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Sensory integration as a treatment for automatically reinforced behavior

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Sensory Integration as a Treatment for Automatically Reinforced Behavior

A Thesis Presented

by

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Sensory Integration as a Treatment for Automatically Reinforced Behavior

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Abstract

Sensory integration is a theory that suggests that many of the characteristics of autism are caused by poor integration of sensory experiences. Conceptualized in behavioral terms, sensory integration therapy could serve to abolish automatically reinforced behavior. The purpose of this research was to investigate sensory integration as a treatment for repetitive behavior in individuals with autism. Two teenage boys with autism participated in Experiment 1. Both participants had high levels of automatically-reinforced motor stereotypy. A typical sensory diet treatment was examined to determine whether this treatment would have an abolishing effect on motor stereotypy. It was determined that the sensory diet had no long-term effects on motor stereotypy for either participant. One participant from Experiment 1 participated in Experiment 2, an extension to determine whether the sensory diet had any immediate or short-term effects on motor stereotypy. Results of Experiment 2, showed that the sensory diet suppressed stereotypy while it was being administered, but had no abolishing effects on stereotypy immediately after removal. Based on the results of these two experiments, Sensory Integration therapy, particularly the sensory diet approach was shown to be ineffective in decreasing motor stereotypy.

SENSORY INTEGRATION

Sensory integration is a theory of brain-behavior relationships, which proposes that in order to function properly a person must be able to “integrate” or organize sensory input from the world around him (Ayres, 2005). If an individual cannot properly integrate sensations he can end up with anything from mild problems such as difficulty concentrating to severe developmental problems like autism. According to A. Jean Ayres, the originator of sensory integration theory, people receive millions of sensations from the world around them each day, each of which are sent on to the brain. The brain and central nervous system then have to organize and interpret all of these sensations and make sense of them so that the individual is able to make meaning of the things he experiences in the world, and so that he can make adaptive (purposeful, goal-directed) responses to the things he experiences.

Sensory integration theory is based on three main components (Bundy, Lane & Murray, 2002). The first component is that all learning depends on the ability to receive and organize sensations from the environment, and to then be able to use this information to “plan and organize behavior” (p. 5). Second is that individuals who are unable to process sensations accurately may then have difficulty producing appropriate actions based on these sensations. Again, this may interfere with learning as well as behavior. The third component of sensory integration is that meaningful activity can produce enhanced sensation and therefore adaptive responding, which can develop sensory integration in an individual who is lacking appropriate sensory integration. This will then lead to an increase in learning and appropriate behavior.

Sensory integration as a process begins when a child is still in the womb and develops with age through experience and interaction with the world, according to Ayres (2005). Disorders of sensory integration usually begin very early on in development, possibly because of a lack of properly interacting with and experiencing sensory stimulation. Ayres claims normal sensory integration develops because humans have an innate “inner drive” to develop sensory integration and will seek appropriate sensations. People with sensory disorders (such as children with autism) often lack this inner drive, and therefore do not seek appropriate sensations and do not experience appropriate sensory integration. As suggested by Bundy et al. (2002), if normal sensory integration does not occur starting in infancy, normal learning and development cannot take place.

According to Bundy et al. (2002), sensory integration theory includes five assumptions involving the neural and behavioral bases of sensory integration. The first assumption is that “the central nervous system is plastic” (p. 10). This means that the brain and CNS can change throughout a person’s life, and that although a person may not be able to properly integrate sensations due to the way their brain and CNS have developed, this does not have to be a permanent impairment. Sensory integration theorists believe that with proper therapy the brain and CNS can be changed and learn to properly integrate sensations. The second assumption held by sensory integration theorists is that “sensory integration develops” (p. 11). This means that behaviors at each developmental stage occur in sequence, and this allows for proper development of more complex behavior. If sensory integration does not occur properly, normal development gets disrupted and certain more complex behaviors cannot occur or will occur out of sequence. The third assumption is that “the brain functions as an integrated whole” (p.

11) and that if lower-level brain structures (sensorimotor experiences) do not develop properly, higher-level brain structures (abstraction, language, reasoning, and learning) will not develop properly either. The fourth assumption of sensory integration theory is that “adaptive interactions are critical to sensory integration” (p. 11). In other words, individuals must make purposeful, goal directed responses to sensations from the environment in order to advance sensory integration. The final assumption is that “people have an inner drive to develop sensory integration through participation in sensorimotor activities” (p. 12). This inner drive leads people to seek new sensory experiences and integrate new sensations.

Sensory Integration and Autism

Sensory integration theorists believe that many behaviors characteristic of autism can be explained by poor sensory integration (Ayres, 2005). Supporters of sensory integration therapy believe that sensory integration is the best treatment method for autism because it is the only therapy that changes the conditions of the brain that cause the maladaptive behaviors (Ayres). According to Ayres, children with autism have problems with three aspects of sensory processing that lead to many of their maladaptive behaviors and inability to learn and develop appropriately. The first major problem that most children with autism have is that they are unable to properly “register sensory information” (p. 128). The portion of the brain which decides whether or not to register each piece of incoming sensory information and whether or not to act on that sensory information may not work properly for children with autism, causing them to not pay attention to many sensations they experience. The child with autism’s brain has a difficult time sorting out all of the different sensations it receives, making sensory

integration and, therefore, normal learning and development difficult. Ayres believes that the second problem that most children with autism have is that they are unable to properly modulate sensory input, especially from vestibular and tactile input. Many children will only register very strong sensations or may be extremely defensive to certain sensations such as light touch. These children may also have difficulty growing accustomed to continuous sensations, and may over-register some sensations and under-register others. The third common problem for children with autism is that they are unable to integrate the sensations that they register to “form a clear perception of space and (their) relationship to space” (p. 131). Children with autism are also unable to form a clear perception of their own body because they do not get adequate sensory information from skin, muscles, joints and the vestibular system. This makes it very difficult for these children to interact with their environment or with others when it is difficult for them to feel what their own body is doing. Again, this greatly impacts learning, development and social skills.

Ayres (2005) also believes that children with autism may have difficulty registering the meaning or usefulness of objects in their environment, and therefore are unable to appropriately interact with them. Because children with autism have difficulty with sensory integration, the normal path of brain development has been disrupted and complex behaviors such as abstract thinking are sometimes impossible, without first taking a step back and learning to properly integrate sensations. Ayres also maintains that children with autism lack the “inner drive” necessary to achieve proper sensory integration, and therefore need intensive therapy to expose them to different sensations that they would not otherwise seek themselves. Sensory integration therapy for children

with autism seeks to expose children to different sensory experiences and improve sensory processing. Through this therapy, it is believed that the children will learn to better register and modulate sensations, and make more appropriate adaptive responses. While supporters of sensory integration therapy claim that the child's life can be "changed considerably" they also admit "no therapy can cure autism" (Ayres, 2005, p. 135).

Sensory Integration Treatment

The goal of sensory integration as a treatment for autism (or other sensory disorders) is to improve the ability to process and integrate sensory information in order to allow children to be more independent and to participate more in daily activities (Schaaf & Miller, 2005). This is accomplished by giving the child access to sensory experiences that they have missed out on, or not had appropriate interactions with, and to allow the child's brain to learn how to process sensations and integrate sensations (Ayres, 2005). During sensory integration therapy, a child is provided with an enhanced environment, to help to meet his or her specific sensory needs. According to Ayres, sensory integration therapy sessions often involve providing children with equipment or toys that will stimulate them in certain ways, then allowing them to explore and play with the items however they feel comfortable, and allowing the child to guide the therapy sessions.

Ayres specifies several guiding principles of sensory integration therapy, including: the sensory aspects of activities are important to learning, as children organize their sensory perception they gain better control over their behavior, simple responses must be learned before more complex ones, therapy should be grounded in play, and

effectiveness of therapy is measured by whether the child is able to successfully respond to challenges that are presented (p. 143). Bundy et al. (2002) stress the importance of incorporating play into sensory integration sessions. Bundy et al. describe three criteria for a therapy session to be considered “play.” First, any interactions between the child and the environment must be “relatively intrinsically motivated” meaning that the child is engaging in the activity because something about the activity itself is reinforcing, not because of some external reinforcement (p. 230). Second, all of the activities used during therapy must be “relatively internally controlled,” meaning that the child determines who and what they want to play with during the session, and are free to move from activity to activity (p. 231). The final criterion for the session to be considered play is that it must be “free of some of the constraints of objective reality,” meaning that children can engage in pretend or fantasy play and there should not be normal “real life” consequences (p. 232).

One common sensory integration treatment plan is known as the “sensory diet.” This protocol was developed by Wilbarger (1991), and involves the “therapeutic use of sensation in the context of daily activities” (Bundy et al., 2002, p. 336). In other words, individuals are provided with certain types of sensory stimulation on a planned and regular basis. Sensory diets are most often prescribed for people who are sensory defensive, and are often used with children with autism (Bundy et al.). With this treatment plan, according to Bundy et al., sensory-based activities are given to the individual at regular intervals throughout his or her day, in order to provide access to certain types of sensory stimulation. Activities, as well as duration of access and length of treatment vary based on each individual’s sensory stimulation needs..

According to Wilbarger (1991), the rationale behind the sensory diet is that individuals require a “certain quality and quantity of sensory experiences to be skillful, adaptive, and organized in their daily lives” (Bundy et al., 2002, p. 339). Wilbarger believed that repeated sensory input could cause lasting changes in brain functioning; allowing individuals to more properly integrate sensations (Bundy et al.). According to Bundy et al., the sensory diet is especially helpful in achieving sensory integration for those individuals who need appropriate sensory stimulation but do not independently seek this stimulation. Some benefits of the sensory diet, as described by Bundy et al., include improved postural functioning, improved body awareness, improved self-regulation, decreases in tactile defensiveness, reductions in sensory-deprivation, and decreases in self stimulatory behavior.

