to the behavioral reduction noted in the Carr et al. (2002) study in which they successfully decreased object mouthing in a seven year old girl with autism using NCR access to a vibrating toy placed to the mouth.

It is possible that this study did not replicate the Carr et al. (2002) finding, because the current stimuli delivered noncontingently were not properly matched to the stereotypic behavior targeted for reduction or were not as preferred as the stereotypic behaviors. It is important to note that across all participants, the stereotypic behavior targeted for reduction seemed more preferred by participants than the matched activities that I chose. For instance, I often had to prompt participants to engage with the matched activities. The inability to find activities that participants preferred as much as they preferred their stereotypic behaviors may be a result of the lack of specificity of the target behaviors chosen for reduction. Compared to object mouthing that Carr et al. (2002) studied, the behaviors treated in the current study (inappropriate toy play and stereotypic movements) were more vague, making them more difficult to approximate successfully with an alternative activity. In other words, the exact sensory nature of the automatic reinforcement was more unknown in the current study than in the study by Carr et al. (2002). Behaviors in which the exact nature of the reinforcement is known (i.e., oral sensation resulting from object mouthing) are easier to match to alternative stimuli that will produce the same reinforcer. This explanation is supported by Peter's data. Peter's stereotypic behavior of book flipping was more discrete than the stereotypic behaviors of the other participants, and it was, therefore, more easily replicated by the activity that I chose (i.e., magazine flipping). Peter displayed the highest percent of decrease in stereotypic behavior between baseline and NCR compared to the other three participants. Also, I needed to prompt Peter less than I had to prompt Davey, Jimmy, or Michael to engage in the matched activity.

Another possible reason for the lack of effectiveness of the NCR procedure was the initial schedule of 1-minute intervals between presentations of the matched stimuli. Studies supporting the effectiveness of NCR in reducing problem behavior often began with either a very short interval (30 seconds or less) (Wilder et al., 1997; Carr et al., 2002) or continuous access to the matched stimuli (Kodak et al., 2003; Roscoe et al., 1998) at the start of treatment. I did not do this in the current study due to practical limitations regarding the presentation and removal of the materials needed for the noncontingent activities. For example, when I provided the NCR to matched stimuli for Davey, I had to remove all of his toys and provide him with his trains at the start of each NCR interval. I also had to prompt some of the participants to engage with the stimuli. The time involved in this process made 30-second intervals between NCR presentations highly impractical. Perhaps if there had been shorter intervals between presentations of the matched stimuli, the stereotypic behavior would have been successfully satiated and therefore the motivation to engage in stereotypic behavior would have been avoided. Of course, the possibility still exists that children with autism have such a strong motivation to engage in stereotypic behavior that the drive cannot easily be satiated. Thus, in the presence of alternative stimuli that produce automatic reinforcement, they will engage in the alternative stimuli. In the absence of the alternative stimuli, they will quickly revert to engagement in stereotypic behavior, if not prevented from doing so (as with response interruption).

Results also did not support the second hypotheses the there would be a greater increase in appropriate object engagement during the combined procedure than during either RI or NCR alone. Peter and Jimmy displayed rates of appropriate engagement that

were slightly higher during all treatment conditions than during baseline conditions. Because the RI conditions (including the combined condition) included brief redirection towards an appropriate play object, it is probable that appropriate behavior emerged in the RI conditions because I specifically directed participants to appropriate play objects.

The exact rationale for the increase in appropriate object engagement during the NCR in isolation condition, however, is unknown. This is further confused by the fact that stereotypic behavior did not decrease during this condition. Data for Davey make the most sense theoretically. Davey's rates of appropriate object engagement only increased during conditions where RI was in effect. Rates of appropriate object engagement during the NCR in isolation condition remained unchanged from baseline. In contrast, Michael's data showed no clear trend in appropriate object engagement across conditions. In fact, for Michael, appropriate object engagement was highest during baseline conditions as compared to treatment. Observing Michael's sessions, it seemed as if any manipulation that I conducted affected not only stereotypic behavior, but appropriate behavior as well. Whereas during baseline, Michael was often very active, during treatment sessions Michael would often lay on the floor. Overall, Michael's appropriate object engagement was not increased to a socially meaningful degree in any treatment condition. These results indicate that, regardless of rates of stereotypic behavior, children with autism will probably require specific training in appropriate object play in order to foster engagement.

