ANALYSIS OF SENSORY INTEGRATION TECHNIQUES ON AUTOMATICALLY MAINTAINED PROBLEM BEHAVIOR

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Sensory integration techniques are a common treatment procedure among occupational therapists. The goal is to “apply” input that competes with input from problem behavior. Although this is a commonly recommended intervention, there is limited empirical evaluation with adults with intellectual disabilities. Therefore, we evaluated the effectiveness of occupational therapist-suggested sensory stimuli on the automatically maintained problem behavior of adults. Specifically, we compared the effects of non-contingent access to sensory stimuli and non-contingent access to highly preferred stimuli on the rate of problem behavior. Results suggested that, relative to highly preferred stimuli, sensory stimuli had either a limited effect on problem behavior, or in some cases, were correlated with increases in problem behavior. This suggests that sensory stimuli may not produce the same automatic stimulation as problem behavior. We will discuss implications for treatment, including methods for better identifying stimuli for use in the treatment of automatically maintained problem behavior.

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CHAPTER 1

INTRODUCTION

Individuals with developmental delays including, but are not limited to, autism spectrum disorder (ASD), attention-deficit/hyperactivity disorder (ADHD), developmental coordination disorders (DCD), and intellectual developmental disabilities (IDD) can show behavioral differences that overlap with sensory processing difficulties (Zimmer et. al., 2012, Engle-Yeger et al., 2011). Clinicians and caregivers commonly report that individuals with ASD exhibit behaviors that are associated with sensory sensitivity such as hyper-responsiveness and hypo-responsiveness to sensory stimuli, or sensory seeking. These behaviors are common in developmentally delayed individuals. Hyper-responsiveness is an exaggerated behavioral response to sensory stimuli (e.g., aversion to lights, covering ears with sudden sounds, and avoidance of touch). Hypo-responsiveness can be manifested by the lack of behavioral responses to sensory stimuli (e.g., lack of orienting to novel sounds, diminished response to pain; Baeanek et. al., 2013). sensory seeking (e.g., rocking or hand flapping; Lane et. al., 2009)). Behaviors such as these could be explained as self-stimulatory behaviors, even if these responses produce self-injury. A possible explanation for the source of self-stimulation is reinforcement from tactile, proprioceptive, or other forms of sensory stimulation (Smith et. al. 2005).

Based upon this theory, occupational therapists use sensory integration therapy (SIT) to attempt to reduce challenging behaviors. This intervention is designed to improve the ability to process and integrate (e.g., discriminative stimuli to a conditioned stimuli; Skinner, 1953) enhance successful participation in daily tasks (May-Benson 2018). Developed by Dr. Jean Aryes, SIT was constructed to provide and control sensory input (Aryes, 1974/1976). Typically, normal play provides children with sensory stimulation. However, children with sensory processing issues may not receive adequate sensory stimulation from common play activities (e.g., Aryes,). Children with sensory dysfunctions tend to avoid stimuli that will integrate the sensations that help the brain develop (Aryes). An OT will diagnose the child based on a sensory assessment, focused on determining how the child integrates vestibular, visual, tactile, proprioceptive, motor planning and hand eye coordination. This will determine if the sensory dysfunction is causing hyperactivity, distractibility, tactile defensiveness, or gravitational insecurities (Aryes). SIT provides external direction and structure from a therapist, allowing children to interact with specialized equipment to get the sensory input to get adaptive responses the child needs to learn to organize the stimuli (Aryes). Examples of SIT may include procedures such as deep pressure sensations to organize tactile defensiveness, hyperactivity, or distractibility (Ayres). An example of this would have a child laying down on a pad and having the therapist role a yoga ball over their body. This is theorized to relax muscles and form a sense of comfort so that the individual can concentrate on a task (Aryes).

Sensory Integration in Research

SIT uses planned and controlled stimulating sensory activities such as jumping on a trampoline, swinging, deep pressure, and or joint compressions (Devlin, 2010). Urwin et al. (2005) evaluated the effectiveness of SIT on the problem behavior (specific problem behavior was not identified) of five adults that had tactile sensory modulation disorder. They evaluated SIT using a reversal design. During baseline, there were no programmed procedures. During the SIT phase, a therapist provided SIT immediately prior to a gardening task. Their primary dependent variables were the duration of problem behaviors and duration of engagement with the activity. They also conducted a goal outcome scale (GAS) with the instructor, which involved a score based on five levels, ranging from -2 (much less expected outcome) to +2 (more than expected outcome). Results determined positive evidence of reducing sensory-based challenging behaviors four out of the five participants, by decreasing problem behavior and increased engagement in the gardening task. Interestingly, GAS scores did not significantly change.