Sensory diets are sometimes used as a sensory integrative technique for children with autism, in an attempt to decrease self-stimulatory behaviors. Bodfish, Symons, Parker and Lewis (2000), found that approximately 75% of children with autism showed high levels of stereotypic behavior and exhibited a variety of different response forms. Bodfish et al. also found that, relative to other children with similar developmental delays, children with autism showed much higher rates of stereotypical behaviors and self-stimulatory behavior. Iarocci and McDonald (2006) also found that between 30-100% of people with autism showed some type of sensory sensitivity. In another study, surveys were sent out to caregivers of children with autism (Lam and Aman, 2007),. The results of these surveys showed that 80% of the children had some type of sensory sensitivity. Since children with autism generally display such high rates of stereotypy and self-stimulation, they are often appropriate candidates for a sensory diet approach.

Sensory Integration Controversy

Although major proponents of sensory integration theory such as Ayres believe that sensory integration is an effective means of treating many sensory disorders including autism, there has been much debate over the past decade about its utility. In a review by Dawson and Watling (2000), four separate studies of the effects of sensory integration on autism were examined. All four studies had positive results, with children showing increased appropriate behaviors (vocalizations, engagement, socialization, etc.) and decreases in inappropriate behaviors such as non-engagement. Dawson and Watling concluded, however, that because minimal research had been conducted on sensory integration, that no conclusions could be drawn about whether it is an effective therapy for autism.

In 1992, Temple Grandin, wrote an article about the calming effects of deep pressure for people with autism. In this article she defended sensory integration, and explained from the perspective of a person with autism, how deep pressure and certain forms of touch can help to calm a person with autism and help him to achieve sensory integration. Grandin claimed that in a study she conducted, when 18 children with autism were exposed to a “squeeze machine” that applied deep pressure over their whole body, up to 89% felt calmer.

Goldstein (2000) claimed that research evaluating the effects of sensory integration lacked “scientific rigor” and should not be taken to show that sensory integration is an appropriate treatment for autism. According to Goldstein, there is not enough clinically significant research showing that sensory integration is an effective treatment for autism, and therefore it is not appropriate for researchers to advocate its use

as a valuable treatment. Edelson, Rimland and Grandin (2003), responded to Goldstein's commentary by noting there are plenty of data supporting sensory integration as an effective treatment, and research findings do warrant the use of sensory integration as a treatment for autism. In defense of Grandin's deep pressure research, Edelson et al., claim that it is acceptable to use a therapy that has not yet been proven effective, as long as there is no danger to the individuals receiving the treatment or when there are no alternative treatments available and when there is no evidence that the treatment is ineffective. Goldstein wrote a second commentary in 2003 in response to Edelson et al., again arguing that the data supporting sensory integration was weak, and that it is unethical to provide services without some reasonable evidence that they are effective. Goldstein also discussed how the cost of using treatments that are not scientifically proven effective greatly outweighs the benefits, and how it is better to just use proven treatments.

Griffer (1999) also contributed to the debate over whether sensory integration is an effective treatment with a review of research using sensory integration as a treatment for children with "language-learning disorders." Griffer, like Goldstein, concluded that there was a lack of empirical evidence supporting sensory integration as a treatment. In the research reviewed by Griffer, there were mixed reviews of sensory integration, with sensory integration being most effective when applied to some type of motor or reflexive measure, and least effective when applied to language.

Treating Automatically Reinforced Behaviors with Sensory Integration

Sensory integration therapy and sensory diets, despite the controversy that surrounds them, are sometimes used in an attempt to control automatically-reinforced

problem behaviors, such as stereotypy, self-injury or other self-stimulatory behaviors, often with children with autism (Bundy et al., 2002). According to Vaughan and Michael (1982), automatic reinforcement can be defined as any behavior that does not require mediation by another person. Vollmer (1994) specifies that any behavior that is automatically reinforced should meet the following criteria: the behavior persists when the person is alone, contingent access to the automatically-reinforced behavior should function as a reinforcer, blocking the automatically-reinforced behavior will result in response suppression, and social contingencies are not necessary to maintain the behavior. Sensory integration interventions may be effective for treating automatically reinforced behaviors because they may alter the sensory consequences of those behaviors by providing alternate forms of stimulation.

Few empirical studies evaluating the effects of sensory integration have been conducted. Of those that have, as previously mentioned, many lack scientific rigor and do not have sufficient data to support sensory integration as a valid treatment (Goldstein, 2003). Ayres' book about sensory integration theory is based on personal anecdotes involving her experiences with clients. No experimental data are provided, and she mentions few empirical studies or measurable results of therapy. Despite the lack of research evaluating sensory integration, it has become a popular therapy option for children with autism. In the following section the few empirical studies evaluating sensory integration are reviewed.

Mason and Iwata (1990) studied the effects of sensory integration therapy on the self-injurious behavior of three children with profound disabilities. Results of a functional analysis showed that one participant's self-injury was maintained by attention,

one by escape and one by automatic reinforcement. After a stable baseline was established, sensory integration techniques were used for each participant as treatment for their self-injury. During sensory integration therapy, participants were provided with continuous access to items that provided them with auditory, visual, kinesthetic, tactile, and vestibular stimulation for 15 min. During treatment a therapist was present, but did not provide attention (the therapist was only there for safety reasons). Following the sensory integration therapy, the participants were each exposed to a behavioral intervention for their self-injury. For the two participants who had socially maintained self-injury, extinction was used as the behavioral intervention, and for the participant whose behavior was automatically-reinforced, a treatment package involving competing items and DRO was used. Results of this study showed that sensory integration was ineffective in reducing levels of SIB for the participant with attention maintained behavior, unless attention was non-contingently provided as part of the sensory integration treatment (in this case the behavior decreased slightly). For the participant with escape-maintained SIB, sensory integration slightly decreased SIB relative to baseline. For the participant with automatically reinforced SIB, sensory integration actually increased the behavior relative to baseline. In the second phase, when behavioral techniques were applied to the SIB of each participant, SIB was reduced to the lowest levels (zero or near zero levels for all participants). These results showed that sensory integration was not an effective treatment for SIB, especially when it was maintained by automatic reinforcement. In all three cases, contingency-dependent, behavioral treatment strategies were more effective than the sensory integration techniques.

Hoehn and Baumeister (1994) examined meta-analyses of sensory integration research. In eight studies involving children and adults with developmental disabilities, sensory integration appeared to have an overall positive effect on behavior, being most effective for treating motor/reflexive responses, and least effective for treating language problems. However, Hoehn and Baumeister noted that many of these studies had empirical flaws or lacked scientific rigor, preventing their use to support sensory integration therapy. A second meta-analysis was conducted which included seven studies of children with learning disabilities who were exposed to sensory integration therapies. Based on the results of these studies, Hoehn and Baumeister concluded that sensory integration therapy lacked validity and utility as a therapy, and should not be used as a therapy until there is clear empirical support for it.

Wells and Smith (1983) studied the use of sensory integration to reduce SIB with four profoundly mentally retarded participants. SIB in this study was assumed to be automatically maintained, although no experimental analysis of maintaining variables was conducted. Sensory integration treatment consisted of slow repetitive, vestibular stimulation (rocking in a hammock or chair) and firm, deep tactile stimulation (vibrator or massage), rolling on a therapy ball, and rolling a large bolster over legs, back and shoulders. Sensory integration sessions lasted 30 min each weekday. Results showed immediate and large decreases in SIB for all participants, and an increase in SIB when baseline was reinstated for one participant. Although these results seem promising, this study, like many others lacked scientific rigor. For example, there were no reliability measures, and there was only a reversal in treatment for one participant.

Function-based Treatment for Automatically-Reinforced Behavior

Although there has been little experimental research on treating automatically-reinforced behavior with sensory integration, there has been much research on other empirically supported function-based behavioral treatments for these behaviors. Vollmer (1994) suggested several methods for treating automatically-reinforced behaviors including: punishment, extinction, differential reinforcement, and altering motivating operations. As with all behavioral treatments, it is important to first identify the maintaining variables of problem behavior (Iwata et al., 1994). If it is determined that the behavior is maintained by automatic reinforcement, punishment, differential reinforcement, and manipulation of motivating operations have been shown to be effective interventions.

Punishment-based Procedures

Punishment-based procedures for automatically maintained behavior involve delivering an aversive consequence contingent on the target behavior, with the goal of decreasing the target behavior (Vollmer, 1994). In a study conducted by Foxx and Azrin (1973), overcorrection (practicing the correct form of behavior for a specific period of time contingent on the target inappropriate behavior) was compared with other potential punishers (slap contingent on target behavior, differential reinforcement of other behavior, distasteful solution painted on the hand of a hand-mouther, and free access to reinforcement) for various behaviors of children with mental retardation and autism. Results showed that overcorrection eliminated behaviors in all four participants, and was more successful than all of the other alternative procedures. The experimenters

concluded that overcorrection appeared to be a rapid, effective, enduring treatment method for eliminating problem behavior.

Ricketts, Goza and Matese (1992) also used punishment to decrease automatically maintained behavior. In their case study, they used a combination of Naltrexone (an endogenous opiate used to decrease sensation from automatically reinforced behaviors) and contingent electric shock (Self Injurious Behavior Inhibition System) to treat the severe self-injury of a 28-year-old man with profound mental retardation. A single electric shock was delivered contingent on each instance of self-injury during treatment. According to the experimenters, SIBIS was clearly superior in treatment of SIB to no treatment or Naltrexone alone in the beginning of the case study, however as SIBIS and Naltrexone were combined, the effectiveness of SIBIS became dose-dependent, with more and more Naltrexone being needed to control SIB and SIBIS having less of an effect (possibly because Naltrexone weakened the painful effects of the shock).

Ahearn, Clark, MacDonald and Chung (2007) also examined a treatment strategy that could be considered punishment for treating automatically-reinforced behavior. They used a response interruption and redirection (RIRD) procedure to decrease automatically-reinforced vocal stereotypy in four children with autism. The procedure consisted of issuing a series of vocal demands contingent on any vocal stereotypy, and continuing these vocal demands until the child successfully complied with three of them while not exhibiting vocal stereotypy. Relative to baseline, the RIRD procedure produced substantially lower levels of vocal stereotypy, and higher levels of appropriate communication for all three participants. Although the RIRD procedure may function as punishment for automatically-reinforced behavior (the vocal demands can be aversive

and are applied contingent on the behavior), another component of this procedure involves differential reinforcement of mutually exclusive response topographies (i.e. vocal stereotypy and appropriate vocalizations can not occur at the same time).