Study Implications for School Psychologists

Although the current data did not support the original hypotheses, the results of the study still have important implications for the practice of school psychology and the

treatment of stereotypic behavior by children with autism in general. With the rising rates of autism across the country (CDC, 2007), school psychologists will be encountering more children on the autism spectrum in their caseloads. Since stereotypic behavior interferes with many aspects of learning, socialization, and community integration, reduction of stereotypic behavior is likely to be one of the foremost goals of psychological services within the schools. The current results provide a suggestion to school psychologists for developing an effective treatment program for reducing stereotypic behavior maintained by automatic reinforcement, this being RI of stereotypic behavior. Given that the current data patterns indicate that, at least in some cases, the effectiveness of RI may work on a punishment paradigm, the suggestion to use RI within a school system may be somewhat controversial. Despite some detractors, research continues to show the effectiveness of punishment-based interventions in the reduction of problem behavior. Lerman and Vorndran (2002) in their review of punishment-based interventions state that response suppression produced by punishment may occur more rapidly and to a greater extent than suppression produced by extinction, satiation and differential reinforcement. They also state that undesirable side effects of punishment-based procedures may be less problematic than assumed because the contingency itself provides an avoidance of the punishment. The decision whether or not to use a punishment-based procedure needs to be made on a case-specific basis. The use of a punishment procedure may be warranted in situations where the target behavior is dangerous to self or others, interferes significantly with learning or socialization and/or has not been responsive to proactive procedures. Positive reinforcement of appropriate behavior should always be used in combination with a punishment-based procedure

(Alberto & Troutman, 2003). Of course, the question remains as to whether or not RI is truly a punishment procedure or an extinction procedure.

Regardless of the principles underlying the effectiveness of the intervention, the program must be implemented on a continuous basis within the treatment environment in which the behavior reduction is expected. This suggests that school psychologists may have to break away from a traditional counseling framework and step into a more behavioral consultation and training role with teachers and paraprofessionals. The current results also highlight the difficulty in increasing appropriate play behavior in children with autism without direct teaching in this area. In order to achieve best results, it is recommended that school psychologists obtain training in the principles of applied behavior analysis and keep current in their knowledge on behavioral teaching techniques designed to promote appropriate behavior in students on the autistic spectrum.

Study Limitations and Suggestions for Future Research

The current study is not without its limitations and the data need to be interpreted with an awareness of these limitations. First, as with all single subject designs, findings are based on a limited number of participants that were not randomly selected, but rather chosen because of their characteristics. Although this restricted sample is a possible limitation to the generalizability of the findings, the rigor of single-subject designs, including the reversal design used in the current study, establishes a functional relationship between the independent and dependent variables (Cooper et al., 1987). A second limitation to the study was the limited number of data points within each phase. It is possible that treatment effects would have been obtained, where they were not obtained, if the treatment phases were conducted for a greater number of sessions. For

example, rates of appropriate object engagement (DV2) may have been on an increasing trend in the RI + NCR phase for Jimmy (refer to Figure 4), however, the extent of this trend could not be evaluated because the phase was discontinued due to stability in the rate of stereotypic behavior (DV1). As explained in the results section, I made individual decisions as to when to discontinue phases based on a combination of trend analysis and variability.

A third limitation is the possibility that order or sequence effects could have affected the data. Whenever multiple treatments are being compared with a reversal design, there is a possibility that the sequential order in which the treatments are initiated may affect rates of the dependent variable (Bailey & Burch, 2002). In the present study, this possibility is unlikely given the return to the RI treatment within the last phase. Although unlikely, differentiating the order in which treatments were implemented across participants may have been beneficial.

Finally, there was a question as to the reinforcing properties of the activities used for the NCR condition. It remains a possibility that the NCR treatment would have shown greater effectiveness if the activities were more closely matched to the automatic reinforcement produced by the stereotypic behavior of the participants. It may have been beneficial to conduct data-based matching assessments prior to implementing NCR. Although some studies used a logical (non-data based) analysis to choose matched stimuli (Wilder et al., 1997; Thompson et al., 1998), other studies used data based preference assessments to assess matched versus non-matched stimuli (Rapp, 2006; Britton et al., 2002). Some researchers used a combination of logical analysis with more data based methods (Carr et al., 2002; Fisher et al., 1998). Perhaps different results would

have been obtained if the current study used a data-based preference assessment, in addition to the methods used, to assess and choose items used as matched stimuli in the NCR and RI+NCR phases.

The current findings suggest some areas for future research. One important study would be to see the effectiveness of using an RI procedure in combination with a systematic teaching procure designed to increase appropriate play in children with autism. Another interesting investigation would be to run a similar study to the current research (at least for the RI intervention), however, implement the treatment contingencies on a full-day basis within a natural setting instead of within short, isolated treatment sessions. This would show the longer-term effectiveness of the interventions and may highlight practical difficulties in implementing these interventions across an entire school day using trained teachers instead of external researchers. A study such as this would, of course, be an ambitious project to undertake. Suggestions for such a study are in accord with research findings presented in a literature review (Ramey & Ramey 1998) that indicate that the most effective behavioral interventions for children with autism are intensive and of long duration.

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