In a similar study, Green et al. (2003) evaluated the effects of SIT on the problem behavior of two adults with intellectual disabilities. Target behaviors were identified based on The Sensory Integration Inventory – revised for Individuals with Developmental Disabilities, the results of which hypothesized primary sensory domains of the problem behavior. SIT was tailored to the specific client need and measured by GAS. Baseline conditions were targeted behaviors observed off of a 15-minute recording and "daily diaries" on the individual's home. Treatment phases were conducted by an occupational therapist outside of the home. There were no specific detail about the exact procedure of SIT in this article. One participant's goal was to increase tactile input with proprioceptive and vestibular stimuli to engage appropriately with the environment by providing SIT two times a week with 50-minute sessions. For this participant, caregivers reported a 75% decrease in the target behavior and an increase of spontaneous environmental engagement. Though there was no significant change in targeted behaviors according to the 15-minute observation period and "daily diaries". The goal for the other participant to interact purposely with the environment by providing SIT three times a week for 30-minute sessions. For the second participant, caregivers reported no measurable change in problem behaviors when SIT was in effect. Similarly, Sandler et al. (2007) evaluated the effects of non-contingent tactile and vestibular stimulation on a child's non-socially maintained problem behavior. During baseline, they measured SIB during specific times of the day in the classroom while engaging in everyday activities. They provided vibration and tactile stimulation to specific target areas of the body one time per day, four days a week (sensory stimulation 1) and NCR vestibular stimulation and a vibrating mattress three times per day, four days per week. Sensory stimulation two condition SIT was increased to two times a day four time per week and NCR vestibular stimulation and a vibrating mattress three times a day, seven days per week. During SIT conditions, they measured SIB prior to SIT and immediately after SIT, while the participant was in the classroom engaging in everyday activities. Results of this study indicated SIT produced reductions in SIB. During baseline, the mean duration of SIB was 82.9%. During the first SIT condition, the mean duration of SIB decreased to 45.3% and during the second SIT condition the mean duration of SIB decreased again, to 40.9%. During a reversal to baseline, the mean duration of SIB increased to 75.5%. One major limitation to this study was that measurement times were two different times of the day. Therefore, it is possible that the changes in problem behavior were due to natural variations across the day, rather than an effect of SIT.

SIT and Behavioral Intervention

Although the majority of published manuscripts are in the OT scholarly literature, several behavior analysts have evaluated the effects of SIT. First, Mason and Iwata (1990) evaluated the effects of SIT with three children that engaged in SIB. They compared SIT and behavioral intervention (BI) using a reversal design. Prior to the SIT and BI comparison, they conducted an FA, using procedures similar to Iwata et al. (1982). Two participants engaged in SIB that was maintained by social consequences and one participant engaged in SIB that persisted in the absence of social consequences. During SIT phases, sessions were 15 min, during which they provided non-contingent access to multisensory stimulation that included auditory stimulation (cassette tape playing rock or jazz music), proprioceptive stimulation, tactile stimulation, vestibular stimulation (rocking chair with vibrating pillow), and visual stimulation (flashing ember and blue light) without therapist interaction. Additionally, with one participant, the evaluated SIT with and without therapist attention. During BI phases, they used behavioral intervention based on the function of the behavior for each participant. For the two participants with socially maintained SIB, they removed the contingency between SIB and the consequence, by either continuing to present demands if SIB occurred or ceasing the delivery of attention. For the participant whose SIB maintained in the absence of social interaction, the behavioral interventions used was access to toys, differential reinforcement of other behaviors (DRO) (for one participant physical and social reinforcement for no responses of problem behavior and the other participant received verbal praise for the absents of targeted behavior) and response interruption. Mason and Iwata found mixed results with SIT. For one participant (escape maintained SIB), SIT had an effect on their SIB. For another participant, SIT only reduced SIB when attention was also provided (socially positive maintained problem behavior). Finally, for the third participant (automatically maintained problem behavior), SIT produced an increase in SIB. For all participants, BI produced a decrease in SIB. Interestingly, the participant for whom SIT produced an increase in SIB was the participant with SIB maintained by non-social consequences. Additionally, the participant for whom SIT was effective had escape-maintained SIB and during SIT sessions, there were no demands, which likely functioned as noncontingent reinforcement as an escape from demands. Mason and Iwata noted that, based on the SIT literature, the participant with SIB maintained by automatic reinforcement should have shown a decrease in SIB during the SIT phase. However, for this participant, SIT made SIB worse. Mason and Iwata noted that the SIT items were not topographically similar to the SIB, which could suggest that the specific SIT items did not compete with SIB but other SIT items may have competed with SIT. For the other two participants, Mason and Iwata noted that the inclusion of other variables, free access to attention or escape, likely accounted for the seemingly positive effects of SIT, as free access to attention or escape served as an abolishing operation for the respecting socially maintained challenging behavior. Additionally, the inclusion of SIT reduced the efficacy of the artifactual effects of SIT including the addition of attention in SIT research and absence of demands in SIT that could also influence SIB.