Extinction-based Procedures

Extinction procedures can sometimes be used to decrease automatically reinforced behaviors, but these procedures are often very difficult to implement. In order for a procedure to be technically considered extinction, the behavior must be able to occur, without its typical reinforcing consequences occurring. Because the reinforcing consequences of the automatically-reinforced behavior are often unknown, it is difficult to conduct true extinction. Rincover, Cook, Peoples, and Packard (1979) began an important line of research in which they studied sensory extinction for automatically reinforced behaviors. In this study, four children with autism who exhibited high rates of self-stimulatory behavior participated. First, each child's topography of problem behavior was observed to develop a hypothesis about the potential sensory consequences that could be maintaining the behavior (auditory, visual, proprioceptive, etc.). Subsequently, a sensory extinction procedure was created based on this hypothesis. For example, with one participant who spun a plate on a table, it was hypothesized that the auditory consequences of plate spinning were maintaining the behavior. So the sensory extinction procedure involved covering the table with carpeting, so that the participant could still engage in the behavior, but would no longer receive the auditory feedback. It was found that with all participants, when the sensory extinction procedure was conducted, the behavior decreased to low levels. The authors noted that the mechanism responsible for the reductions observed was sensory extinction. Ellingson, et al. (2000),

also used a sensory extinction procedure to decrease automatically maintained thumb sucking in two typical children. In this study, they applied a glove to the child's hand, reducing the sensory consequences of thumb sucking. Thumb sucking was reduced to zero levels for one participant, and reduced moderately for the other participant. Lerman and Iwata (1996) also used sensory extinction (termed response blocking) to reduce hand mouthing in a man with profound mental retardation. Based on an analysis of response patterns across schedule changes in blocking, the authors determined that response blocking actually functioned as punishment.

Differential Reinforcement-based Procedures

Differential reinforcement procedures can also be used to decrease automatically-reinforced problem behaviors (Vollmer, 1994). According to Vollmer, when differential reinforcement procedures are used, reinforcement is delivered contingent on appropriate behavior and (sometimes) withheld contingent on the target behavior. One limitation with using this procedure with automatically reinforced behavior is that it is often difficult or sometimes impossible to withhold reinforcement contingent on the target behavior. Taylor, Hoch and Weissman (2005) conducted a case study in which they compared the effects of differential reinforcement of other behavior (DRO) to fixed-time reinforcement for automatically-reinforced vocal stereotypy of a 6-year-old girl with autism. Taylor et al. conducted both an antecedent analysis and a concurrent-operants analysis to identify leisure items that would compete with the participant's vocal stereotypy, and to ensure that the participant would engage with these toys. After preferred leisure items were found that competed with the participant's vocal stereotypy, two types of treatments were compared using an alternating treatments design. The first treatment was fixed-time

reinforcement, in which the participant was given access to items once per min for 30-s. The other treatment consisted of a 1-min resetting DRO interval, in which the participant received praise and access to leisure items for 30-s if she did not display vocal stereotypy. If she did engage in vocal stereotypy during the interval, it was reset. Results showed that the DRO was much more effective than FT reinforcement in reducing vocal stereotypy, and the DRO interval was successfully increased to 5 min. Although DRO has been found effective for reducing problem behavior, a limitation of this intervention is that it does not involve delivery of consequences for appropriate alternative behavior. Also, DRO interventions can be very time and labor intensive to administer and require some level of training to implement accurately.

One way to reduce the time and resource intensity associated with DRO is to use momentary-time DRO instead of whole-interval DRO. In a momentary-time DRO, reinforcement only depends on whether the behavior is occurring at the moment at the end of the interval. In whole-interval DRO, reinforcement depends on whether the problem behavior occurs during any portion of the interval. Barton, Brulle and Repp (1986) studied whether momentary-time DRO was as effective as whole-interval DRO for reducing the problem behavior of nine children with mentally retardation. The experimenters found that momentary DROs could be used to maintain behavior changes, and were just as effective as whole-interval DROs. The authors also concluded, however, that neither whole-interval DRO nor momentary-time DRO completely eliminated the target behavior.

Manipulation of Motivating Operations

A fourth general treatment option for automatically-reinforced behavior involves manipulating motivating operations (Vollmer, 1994). According to Vollmer, altering motivating operations is often accomplished through response competition, providing matched forms of stimulation, or enriching the environment. These methods are most similar to what are commonly considered sensory integration treatment methods.

According to Laraway, Snyckerski, Michael and Poling (2003), motivating operations are “environmental events, operations, or stimulus conditions that affect an organism’s behavior by altering (a) the reinforcing or punishing effectiveness of other environmental events and (b) the frequency of occurrence of that part of the organism’s repertoire relevant to those events as consequences” (p. 407). Often, treatments for automatically reinforced behavior involve abolishing operations, which according to Laraway et al., involve decreasing the effectiveness of a given consequence.

Piazza, Adelinis, Hanley, Goh and Delia (2000) evaluated the effects of giving access to matched stimulation non-contingently on automatically-reinforced problem behaviors. Participants were three children with developmental disabilities, who exhibited problem behavior that was automatically reinforced. Preferences assessments were conducted to identify preferred leisure items that did or did not match the hypothesized sensory consequences of the problem behavior. Each participant was then given non-contingent, continuous access to either highly-preferred matched or highly-preferred unmatched items. Results showed that providing access to matched stimuli was more effective in reducing problem behavior than providing access to unmatched stimuli.

Another study that examined modifying establishing operations to decrease automatically-reinforced behavior was conducted by Rapp (2007) who evaluated a method for empirically identifying matched stimulation. Participants were 9-year-old boys diagnosed with autism, who exhibited high levels of automatically-reinforced vocal stereotypy. Rapp first examined the effects of matched and unmatched stimulation and found that the sensory consequence maintaining vocal stereotypy was auditory stimulation. Therefore, leisure items that produced auditory stimulation were selected as matched stimulation and leisure items that did not provide any auditory stimulation were selected as unmatched. For both participants, levels of stereotypy were lower when given non-contingent access to matched stimulation.

Sidener, Carr and Firth (2005) also evaluated environmental enrichment as an abolishing operation for automatically reinforced behavior. In this study, several treatments were compared for two 6-year-old girls with autism who displayed automatically reinforced scratching behaviors. The experimenters first tried superimposing, then withholding edible reinforcers contingent on scratching behavior, which was not successful for either participant. An environmental enrichment condition was then implemented, in which many items that had previously been found to compete with the scratching behavior (and have high levels of engagement) were placed in the room with the participant. Both participants showed decreased levels of scratching and increased levels of appropriate play during the environmental enrichment condition. The authors concluded that in some cases of behaviors that are automatically reinforced, enriching the environment with items that compete with the behavior might help to decrease the behavior.

Purpose of Current Study

The purpose of the current study is to determine whether sensory integration therapy, when used as an antecedent intervention, can decrease automatically-reinforced problem behavior. In the current study, participants were exposed to a sensory diet in which items that were shown to compete with stereotypy were provided non-contingently at pre-specified intervals throughout the day. Participants' stereotypy was measured both in the morning and in the afternoon during baseline (no sensory integration) and treatment sessions in order to determine whether there was any long-term effect of sensory integration. In a second experiment, stereotypy was measured while the participant had access to the sensory diet, as well as immediately after access to the sensory diet, in order to examine short-term effects of the sensory diet. This research provides an important experimental analysis of sensory integration, in order to determine whether sensory integration, and specifically sensory diet-type treatments are effective ways to treat automatically reinforced behaviors.

EXPERIMENT 1

Method

Participants

Two boys diagnosed with autism, who received services at the New England Center for Children participated in this study. Pat was a 14-year-old student in a day program, and Luke was a 19-year-old student in a residential program. Clinical and educational providers referred participants for this study based on their high levels of motor stereotypy, which interfered with educational programming.

Setting and Materials

Assessments for Pat and Luke (functional analysis, competing items assessments, and treatment assessments) took place in a 1.5m x 3m research room at the participants' school, which was equipped with a wide-angle camera, microphone and video recording equipment. All sensory integration treatment sessions for Pat and Luke, took place in the participants' classroom, at his desk.

During the competing items assessment, 10 or more sensory items were evaluated with each participant. These items were recommended by an Occupational Therapist trained in sensory integration. Items were chosen based on their sensory properties, in order to compete with the hypothesized sensory consequences of the target behavior. Items that were shown to compete with the target behavior were then used for treatments (sensory diet and direct competition).

Response Measurement and Interobserver Agreement

Pat's *motor stereotypy* was defined as any non-functional movement of the hands, arms or fingers, including: hand and finger flapping, finger posturing, clenching of the hands or fingers in front of the face, tapping on objects with the hand or fingers, clapping hands, waving arms up and down, or rubbing fingers on objects. Examples of motor stereotypy included: repeatedly clapping hands, waving hands in front of face, clenching hands and fingers and running around the room, and tapping on walls. Non-examples of motor stereotypy included: walking around with hands in pockets, placing a hand on the wall or window, and biting the backs of hands.

Luke's *motor stereotypy* was defined as any non-functional movement of the fingers and hands including finger tapping, or full body rocking. Examples of motor

stereotypy for Luke included: raising arms above head and moving fingers quickly, and body rocking while standing or sitting. Non-examples of motor stereotypy for Luke included using appropriate sign language to communicate, and folding hands.

All functional analysis conditions were 5 min. Data on motor stereotypy were collected using a 10-s momentary time sampling. At the end of each 10s interval, an observation of 2s occurred during which the occurrence or non-occurrence of motor stereotypy was recorded (i.e 10s through 11s, 20s through 21s, etc.).

During the competing items assessment, data were collected on stereotypy and item engagement using a 10-s momentary time sample. Based on the results of this assessment, items were chosen for the treatment phases. Items were chosen based on high levels of engagement (at least 80%) and low levels of stereotypy (below 20%). Each participant was given at least 7 items in his sensory diet, based on the results of the competing items assessment.

Interobserver agreement data were collected during at least 33% of all sessions throughout the study. For all sessions, mean agreement was calculated by dividing the number of intervals with agreements by the total number of intervals with agreements plus disagreements, then multiplying this number by 100%. Mean total agreement for functional analysis sessions for Pat was 94.6% (range = 90%-100%), and mean agreement for Luke was 91.9% (range = 86%-97%). Mean total agreement for competing items sessions for Pat was 90.1% (range = 80%-100%) for motor stereotypy and 90.5% for engagement (range = 83%-100%), and mean agreement for Luke was 96.1% (range = 83%-100%) for motor stereotypy and 99.3% (range = 94%-100%) for engagement.

Data were taken during sensory integration treatment on participants' motor stereotypy using 10-s momentary time sampling (2-s observation periods). Mean total agreement for Pat's motor stereotypy during baseline was 82% (range = 72%-95%). Mean total agreement for Pat's motor stereotypy during treatment was 90% (range = 85%-98%). Mean agreement for Luke's motor stereotypy during baseline was 91% (range = 90%-100%). Mean agreement for Luke's motor stereotypy during treatment was 90% (range = 83%-100%).

Pre-treatment Analyses

Functional Analysis

A functional analysis of the targeted stereotypy was conducted for each participant similar to that described by Iwata, Dorsey, Slifer, Bauman, & Richman (1994). Three conditions (alone, attention and demand) were conducted in each functional analysis in the following order: alone, alone, attention, alone, alone, demand. This series was repeated until the behavior showed a stable trend. During the alone condition, the participant was placed in the room alone with no materials or furniture. During the attention condition, the participant was given leisure items (books, toys, etc.) to engage with, while the experimenter sat in the corner of the room and acted as if they were doing work. During this condition, the experimenter gave the participant no attention unless he exhibited the target behavior (vocal or motor stereotypy). If the participant exhibited the target behavior, the experimenter gave him direct eye contact and verbal attention (i.e., "Stop doing that," "Don't do that"). During the demand condition, the experimenter presented demands that were difficult for the participant to complete (i.e., "Write the letter P," "wipe the table"). Demands were presented every 15-

s. If the participant did not correctly comply with the response within 5-s, the experimenter modeled the response. Verbal praise was delivered only if the participant independently and accurately complied with the response. If the participant exhibited the target behavior during the demand session, the experimenter said, “OK, you don’t have to do it,” and immediately removed the task materials and attention for 15-s. If the participant re-emitted the target behavior at the end of 15-s, the experimenter turned back around as if to present the demand, but immediately stated “OK you don’t have to do it,” then removed attention for 15 additional seconds. All other behavior was ignored during this session.

Functional Analysis Results

It was found that motor stereotypy occurred at the highest level during the alone condition for Pat (See Figure 1). The mean rate of stereotypy during the alone condition was 47.7% (range 27%-70%), while the mean rate of stereotypy during the attention condition was 26.7% (range 20%-33%), and the mean rate of stereotypy during demand conditions was 9.5% (range 3%-27%). These findings indicate that Pat’s stereotypy was maintained by automatic reinforcement.

It was found that motor stereotypy occurred at the highest level during the alone condition for Luke (See Figure 2) The mean rate of stereotypy during the alone condition was 44.2% (range 0%-93%), while the mean rate of stereotypy during the attention condition was 22.0% (range 0%-47%), and the mean rate of stereotypy during demand conditions was 24.0% (range 0%-43%). These findings indicate that Luke’s stereotypy was maintained by automatic reinforcement.

Competing Items Assessment

Following the functional analysis, a competing items assessment was conducted. During this assessment, the participant was presented with at least 10 different toys/items that were suggested for inclusion by an occupational therapist who was trained in sensory integration therapy. These items were chosen based on their sensory properties, in order to provide the same type of sensory stimulation that stereotypy was hypothesized to provide. During each 3-min session, the therapist presented the participant with one of the items, and instructed the participant to play with the item at the start of the session, then provided no further attention. Two separate competing items assessments (both with similar items that were suggested by the occupational therapist) were conducted, one to determine items for the sensory diet phase, and one to determine items for the direct competition phase.

Competing Items Assessment Results

Results of the competing items assessment for Pat showed that the tornado water bottle (motor stereotypy = 3%, engagement = 83%), pinwheel (motor stereotypy = 10%, engagement = 93%), clapper hands (motor stereotypy = 6%, engagement = 100%), light stick (motor stereotypy = 6%, engagement = 93%), moon sand (motor stereotypy = 10%, engagement = 90%), slinky (motor stereotypy = 0%, engagement = 100%), elmo ball (motor stereotypy = 3%, engagement = 90%), and koosh ball (motor stereotypy = 3%, engagement = 87%) all successfully competed with motor stereotypy (See Figure 3).

Results of the competing items assessment for Luke showed that the large koosh (motor stereotypy = 5.6%, engagement = 100%), brush (motor stereotypy = 5.6%, engagement = 100%), chewy tube (motor stereotypy = 16.7%, engagement = 100%),

small koosh (motor stereotypy = 0%, engagement = 100%), television (motor stereotypy = 5.6%, engagement = 100%), rain stick (motor stereotypy = 0%, engagement = 100%), feather (motor stereotypy = 5.6%, engagement = 100%), kaleidoscope (motor stereotypy = 11.1%, engagement = 94.4%), large therapy ball (motor stereotypy = 16.7%, engagement = 94.4%), jacks (motor stereotypy = 0%, engagement = 88.9%), CD player (motor stereotypy = 5.6%, engagement = 89.9%), and turning wheel (motor stereotypy = 0%, engagement = 83.3%) all competed successfully with motor stereotypy (see Figure 4).

Sensory Diet Treatment

Experimental Design

During this experiment, a sensory diet treatment approach was used, in which participants were given access to all of the items determined to compete with their stereotypy for a specified amount of time each day. Stereotypy was then measured in the morning and in the afternoon both when the participant was given access to the items, and when no treatment was in place. An ABABA design was used for Pat, while an ABAB'A was used for Luke (A was baseline, B was 10 min per hour of sensory diet exposure, B' was 15 min per hour of sensory diet exposure). This experiment was designed to determine whether the sensory diet treatment would have any long term abolishing effects on motor stereotypy.

Baseline

Baseline sessions were conducted with each participant to determine levels of stereotypy during the morning and afternoon when the sensory integration intervention was not in effect. Baseline observations were conducted in the morning (approximately 9

A.M.) and afternoon (approximately (2 PM), 2-to-3 times per week, in the same place functional analyses were conducted (research room for Luke and Pat, classroom for Ben and Evan). During these sessions, the participant was alone and had no materials for 10-min.

Sensory Integration Treatment (Sensory Diet)

After levels of stereotypy were stable, sensory integration treatment was begun, in the form of a sensory diet. During treatment, each participant was given access to the sensory diet for the first 10 min of each hour that he was in school (6 hours for Pat and 5 hours for Luke). The sensory diet included all of the competing items identified during the preference assessment. If the participant did not engage with the items, he was prompted to do so using a least-to-most prompting procedure to engage with the items. Participant's teachers initialed a sign-off sheet each hour (See Appendix 1), verifying that the student was given the sensory diet for 10 min. During the treatment phase, 10-min observations, identical to those described above, were conducted.

Results

During the first baseline, the mean level of motor stereotypy in AM sessions for Pat was 38.8% ($sd = 12.0$), while mean level of motor stereotypy in PM sessions was 41.6% ($sd = 15.1$) (See Table 1, Figure 5). During the first SI treatment phase, motor stereotypy was reduced slightly in the AM to a mean level of 23.0% ($sd = 11.8$), and in the PM to a mean level of 22.8% ($sd = 8.9$). During the second baseline, the mean level of stereotypy in the AM was 31.5% ($sd = 13.6$), and in the PM was 32.5% ($sd = 12.5$). During the second treatment, AM motor stereotypy increased to 38.8% ($sd = 10.8$), and in the PM increased to 28.8% ($sd = 13.3$).

During the first baseline, the mean level of motor stereotypy in AM sessions for Luke was 71.86% ($sd = 11.28$), and the mean level of motor stereotypy in PM sessions was 61.28% ($sd = 26.98$) (See Table 2, Figure 6). During the first SI treatment phase, motor stereotypy was reduced slightly in the AM to a mean level of 68.76% ($sd = 32.54$), and increased slightly in the PM to a mean level of 82.48 ($sd = 12.06$). During the second baseline, the mean level of stereotypy in the AM was 77.62% ($sd = 28.72$), and in the PM was 57.15% ($sd = 36.55$). During the second treatment, AM motor stereotypy increased to 89.00% ($sd = 21.93$), and in the PM increased to 71.78% ($sd = 37.77$).

Discussion

Results of Experiment 1 showed that the sensory diet treatment was ineffective in reducing participants' stereotypy during both AM and PM sessions. Morning sessions were conducted before participants had access to the sensory diet items, and afternoon sessions were conducted at least 10-min after the last exposure to sensory diet items. It is presumed that if the sensory diet treatment was effective, PM sessions would have been associated with lower levels of stereotypy than AM sessions. This effect was not consistently observed for either participant. Also, if sensory integration treatment were effective, general levels of stereotypy should have been lower during treatment phases than during baseline. Again this effect was not consistently observed for either participant. Although it appears that stereotypy was lower during the first treatment for Pat, this effect was not replicated when the treatment was introduced for the second time. Despite being given access to sensory diet items for a total of 50-75 min a day (which is much more than the average amount of exposure during actual sensory integration treatments), stereotypy did not decrease for any of the participants. Experiment 1

determined that sensory integration did not have any lasting or long-term effects on behavior, but it was still unknown whether this type of treatment had any immediate or proximal effects on behavior. Experiment 2 was designed to determine how the sensory diet treatment affected behavior both during treatment (while accessing sensory diet items) and immediately after treatment. As in Experiment 1, Pat was given access to the sensory diet items for 10 minutes one time in the morning and one time in the afternoon. However, motor stereotypy was measured both during access to the sensory diet and immediately after access to sensory diet items to determine if there were any immediate or short-term abolishing effects of the sensory diet.