Although Mason and Iwata (1990) found SIT produced negative effects on SIB, other researchers have found different effects of SIT. Delvin et al. (2010) compared BI and SIT using an alternating treatment design. SIT procedures included a noncontingent access to a multi-sensory room for 15 min before tabletop activities or access to the multisensory room contingent on problem behavior. In the multisensory room, participants had access to a “sensory diet” that would facilitate vestibular, proprioceptive, and tactile stimulation. This included activities such as Wilbarger’s (1995) joint compression and brushing protocol, a net swing, jumping on a trampoline, rocking and rolling on a peanut ball, being wrapped in a blanket and having pressure applied with a large yoga ball, crawling on knees and elbows, having bean bags lightly tapped on the body, chewy tubes, and having the lips and cheeks massaged, no measurements were collected during SIT. Prior to baseline, all participants received a functional assessment: two participants received an FA and two participants received anecdotal assessments (Questions about Behavior Function {QABF} and FAST-R). For all four participants, the functional assessment indicated that each participant’s problem behavior was maintained by social consequences. BI were tailored to each participant, and involved both antecedent strategies (e.g., varied instruction, errorless instruction, etc.) and consequent strategies (e.g., differential reinforcement, extinction, error correction, etc.). Results concluded that participant one showed lower levels of problem behavior on days that BI was being implemented. On days that SIT was implemented problem behavior was higher than days that BI was implemented. All other participants followed this pattern. Similar to Mason and Iwata (1990), Devlin (2010) demonstrated that SIT did not reduce SIB and BI did reduce problem behaviors to near zero levels. Devlin explained the importance of function-based treatments to reliably decrease problem behavior, Devlin also explained that during the rapid alternation between SIT and BI did not provide a consistent effect with either procedure even though the better treatment resulted in BI, which is a common limitation to alternating treatment designs. BI showed a more efficient decrease when the BI was consistently applied.

Overall, SIT remains a popular treatment with OTs, despite the variability in efficacy. The variability in efficacy may be due to a mismatch between behavioral function and SIT. For example, for all but one participant, both Mason and Iwata (1990) and Devlin et al. (2010) evaluated SIT with participants with problem behavior that was mainly maintained by social consequences. Behavioral treatments to treat non-socially maintained problem behavior include sensory treatments such as competing stimuli and matched stimuli. These interventions are delivered in a manner similar to SIT, as noncontingent antecedent interventions. Because SIT typically involves an antecedent manipulation, noncontingent delivery of sensory stimuli, it is possible that SIT may be most effective with individuals with problem behavior maintained by automatic positive reinforcement.

Matched and Competing Stimuli on Non-Socially Maintained Problem Behavior

Simmons et al. (2003) conducted a multiple-schedule evaluation on fixed-time food presentation on automatically maintained hand mouthing. Each session was divided into three components. The first and third component were identical to the alone condition of an FA – the participant was in the room, no social stimuli were present, and there were no programmed consequences. During the second component, a therapist delivered a small, fixed amount of food on a fixed-time (FT) schedule. Across sessions, Simmons et al. gradually increased the time between deliveries. Results showed that hand-mouthing decreased in both the second (food delivery) and third (alone) components indicating the stimulation provided by food had a prolonged effect, similar to reports from caregivers and OTs who implement SIT. That is, Simmons and colleagues concluded that the presentation of the food provided an alternative form of oral stimulation that was linked to the simulation that maintained hand-mouthing. This presentation of food may have completed with the hand-mouthing to decrease motivation to hand-mouth.

Rapp and colleagues (2004) evaluated the effects of response allocation on motor stereotypy. Three participants engaged in three or more forms of motor stereotypy that interfered with everyday tasks. In the first experiment, Rapp and colleagues used a free-operant arrangement to identify the most probable form of stereotypy to occur. They then implemented response restriction for the most probably form of stereotypy (target behavior) and measured other forms of stereotypy. Results showed that for three of four participants, response restriction decreased the target behavior, produced a decrease in one untargeted form of stereotypy, and produced an increase in two or more forms of untargeted stereotypy. In the second experiment, with three participants, Rapp et al. evaluated the effects of environmental enrichment on targeted stereotypy. For two participants, results showed an increase in interaction with the environmental enrichment items and a decrease in targeted stereotypy. For one participant, results showed an increase in interaction with the environmental enrichment items but no change in the most targeted stereotypy. In the third experiment, Rapp conducted an extended analysis that added procedures for two of the individuals that just the free operant with environmental enrichments had minimal effects on stereotypy. Another condition was conducted with two participants that there was minimal effect on stereotypy with NCR of environment enrichments alone. Behavioral procedures such as an addition of a FR 1 for one participant and response restriction for the other participant yield increase in engagement of environment enrichment items and a decrease in probable stereotypy. Taken together, the results of Rapp et al. demonstrate that environmental enrichments can produce positive results in competing with automatic maintained stereotypy.

Given that the two previous papers found that competing stimuli reduced problem behavior, a more direct approach of competition stimuli is the use on “matched” stimuli Piazza et al., (2000) evaluated the effects of “matched” stimuli on automatically maintained problem behavior of three individuals with severe or profound intellectual disabilities.. “Matched” stimuli were defined as stimuli that appeared to provide similar sensory consequences as problem behavior. “Unmatched” stimuli were defined as items that provided sensory stimulation, but the putative sensory consequences did not match the putative sensory consequences of problem behavior. Piazza et al. conducted an FA using procedures similar to Iwata et al. (1982) and found all the participants problem behavior was maintained by non-social consequences. Next, they conducted a preference assessment, using procedures similar to Piazza et al. (1996). They selected “nonmatched” items based on the parent-completed Reinforcer Assessment for Individuals with Severe Disabilities (RAISD) and selected they “matched” items were based on the topography of problem behavior and the putative sensory consequences of that topography. During the preference assessment, they ranked items based on duration of interaction with the item and changes in problem behavior, with items that evoked greater interaction and lower levels of problem behavior considered more preferred. Finally, Piazza et al. then compared the effects of matched and unmatched in either a multielement or reversal design. During this evaluation, they provided free access to a single stimulus in each session and measured item interaction and problem behavior. Results showered that for all three participants, matched stimuli produced lower levels of problem behavior compared to unmatched stimuli. Although these results were promising, Piazza et al. (2000) noted that matched stimuli were more preferred than unmatched stimuli. Thus, the effects may have been due either the matched stimuli displacing problem behavior or the consequences produced by matched stimuli competing with the consequences for problem behavior.