EXPERIMENT 2

Method

Participant and Setting

Pat from Experiment 1 participated in Experiment 2. Again, Pat's motor stereotypy was targeted in this experiment. All sessions were conducted in the research room where initial assessments took place. Sessions were each 10 min in length, and took place 2-3 times per week.

Response Measurement and Interobserver Agreement

Motor and vocal stereotypy were defined exactly the same as in Experiment 1 for Pat. Engagement was defined as any contact with any of the sensory items. Interobserver agreement data were collected during at least 33% of treatment sessions. Mean agreement was calculated by dividing the number of intervals with agreements by the total number of intervals with agreements plus disagreements, then multiplying this number by 100%. Mean total agreement for Pat's motor stereotypy during baseline was

95% (range = 90%-100%). Mean total agreement for Pat's motor stereotypy during treatment was 95% (range = 82%-100%). Mean total agreement for Pat's engagement during treatment was 99% (range = 98%-100%).

Competing Items Assessment

A second competing items assessment, exactly the same as the first was conducted with new items similar to the items in the first assessment. This was done to ensure that Pat was not satiated with the items used in Experiment 1. Again, 20 items determined by an Occupational Therapist who consulted with a Sensory Integration therapist were used. In this assessment 15 items were identified that competed with Pat's motor stereotypy.

Competing Items Assessment Results

Results of the competing items assessment showed that the neck pillow (motor stereotypy = 13%, engagement = 100%), light up globe (motor stereotypy = 16%, engagement = 100%), squishy skull (motor stereotypy = 13%, engagement = 100%), noisemaker (motor stereotypy = 0%, engagement = 93%), confetti bin (motor stereotypy = 6%, engagement = 86%), electric toothbrush (motor stereotypy = 10%, engagement = 93%), spoons (motor stereotypy = 13%, engagement = 100%), lion king radio (motor stereotypy = 20%, engagement = 100%), chewy ring (motor stereotypy = 3%, engagement = 100%), moo can (motor stereotypy = 20%, engagement = 100%), exercise ball (motor stereotypy = 7%, engagement = 100%), scrub brush (motor stereotypy = 3%, engagement = 100%), ribbon wand (motor stereotypy = 0%, engagement = 100%), and colored glasses (motor stereotypy = 7%, engagement = 83%) all competed with Pat's

motor stereotypy (See Figure 7). The exercise ball and colored glasses were not used during the direct competition assessment due to the items breaking too easily.

Baseline

Baseline sessions in Experiment 2 were run exactly identical to Experiment 1. Pat was placed in the research room alone for 10-min upon arrival to school and 10-min at the end of the school day, and stereotypy was not consequated. 10-s momentary time sampling was used to measure motor stereotypy during all baseline sessions.

Direct Response Competition

During direct competition sessions, Pat was given access to the items from the second competing items assessment once in the morning for 10-min, and once in the afternoon for 10-min. Items were given to Pat in the research room, and he was instructed, “Play with your toys,” and left alone in the room for 10-min. During this time, stereotypy was measured using a 10-s momentary time sample. Following the 10-min exposure to sensory items, Pat was taken for a short walk (no more than 2-min), and then returned to the room for a 10-min alone session. Again during this session, stereotypy was measured using a 10-s momentary time sample.

Results

During baseline, motor stereotypy occurred an average of 25.2% of intervals during AM sessions ($sd = 61.1$), and 34.4% of intervals during PM sessions ($sd = 12.9$) (See Fig. 8, table 3). During the first treatment, stereotypy occurred in 1.7% of AM intervals with toys ($sd = .8$), compared to 35.3% of intervals immediately following access to toys ($sd = 9.5$). Stereotypy occurred during 3.8% of intervals with toys in PM sessions ($sd = 3.1$), compared to 34.3% of intervals immediately following access to toys

($sd = 18.3$). During the second baseline, stereotypy occurred during 30.0% of intervals in AM sessions ($sd = 14.3$), and 27.9% of intervals during PM sessions ($sd = 16.2$). During the second treatment, stereotypy occurred during 9.5% of intervals during AM sessions with access to toys ($sd = 5.2$), compared to 37.0% of intervals immediately following access to toys ($sd = 13.4$). Stereotypy occurred during 7.5% of intervals during PM sessions with toys ($sd = 4.1$), compared to 37.2% of sessions immediately following access to toys ($sd = 14.1$).

Discussion

The results of Experiment 2 suggest that the sensory diet approach may decrease motor stereotypy while sensory items are available. However, as soon as the individual is no longer in contact with the sensory diet items, stereotypy persists at levels similar to no treatment. The results of this experiment also suggest that individuals may satiate very quickly on items, even after very short durations of access (as evidenced by Pat's quickly decreasing rates of engagement). If individuals satiate quickly on sensory diet items, they may need to constantly be replaced or rotated in order for the treatment to be effective. Also, although the sensory diet effectively reduced stereotypy when Pat had access to the items, this is not necessarily a practical treatment, as the items cannot be available all the time, and constant manipulation of the items may interfere with the individual's engagement with other activities.

General Discussion

During Experiment 1, participants were given hourly access to sensory diet items, for a total of 50-75 minutes per day. This is greater duration than children with autism would typically get during SI therapy (typically 1-3 hours per week). Even though a

large duration of access to sensory items was used, there was no change in stereotypy for either participant. From a behavioral perspective, it was presumed that the sensory diet approach would work by abolishing the reinforcing sensory consequences of the stereotypy. Sensory diet items were carefully and specifically chosen in order to provide competing sensory stimulation to the target behavior. Although an empirical analysis was used to identify items that competed with the target behavior (something which is not typically done in SI therapy), there was still no effect on levels of stereotypy across the day. If 50-75 minutes of access to carefully chosen items did not have any effect on stereotypy, it can be assumed that access to a typical sensory diet (less than 50-75 min per day) would not be effective in treating stereotypy for children with autism. Also, considering that most children who use SI therapy only have access to the therapy at most several times per week, we cannot expect to see any lasting effects on behavior, therefore making the treatment ineffective.

The results of Experiment 2 further showed that the sensory diet treatment does not have even proximal effects. As soon as the participant no longer had access to sensory diet items, levels of stereotypy returned to levels similar to baseline, and occasionally higher than baseline. This shows that the sensory diet did not actually serve as an abolishing operation, and did not decrease the future probability of stereotypy at all. The treatment was only effective while the participant was in contact with the items, which would be expected based on the results of the competing items assessment. Experiment 2 also showed that Pat began to satiate quickly with the items present, and motor stereotypy began to slowly increase during sessions with access to the sensory items. This shows that this treatment may not be effective at all if items have to

constantly be replaced or rotated. Also, because the sensory diet had no effect on behavior after items were no longer available, it would not be a functional means of treating problem behavior, unless access to sensory items could be given all the time. The results of these two experiments, taken together, are further evidence that sensory integration is not an effective treatment for children with autism.

The current study had some limitations that deserve comment. First, we did not include some common elements of SI therapy such as swinging, spinning, and brushing were not included. Since there were no SI therapists on site, it would not have been advantageous for experimenters to use these methods without proper training. Although some of these techniques were not used, the same basic principles of SI therapy- giving each participant certain types of sensory stimulation that matched the hypothesized sensory consequences of his problem behavior, were used throughout the study. Based on the results obtained, it is doubtful that including these other methods would have affected the problem behavior, however further research should examine the use of all commonly used SI techniques.

A second limitation of this study is that only two participants were included, and motor stereotypy was the only behavior examined. Many other studies on SI have claimed that it is effective in treating a wide range of behaviors including self-injury, destructive behaviors, hyperactivity and even mood regulation. Although we were unable to study the effect of SI on other facets of behavior, we chose stereotypy as it was easiest to measure and would not cause the participants any harm if it persisted at high levels. Further research on other problem behaviors as well as hyperactivity and mood regulation

would help to more fully understand the effect (or lack of effect) of SI therapy on all aspects of behavior.

Taken together, the results of this research and the results of past research (Hoehn & Baumeister, 1994; Mason & Iwata, 1990; Wells & Smith, 1983; etc.) show that SI therapy should not be used as a treatment for children with autism, until there is further scientific research showing that it has any positive effect on behavior. Although there is no evidence that SI therapy causes any harm to children with autism, time would be better spent using proven treatment methods such as Applied Behavior Analysis to treat problem behavior in children with autism.

References

- Ahearn, W., Clark, K., MacDonald, B., & Chung, B. (2007). Assessing and treating vocal stereotypy in children with autism. *Journal of Applied Behavior Analysis*, *40*, 263-275.
- Ayres, A.J. (2005). *Sensory Integration and the Child: Understanding hidden sensory challenges. 25th Anniversary Edition*. Los Angeles: CA: Western Psychological Services.
- Barton, L., Brulle, A., & Repp, A. (1986). Maintenance of the Therapeutic Change by Momentary DRO. *Journal of Applied Behavior Analysis*, *19*, 277-282.
- Bodfish, J., Symons, F., Parker, D., Lewis, M. (2000). Varieties of Repetitive Behavior in Autism: Comparisons to Mental Retardation. *Journal of Autism and Developmental Disorders*, *30*, 3, 237-243.
- Bundy, A., Lane, S., Murray, E. (2002). *Sensory Integration: Theory and Practice*. Philadelphia: PA: F.A. Davis Co.
- Dawson, G., & Watling, R. (2000). Interventions to facilitate auditory, visual and motor integration in autism: A review of the evidence. *Journal of Autism and Developmental Disorders*, *30*, 5, 415-421.
- Edelson, S., Rimland, B., & Grandin, T. (2003). Response to Goldstein's commentary: Interventions to facilitate auditory, visual and motor integration: Show me the data. *Journal of Autism and Developmental Disorders*, *33*, 5, 551-552.
- Ellingson, S., Miltenberger, R., Stricker, J., Garlinghouse, M., Roberts, J., Galensky, T., & Rapp, J. (2000). Analysis and Treatment of Finger Sucking. *Journal of Applied Behavior Analysis*, *33*, 41-53.

- Foxx, R., Azrin, A. (1973). The elimination of autistic self-stimulatory behavior by overcorrection. *Journal of Applied Behavior Analysis*, 6, 1-14.
- Goldstein, H. (2000). Commentary: Interventions to facilitate auditory, visual and motor integration: "Show me the data." *Journal of Autism and Developmental Disorders*, 30,5, 423-425.
- Goldstein, H. (2003). Response to Edelson, Rimland and Grandin's commentary. *Journal of Autism and Developmental Disorders*, 33, 5, 553-555.
- Grandin, T. (1992). Calming Effects of Deep Touch Pressure in Patients with Autistic Disorder, College Students and Animals. *Journal of Child and Adolescent Psychopharmacology*, 2, 63-70.
- Griffer, M. (1999). Is sensory integration effective for children with language-learning disorders? A critical review of the evidence. *Language, Speech and Hearing in Schools*, 30, 393-400.
- Hoehn, T., Baumeister, A. (1994). A critique of the application of sensory integration therapy to children with learning disabilities. *Journal of Learning Disabilities*, 27, 338-350.
- Iarocci, G., & McDonald, J. (2006). Sensory Integration and the perceptual experience of persons with autism. *Journal of Autism and Developmental Disorders*, 36, 77-90.
- Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis*, 27, 197-209.

- Lam, K., & Aman, M. (2007). The Repetitive Behavior Scale-Revised: Independent Validation in Individuals with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 37*, 855-866.
- Laraway, S., Snyckerski, S., Michael, J., & Poling, A. (2003). Motivating operations and terms to describe them: Some further refinements. *Journal of Applied Behavior Analysis, 36*, 407-414.
- Lerman, D., & Iwata, B. (1996). A Methodology for Distinguishing between Extinction and Punishment Effects Associated with Response Blocking. *Journal of Applied Behavior Analysis, 29*, 231-233.
- Mason, S. & Iwata, B. (1990). Artfactual effects of Sensory-Integrative Therapy on self-injurious behavior. *Journal of Applied Behavior Analysis, 23*, 361-370.
- Piazza, C., Adelinis, J., Hanley, G., Goh, H., & Delia, M. (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 33*, 13-27.
- Rapp, J. (2007). Further evaluation of methods to identify matched simulation. *Journal of Applied Behavior Analysis, 40*, 73-88.
- Ricketts, R., Goza, A. & Maltese, M. (1992). Case study: The effects of naltrexone and SIBIS on self-injury. *Behavioral Residential Treatment, 7*, 314-326.
- Rincover, A., Cook, R., Peoples, A., & Packard, D. (1979). Sensory extinction and sensory reinforcement principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis, 12*, 221-233.

- Schaaf, R., & Miller, L. (2005). Occupational therapy using a Sensory Integrative approach for children with Developmental Disabilities. *Mental Retardation and Developmental Disabilities Research Reviews*, *11*, 143-148.
- Sidener, Tina M., Carr, James E., and Firth, Amanda M. (2005). Superimposition and withholding of edible consequences as treatment for automatically reinforced stereotypy. *Journal of Applied Behavior Analysis*, *38*, 121-124.
- Taylor, B. Hoch, H., Weissman, M. (2005). The Analysis and Treatment of Vocal Stereotypy in a Child with Autism. *Behavioral Interventions*, *20*, 239-253.
- Vaughan, M. E., & Michael, J. L. (1982). Automatic reinforcement: An important but ignored concept. *Behaviorism*, *10*, 217-228.
- Vollmer, T. R. (1994). The concept of automatic reinforcement: Implications for behavioral research in developmental disabilities. *Research in Developmental Disabilities*, *15*, 187-207.
- Wells, M., & Smith, D. W. (1983). Reduction of self-injurious behavior of mentally retarded persons using sensory integrative techniques. *American Journal of Mental Deficiency*, *87*, 664-666.
- Wilbarger, P., & Wilbarger, J. (1991). *Sensory defensiveness in children aged 2-12: An intervention guide for parents and other caregivers*. Denver, CO: Avanti Educational Programs.

Appendix 1

Please have (student name) engage with the materials for his SI treatment for 10-min. at the beginning of each hour. After completion, record your initials and a Y(es) or N(o) for engagement with the materials.

Date:

Week day (please circle one): Mon Tues Wed Thurs Fri

Time:	Teacher initials:	Did S engage w/ materials? Y/N (If No note reason)
9:00 AM:	_____	_____
10:00 AM:	_____	_____
11:00 AM:	_____	_____
12:00 PM:	_____	_____
1:00 PM:	_____	_____
2:00 PM:	_____	_____

Table 1

Means and Standard Deviations for Pat's Motor Stereotypy (SI treatment)

Session	Mean	Std. Deviation
BSL1 (am)	35.8	12.0
BSL1 (pm)	41.6	15.1
TX1 (am)	23.0	11.8
TX1 (pm)	22.8	8.9
BSL2 (am)	31.5	13.6
BSL2 (pm)	32.5	12.5
TX2 (am)	38.8	10.8
TX2 (pm)	28.8	13.3
BSL3 (am)	39.8	8.5
BSL3 (pm)	31.5	18.3

Table 2

Means and Standard Deviations for Luke's Motor Stereotypy (SI treatment)

Session	Mean	Std. Deviation
BSL1 (am)	71.86	11.28
BSL1 (pm)	61.28	26.98
TX1 (am)	68.76	32.54
TX1 (pm)	82.48	12.06
BSL2 (am)	77.62	28.72
BSL2 (pm)	57.15	36.55
TX2 (am)	89.00	21.93
TX2 (pm)	71.78	37.77
BSL 3 (am)	84.15	16.85
BSL 3 (pm)	66.45	26.83

Table 3

Means and Standard Deviations for Pat's Motor Stereotypy (Direct Competition)

Session	Mean	Std. Deviation
AM BSL 1 (alone)	25.2	61.1
PM BSL1 (alone)	34.4	12.9
AM Tx 1 with toys	1.7	.8
AM Tx 1 alone	35.3	9.5
PM Tx 1 with toys	3.8	3.1
PM Tx 1 alone	34.3	18.3
AM BSL 2 (alone)	30.0	14.3
PM BSL 2 (alone)	27.9	16.2
AM Tx 2 with toys	9.5	5.2
AM Tx 2 alone	37.0	13.4
PM Tx 2 with toys	7.5	4.1
PM Tx 2 alone	37.2	14.1

Figure Captions

Figure 1. Functional Analysis of Pat's motor stereotypy.

Figure 2. Functional Analysis of Luke's motor stereotypy.

Figure 3. Competing Items Assessment 1 results for Pat.

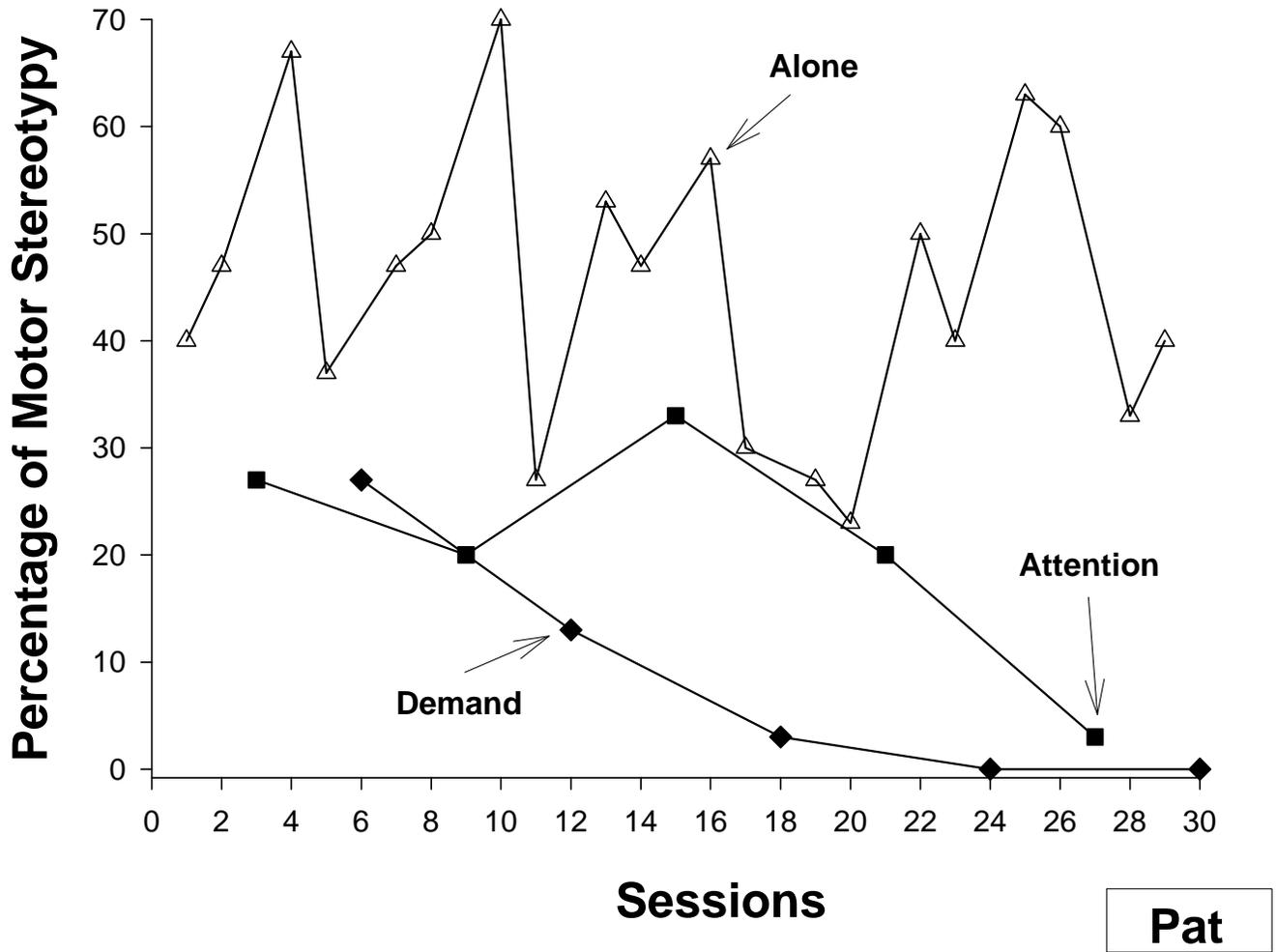
Figure 4. Competing Items Assessment results for Luke.