Purpose

There are many ways to evaluate the effects of sensory stimuli on an individual's problem behavior. According to the sensory theory, an individual engages in problem behavior due to a lack of sensory integration. Occupational therapists provide SIT to integrate the sensation, allowing the individual to appropriately interact with the environment (Aryes 1972/1979, Yeger et al., 2013, Urwin et al.,2005). The OT literature provides limited evidence that SIT can effectively reduce problem behaviors. Additionally, behavior analysts have found that SIT can produce negative, artifactual effects (Devlin et al., 2010; Manson and Iwata 1990), or no effects on problem behavior (Green et al., 2003). These discrepant results could be due a mismatch between SIT and behavioral function or the specific SIT items either competing with problem behavior or producing stimulation that matches the stimulation produced by problem behavior. However, the extent to which the competing or matched effect is influenced by individual preferences is unclear (e.g., Piazza et al., 2000; Rapp et al., 2004; Simmons et al., 2003). Therefore, the purpose of the present study was twofold. First, I evaluated the effects of SIT with individuals with SIB maintained by nonsocial consequences. Second, I evaluated the relationship between item interaction and SIB, to further isolate the effects of item preference on changes in problem behavior.

CHAPTER 2

METHOD

Participants and Setting

All participants were residents of a large, state-run residential facility for adults with ID. Prior to the start of the study, the facility behavior-support committee and human rights committee approved all procedures. After obtaining approval from the facility, all procedures were reviewed and approved by the institutional review board at the University of North Texas. The interdisciplinary team (IDT) of each participant referred the participant to a university-based specialized clinic for the assessment and treatment of severe behavior disorders located on the facility campus. Each participant had a legal guardian and the legal guardian was offered the opportunity for the resident to participate in research. Their participation was voluntary and did not affect their services in the specialized clinic. Additionally, prior to each session, therapists asked each participant if they wanted to come with them to the clinic. If the participant indicated they did not want to come, no sessions were conducted that day. Two participants, Michelle and Leonardo, regularly and independently asked to go to the clinic when they saw research personnel.

Michelle was a 55-year-old female diagnosed with bipolar disorder and moderate ID. Michelle communicated in full sentences. Michelle was referred to the clinic for refusal to walk and SIB, in the form of hand biting and leg hitting. Michelle's pre-treatment FA indicated her SIB was multiply maintained, by social positive reinforcement and non-social reinforcement. Michelle received separate social positive reinforcement treatment and her SIB persisted when that treatment was in effect.

Leonardo was a 30-year-old male diagnosed with ASD and moderate ID. Leonardo communicated in single words and short phrase. Leonardo was originally referred to the specialized clinic for aggression toward others and aggression toward property. Although the original referral was not for SIB, within the past year there was an increase in SIB and self-stimulatory behaviors. Leonardo's interdisciplinary team (IDT) asked the specialized clinic to also assess and treat his SIB. Leonardo's SIB behaviors included headbanging, knuckles to the eyes, punching self, pitching self, and forcefully kneeing a hard surface. A functional analysis was completed and concluded that Leonardo's self-injury was maintained by non-social reinforcement.

All sessions occurred in a 3-m X 3-m session room in the specialized clinic on the campus of the facility. The room had a one-way mirror, through which data collectors could observe unobtrusively. The room contained a table, respective item and a chair.

Response Measurement, Interobserver Agreement, and Procedural Fidelity

The primary dependent variable was the rate of SIB. The secondary dependent variable was interaction with each item. I separated interaction down into three types: specified, non-specified motion, and non-specified static interaction. The definition of specified interaction was determined by each participant's OT. I defined non-specified motion as any action that involved movement that was not specific. I defined non-specified static interaction as touching the item without motion. The individual definitions for each item are listed in Table A.1 in the appendix.

All sessions were video recorded on a Microsoft Surface Pro. Trained data collectors recorded data using BDataPro, installed on a Microsoft Surface Pro. For each participant, data collectors recorded the frequency of SIB and the duration of each type of interaction. At the end of recording, data collectors converted the frequency of SIB to a rate by dividing the total instances of SIB by the duration of the session, in min. Data collectors converted the duration of each interaction type to a percentage of the session by dividing the total duration, in s, of each interaction type by the total duration of the session, in s.

A second observer was present for at 34.88% of sessions for Michelle and 35.16% of sessions for Leonardo. To calculate interobserver agreement (IOA), I used the proportional interval method. First, I divided each session into 10-s intervals. Second, I divided the smaller value by the larger value. Third, I summed the values for each interval. Finally, I divided the total by the total number of 10-s intervals and multiplied by 100. The mean IOA for Michelle's SIB was 98.25% (range: 90.70% - 100%), the mean IOA for Leonardo's SIB was 98.27% (range: 84.81% - 100%), the mean IOA for Michelle's interaction was 98.70% (range: 63.09% - 100%), and the mean IOA for Leonardo's interaction was 98.03% (range: 81.59% - 100%).

Materials

Michelle's OT suggested three sensory items: a scooter board for proprioceptive input, a weighted blanket for proprioceptive input, and vibration for tactile input. To identify a moderately preferred item, I conducted a multiple-stimulus without replacement preference assessments, using procedures similar to those described by Deleon & Iwata (1996). Michelle's moderately preferred item was a coloring book.

Leonardo's occupational therapist suggested three sensory items: "heavy work" (a type of prescription used by OT's) for proprioceptive input, an unstable surface for vestibular input, and weighted blanket for proprioceptive input. To identify a moderately preferred item, I conducted a multiple-stimulus without replacement preference assessments, using procedures similar to those described by Deleon & Iwata (1996). Leonardo's moderately preferred items were a puzzle and a motorcycle. I chose two items for Leonardo because during the preference assessment, once Leonardo finished the puzzle, he would not manipulate other items for the remainder of the session. The addition of the motorcycle ensured that Leonardo had an item he would reliably manipulate throughout the session

General Procedures

During all sessions, the therapist did not interact with the participant, except to block severe SIB. For sessions with items, the participant had continuous access to the item. See Tables A.2 and A.3 in the appendix for detailed definitions of SIB and specific interaction for each of the participants.

- *No items*. No items sessions were similar to alone (Michelle) and no interaction (Leonardo) sessions during each participant's FA. During no items sessions, the therapist was in the room with the participant. No materials were present.

- *Preferred items*. During the preferred items phase, the therapist presented the preferred item to the participant and immediately began the session.

- *SIT items*. Before the session, the therapist selected, at random, a SIT item to use in the subsequent session. Prior to the start of the session, the therapist presented the SIT item to the participant and stated, "Can you touch it?," "Can you hug it?," or "Can you stand on the item?," and asked the participant to interact with the item five times. Following the five interactions, the therapist began the session.

- *Vibration and dog phases*. The vibration and dog phases were conducted in an identical manner to preferred item sessions.

Experimental Design

I evaluated the effects of preferred items and SIT items using a reversal design and a multielement design. For both participants, I alternated between no items, preferred items, and

SIT items phases. For Michelle, I also alternated between vibration, and dog phases. Additionally, within the SIT items phase, I alternated between each SIT item and no items in a multielement format.

CHAPTER 3

RESULTS

Michelle

The results for Michelle are depicted in Figures 1 and 2. In Figure 1, the top panel depicts Michelle's SIB and the bottom panel depicts Michelle's item interaction. In the top panel, the open circles depict SIB in sessions with no items, the closed circles depict SIB in sessions with the preferred item, the closed diamonds depict SIB in sessions with the scooter board, the closed squares depict SIB in sessions with the weighted blanket, the closed triangles depict SIB in sessions with the vibrating dog, and the open triangles depict SIB in sessions with stuffed animal without vibration turned on. The first alone phase was from Michelle's FA. During this phase, Michelle's mean rate of SIB was 1.70 responses per min (RPM). In the first preferred items phase, Michelle SIB reduced substantially to a mean rate of 0.49 RPM. During the first SIT items phase, Michelle's SIB was similar to baseline levels. Her mean rate of SIB with the weighted blanket was 1.07 RPM, her mean rate of SIB with the scooter board was 2.55 RPM, and her mean rate of SIB with no items condition was 2.4 RPM. However, during this phase there, was a significant decrease in her SIB with the scooter board, with a mean rate of 0.55 RPM. In the second preferred items phase, Michelle's SIB remained below baseline levels, at a mean rate of 0.14 RPM. During the second SIT items phase, Michelle's mean rate of SIB with all items was below the original baseline rates. However, there was no differentiation between the SIT items and no items during this phase. Her mean rate SIB in no items sessions was 0.52 RPM, her mean rate of SIB in weighted blanket sessions was 0.67 RPM, her mean rate of SIB in vibration sessions was 0.65 RPM, and her mean rate of SIB in scooter board sessions was 0.65 RPM. During the second no items phase, her mean rate of SIB was 0.73 RPM.

Because there was an overall reduction in Michelle's SIB relative to her initial baseline levels but no differentiation within the SIT items phase, I evaluated whether rapid alternation per se had an influence on her rates of SIB. Therefore, I conducted a multielement phase with both the SIT items and Michelle's preferred item. During this phase, Michelle's mean rate of SIB in preferred items sessions was 0.39 RPM. However, there was a substantially higher mean rate of SIB in the weighted blanket sessions (1.24 RPM) and scooter board sessions (1.58 RPM). Interestingly, Michelle's mean rate of SIB in the vibration sessions was 0.34 RPM, a mean rate similar to sessions with her preferred items. Therefore, I decided to evaluate vibration in isolation. During the first vibration phase, Michelle's SIB further decreased, to a mean rate of 0.03 RPM, with four consecutive sessions with no instances of SIB. When I returned to a phase with her preferred items, Michelle's mean rate of SIB increased to 0.95 instances per min. I then replicated the vibration only phase, which produced a mean rate of SIB of 0.04 RPM. To further isolate whether the effect was due to the vibration itself or the animal in which the vibrating motor was placed, the next phase I conducted included the animal only without vibration enabled, SIT item (turned off). During this phase, Michelle's mean rate of SIB increased to 1.53 RPM. In the fourth no items phase, Michelle's SIB increased to a mean of 1.93 RPM. In the second SIT item (turned off), Michelle's mean rate of SIB was 1.40 RPM. During the final phase, no items, Michelle's SIB substantially increased, to a mean rate of 4.03 RPM.