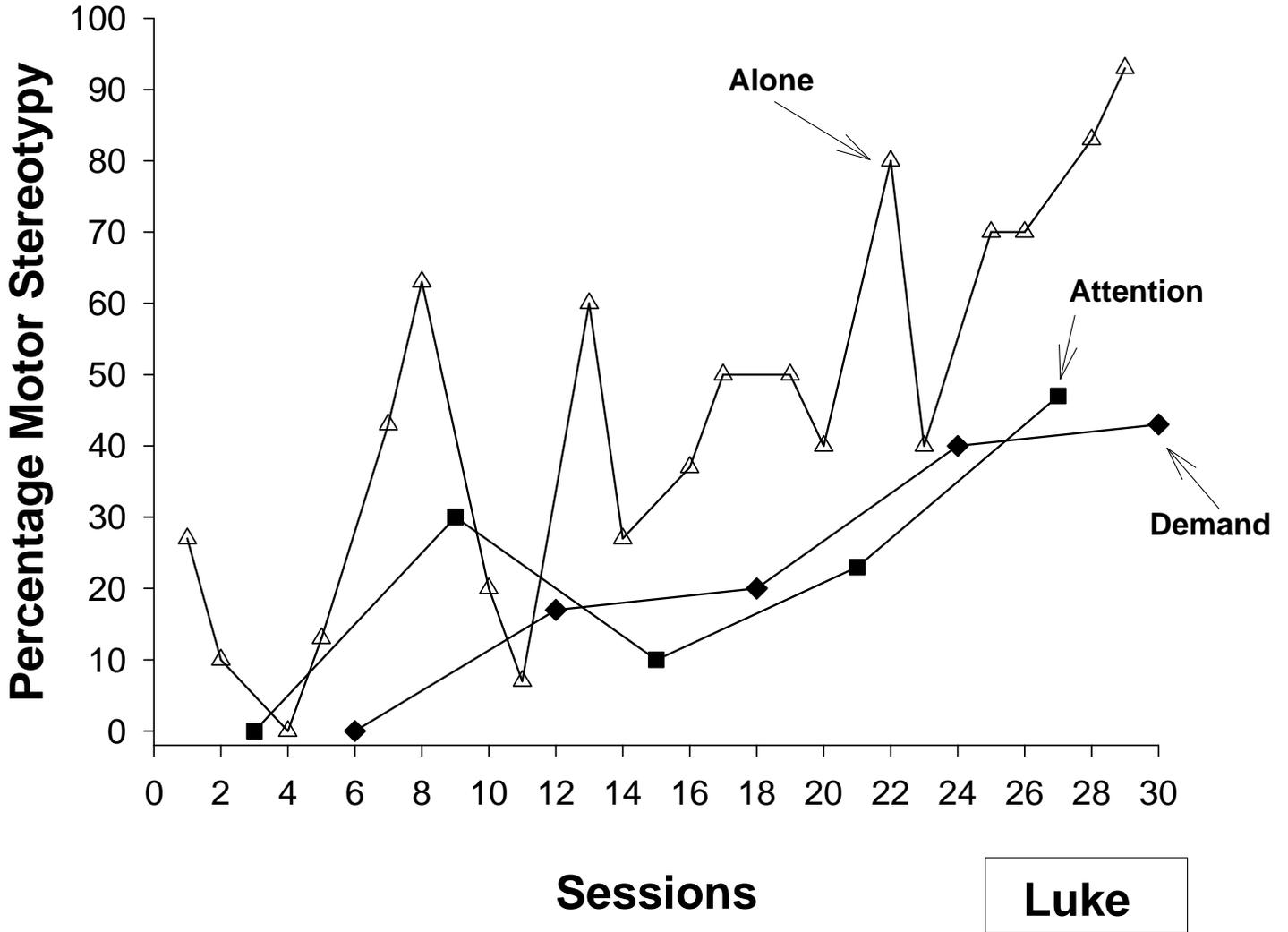
Figure 5. Analysis of the effect of Sensory Integration treatment on Pat's motor stereotypy.

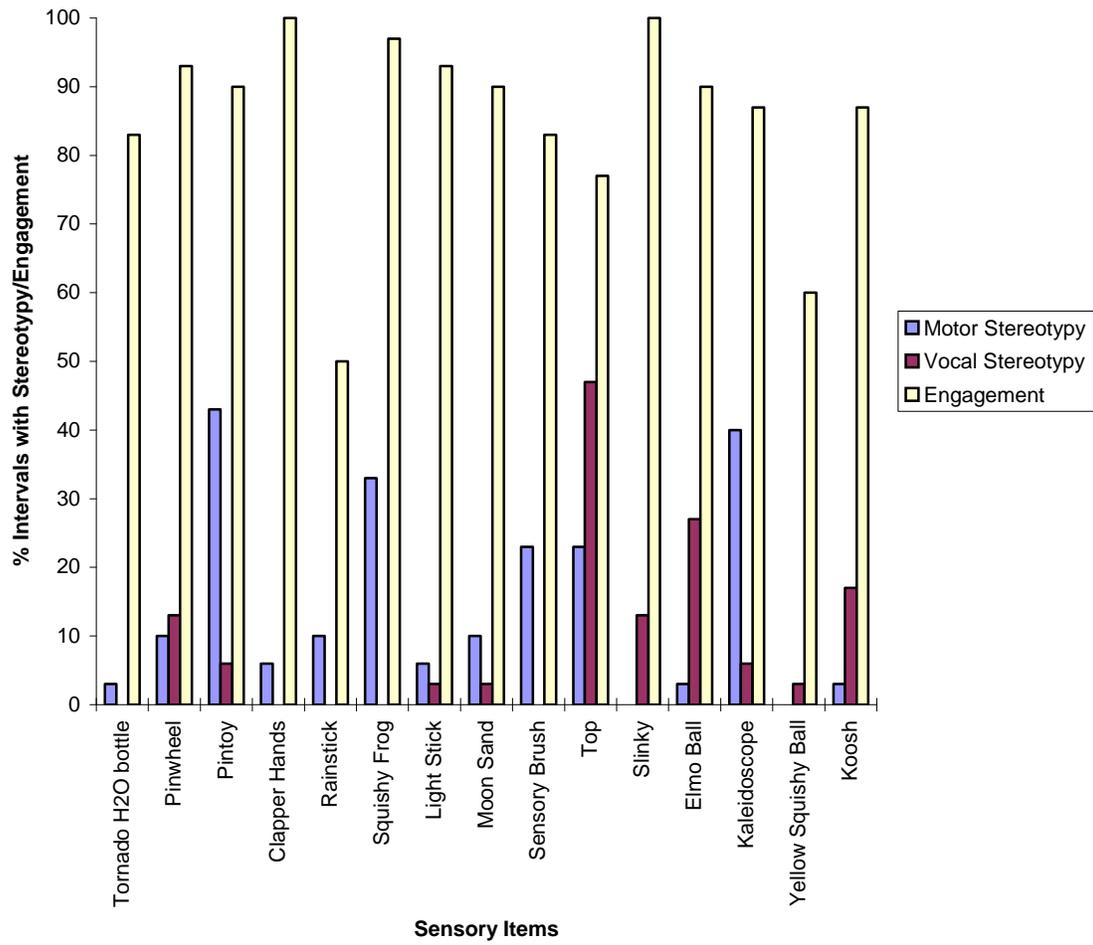
Figure 6. Analysis of the effect of Sensory Integration treatment on Luke's motor stereotypy.