The bottom panel of Figure 1 depicts Michelle's item interaction. There are no data for the alone phases because there were no items available to Michelle. During the first preferred items phase, Michelle's mean specific interaction was 11.08% of the session, her mean non-specified static interaction was 18.19% of the session, and her mean non-specified motion interaction was 27.32% of the session. During the first SIT items phase, there was a substantial decrease in Michelle's item interaction across all items. With the weighted blanket, Michelle's mean specific interaction was 0%, her mean non-specified static interaction was 1.26% of the session, and her mean non-specified motion interaction was 2.42% of the session. With the vibration, Michelle's mean specific interaction was 3.38% of the session, her mean non-specified static interaction was 0% of the session, and her mean non-specified motion interaction was 0.40% of the session. With the scooter board, Michelle's mean specific interaction was 8.31% of the session, her mean non-specified static interaction was 0% of the session, and her mean non-specified motion interaction was 0.66% of the session. During the second preferred items phase, Michelle's mean specific interaction was 22.35% of session, her mean non-specified static interaction of 5.16% of session, and her mean non-specified motion interaction 33.44% of session. During the second SIT items phase, with the weighted blanket, Michelle's mean specific interaction with was 0% of the session, her mean non-specified static interaction was 2.80% of the session, and her mean non-specified motion interaction was 0% of the session. With the vibration, Michelle's mean specific interaction was 10.66% of the session, her mean non-specified static interaction was 0.68% of the session, and her mean non-specified motion interaction was 0% of the session. With the scooter board, Michelle's mean specific interaction was 4.79% of the session, her mean non-specified static interaction was 0% of the session, and her mean non-specified motion interaction was 2.35% of the session. During the phase with alternation of both preferred items and SIT items, with preferred items, Michelle's mean specific interaction was 25.87% of the session, her mean non-specified static interaction was 5.29% of the session, and her mean non-specified motion interaction was 20.93% of the session. With the weighted blanket, Michelle's mean specific interaction with was 0% of the session, her mean non-specified static interaction was 0.63% of the session, and her mean non-specified motion interaction was 2.21% of the session. With the vibration, Michelle's mean specific interaction was 6.78% of the session, her mean non-specified static interaction was 0.98% of the session, and her mean non-specified motion interaction was 0% of the session. With the scooter board, Michelle's mean specific interaction was 3.91% of the session, her mean non-specified static interaction was 0% of the session, and her mean non-specified motion interaction was 2.07% of the session. During the first SIT item (vibration) phase, Michelle's mean specific interaction was 17.98% of the session, her mean non-specified static interaction was 5.25% of the session, and her mean non-specified motion interaction was 0.11% of the session. During the third preferred item phase, Michelle's mean specific interaction was 22.34% of session, her mean non-specified static interaction of 25.58% of session, and her mean non-specified motion interaction 17.47% of session. During the second SIT item (vibration) phase, Michelle's mean of specific interaction was 74.45% of the session, her mean non-specified static interaction was 0.78% of the session, and her mean non-specified motion interaction was 1.10% of the session. During the first SIT item (turned off) phase, Michelle's mean specific interaction was 43.10% of session, her mean static interaction was 2.41% of session, and her mean non-specified motion interaction 0.51% of session. During the second SIT item (turned off) phase, Michelle's specific interaction was 48.15% of session, her mean static interaction was 4.13% of session, and her mean non-specified motion interaction 0.78% of session.

Figure 2 depicts Michelle's mean item interaction (left panel) and mean rate of SIB, across all sessions of each condition. Overall, Michelle's highest specific interaction occurred with the animal, the SIT item (turned off) phases. However, this condition also produced the highest mean rate of SIB. Both the vibration, SIT item phases, and coloring, preferred item phases, produced the lowest rate of SIB but coloring produced higher interaction overall, with a greater proportion of interaction being non-specified motion interaction. The remaining items produced low interaction and levels of SIB similar to levels produced by the animals.

Figure 1

Michelle's Evaluation of the Preferred and SIT Items on SIB [top] and Three Measures of Item Interaction during the Evaluation with Preferred and SIT Items [bottom]