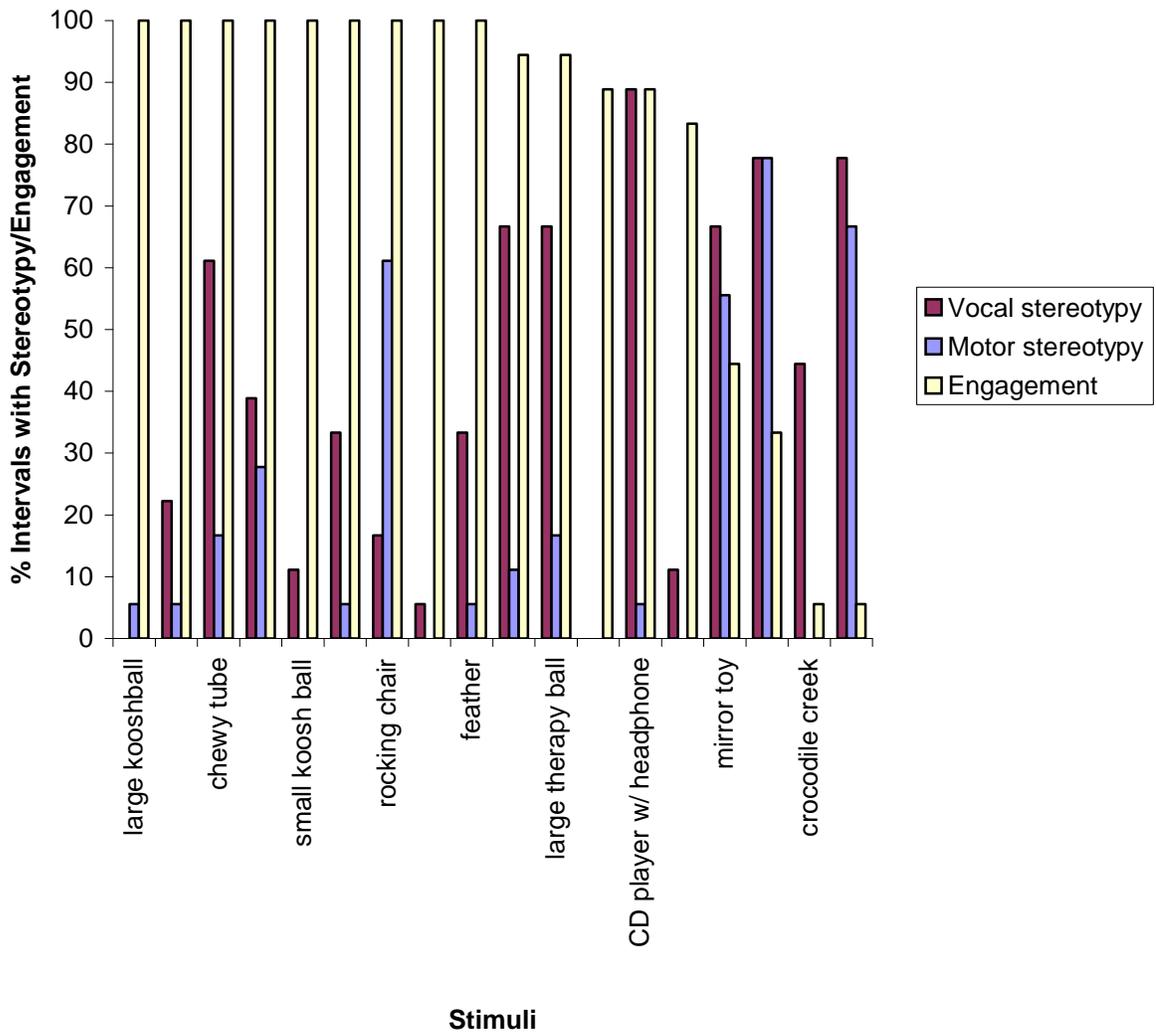
Figure 7. Competing Items Assessment 2 results for Pat.

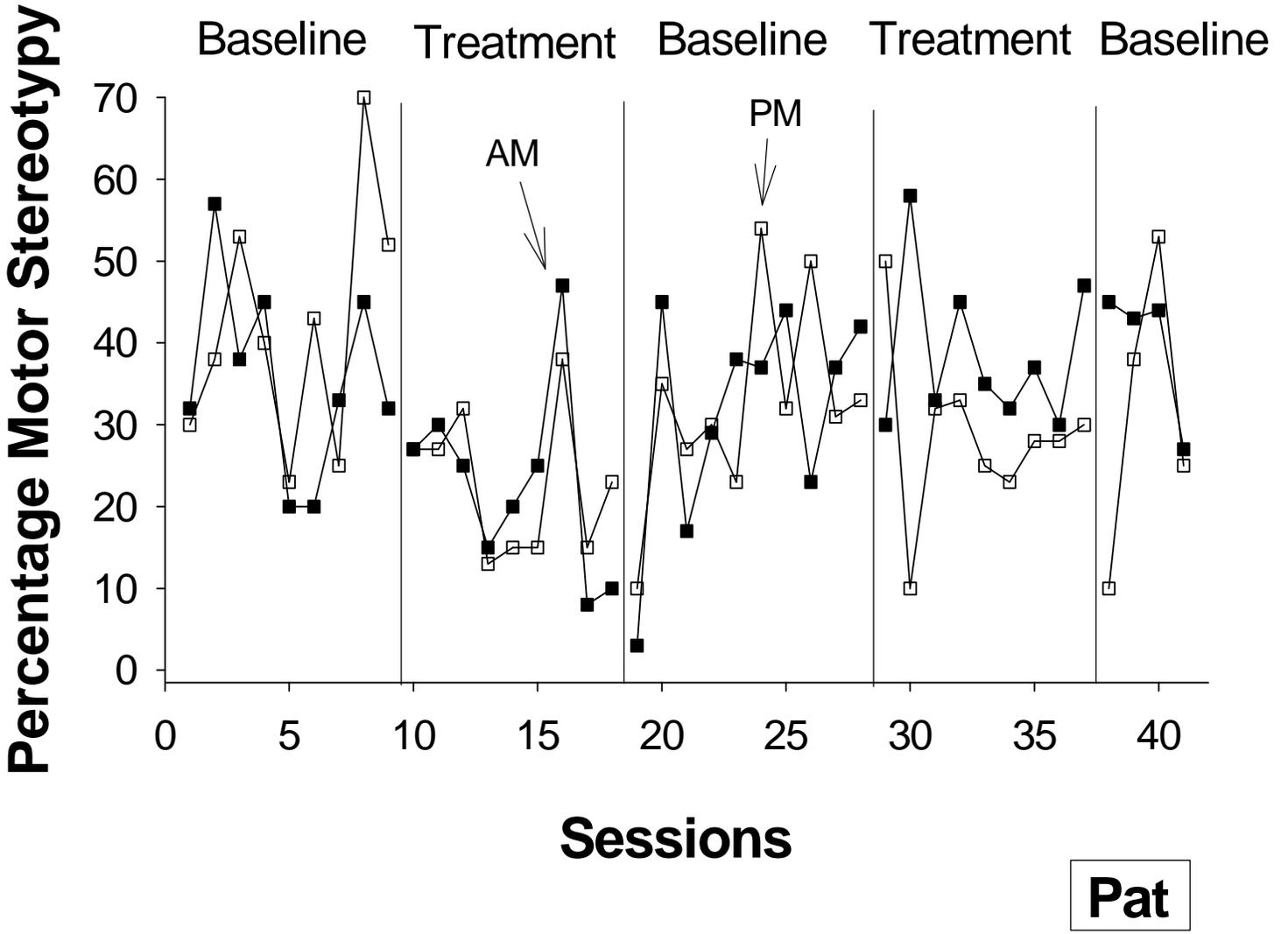
Figure 8. Analysis of the effect of direct response competition on Pat's motor stereotypy.

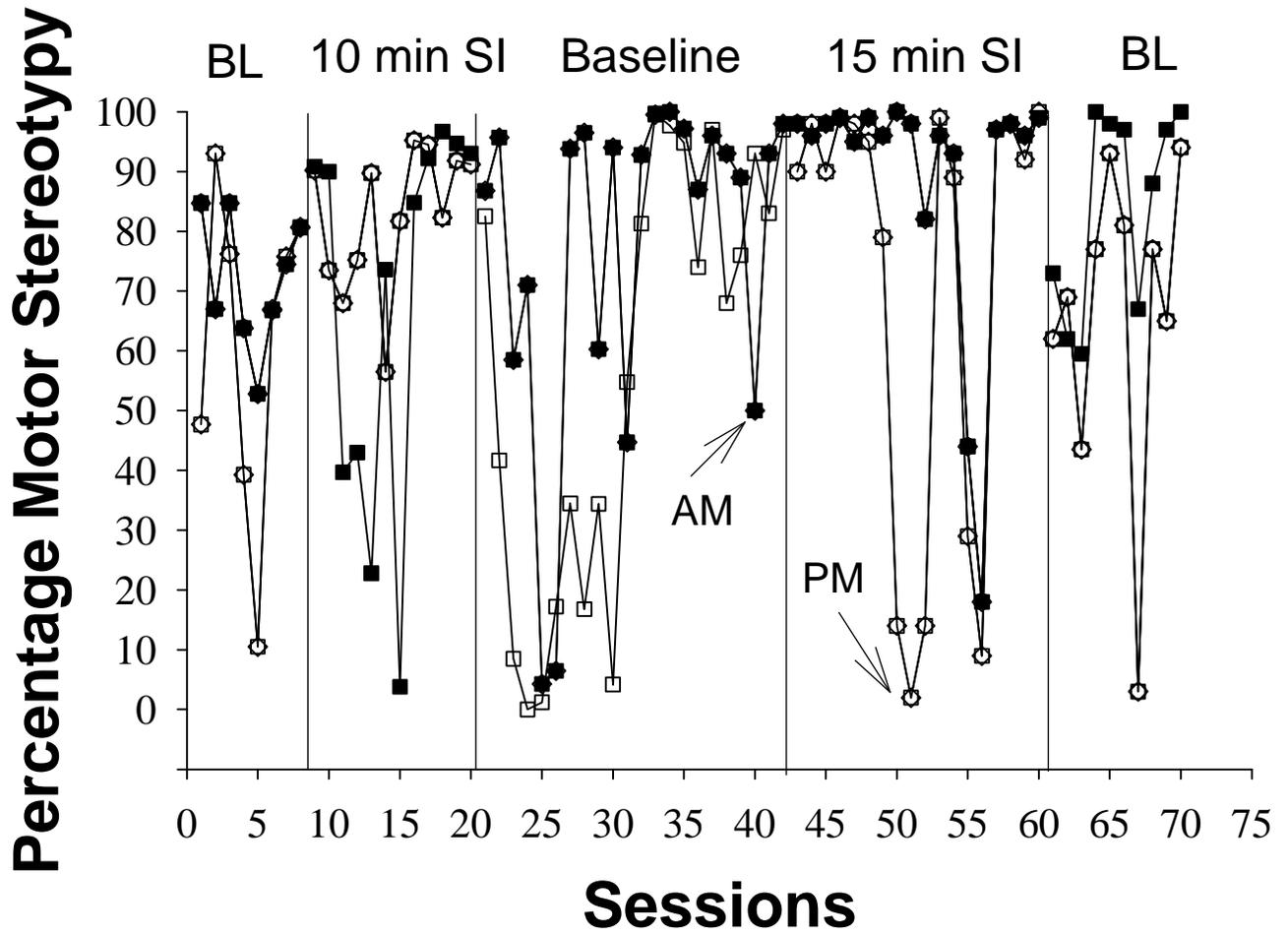












Luke