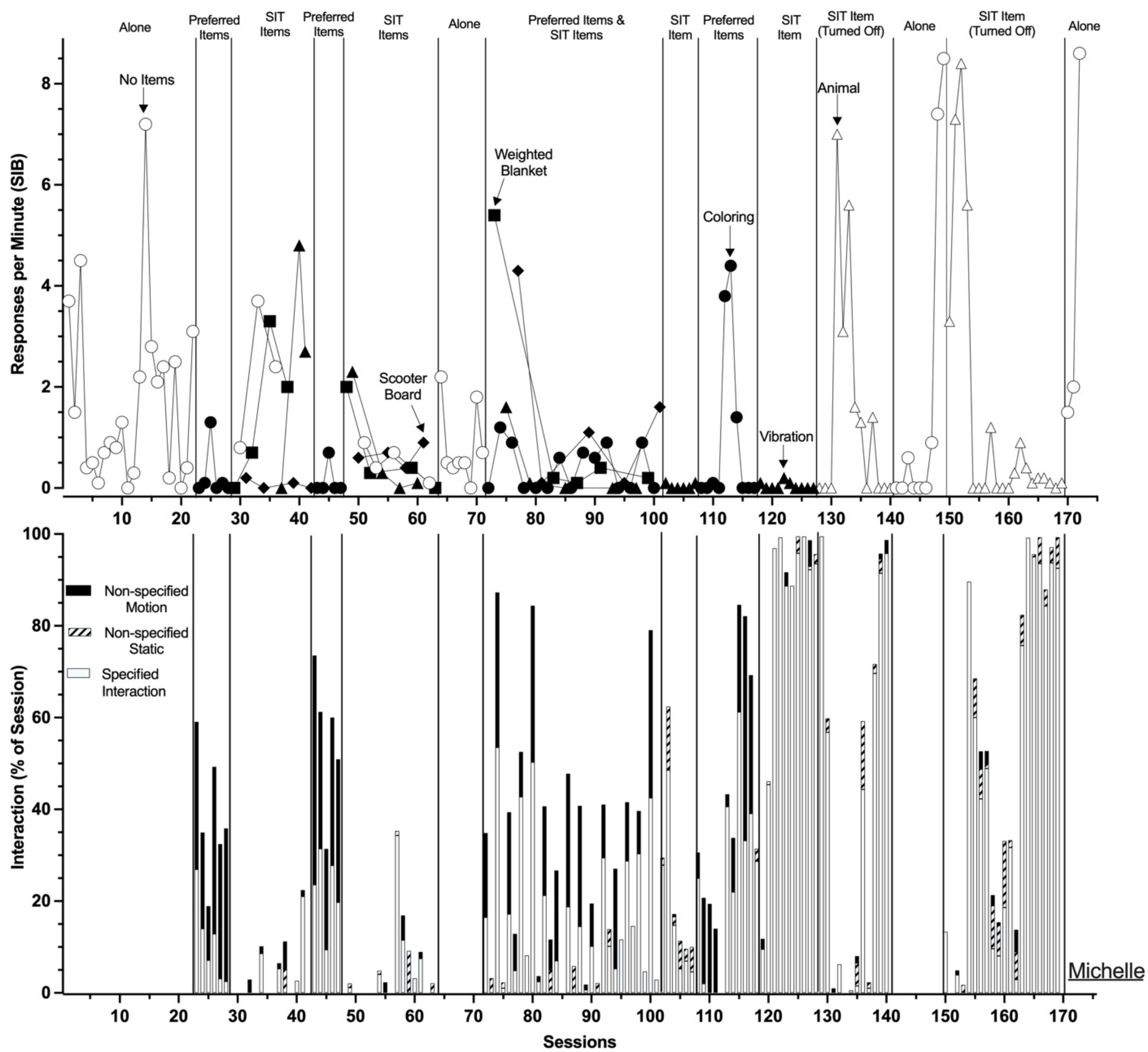
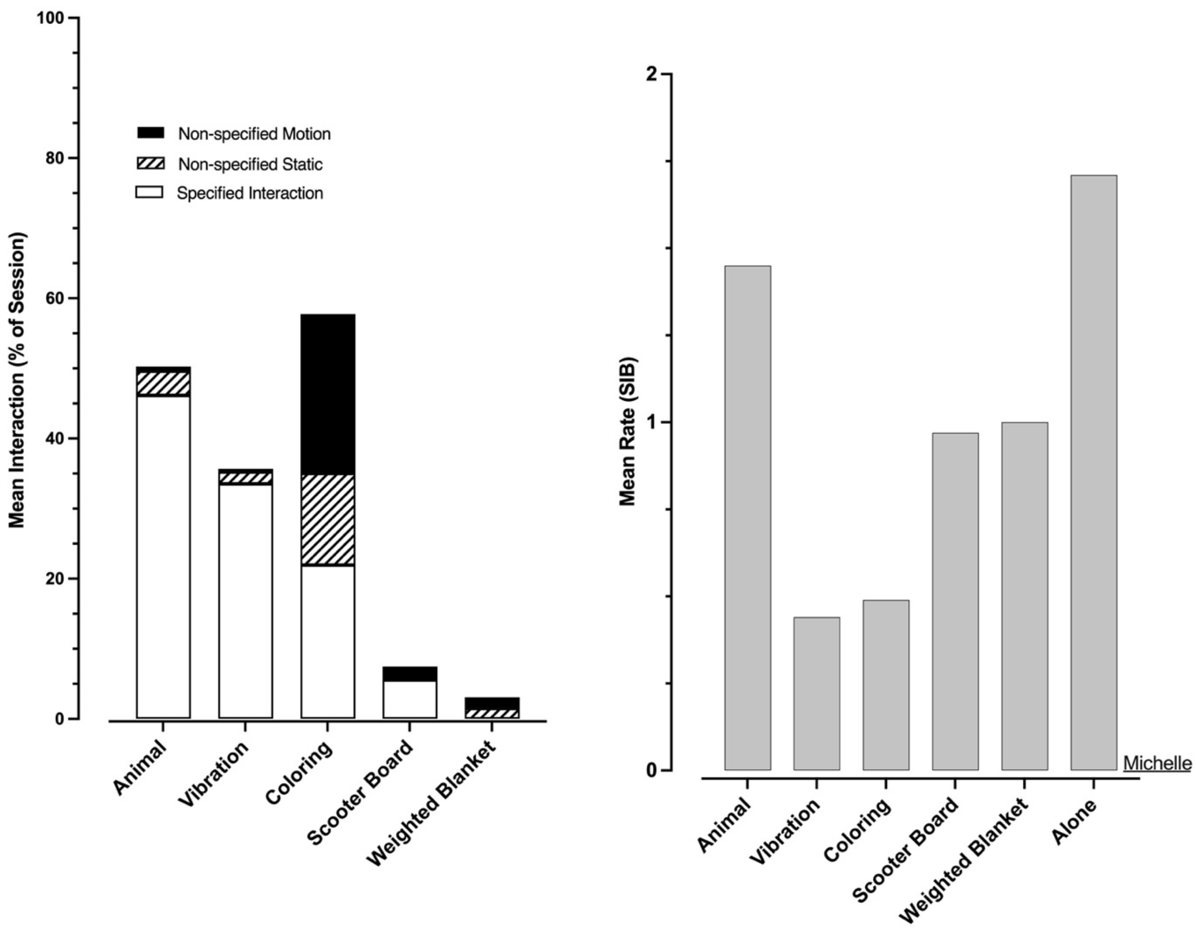


Figure 2

Michelle's Averages of Overall Interaction and Responses per Minute of SIB



The left graph represents average interaction in percent of sessions with the corresponding interaction type on the *Y* axis. The right graph represents average responses overall on the *Y* axis. The *X* axis on both graphs represent each of the respective items.

Leonardo

The results for Leonardo are depicted in Figures 3 and 4. In Figure 3, the top panel depicts Leonardo's SIB and the bottom panel depicts Leonardo's interaction. In the top panel, the open circles depict SIB in sessions with no items, the closed circles depict SIB in sessions with the preferred item, the closed diamonds depict SIB in sessions with the Bosu ball, closed squares depict SIB in sessions with the weighted blanket, closed triangles depict SIB in sessions with the weighted ball, The first alone phase was from Leonardo's FA. During this phase, Leonardo's mean rate of SIB was 1.00 responses per min (RPM). In the first preferred items phase, Leonardo SIB reduced substantially to a mean rate of 0.46 RPM. During the first SIT items phase, Leonardo's SIB of no items in this phase increased 1.22 RPM. Leonardo's SIB below baseline levels with respective items weighted blanket 0.35 RPM, Bosu ball with 0.46 RPM, and Leonardo's mean SIB for weighted ball at 0.40 RPM. In the second preferred item phase Leonardo's SIB increased to 2.87 RPM. The second SIT condition Leonardo's SIB in no items during this phase was 0.98 RPM the respective SIT was above this rate with weighted blanket at 3.3 RPM, Bosu ball 3.75 RPM, and weighted ball at 2.90 RPM. The second no items condition (similar to the no-interaction condition that was conducted in the functional analysis) of 1.56 RPM. Leonardo did not have the same effects as Michelle with one SIT item, therefore an extended analysis was not completed.

The bottom panel of Figure 3 depicts Leonardo's item interaction. There are no data for the alone phases because there were no items available to Leonardo. During the first preferred items phase, Leonardo's mean specific item interaction was 33.55% of the session, his mean non-specified static interaction was 1.44% of the session, and her mean non-specified motion interaction was 2.17% of the session. During the first SIT items phase, there was a substantial decrease in Leonardo's item interaction across all items except weighted blanket. Leonardo's mean weighted blanket specific interaction with was 97.50% of the session, her mean non-specified static interaction was 0% of the session, and her mean non-specified motion interaction was 0.37% of the session. Leonardo's mean of Bosu ball specific interaction was 0% of the session, his mean non-specified static interaction was 0.17% of the session, and his mean non-specified motion interaction was 0% of the session. Leonardo's mean of weighted ball specific interaction was 0.44% of the session, his mean non-specified static interaction was 0.10% of the session, and his mean non-specified motion interaction was 0.21% of the session. The second preferred items phase Leonardo's specific interaction was 31.25% of session, his mean non-specified static interaction of 0.78% of session, and his mean non-specified motion interaction 0% of session. The second SIT items phase Leonardo's mean weighted blanket specific interaction with was 81.30% of the session, his mean non-specified static interaction was 0% of the session, and his mean non-specified motion interaction was 0.19% of the session. Leonardo's mean of Bosu ball specific interaction was 5.00% of the session, his mean non-specified static interaction was 0% of the session, and his mean non-specified motion interaction was 0% of the session. Leonardo's mean of weighted ball specific interaction was 3.39% of the session, his mean non-specified static interaction was 0% of the session, and his mean non-specified motion interaction was 14.63% of the session.

Figure 2 depicts Leonardo's mean item interaction (left panel) and mean rate of SIB, across all sessions of each condition. Overall, Leonardo's highest specific interaction occurred with the weighted blanket. However, this condition also produced one of highest mean rate of SIB. Overall, all of these items (Preferred and SIT) increased SIB.

Figure 3

Leonardo's Evaluation of the Preferred and SIT Items on SIB [top] and Three Measures of Item Interaction during the Evaluation with Preferred and SIT Items [bottom]

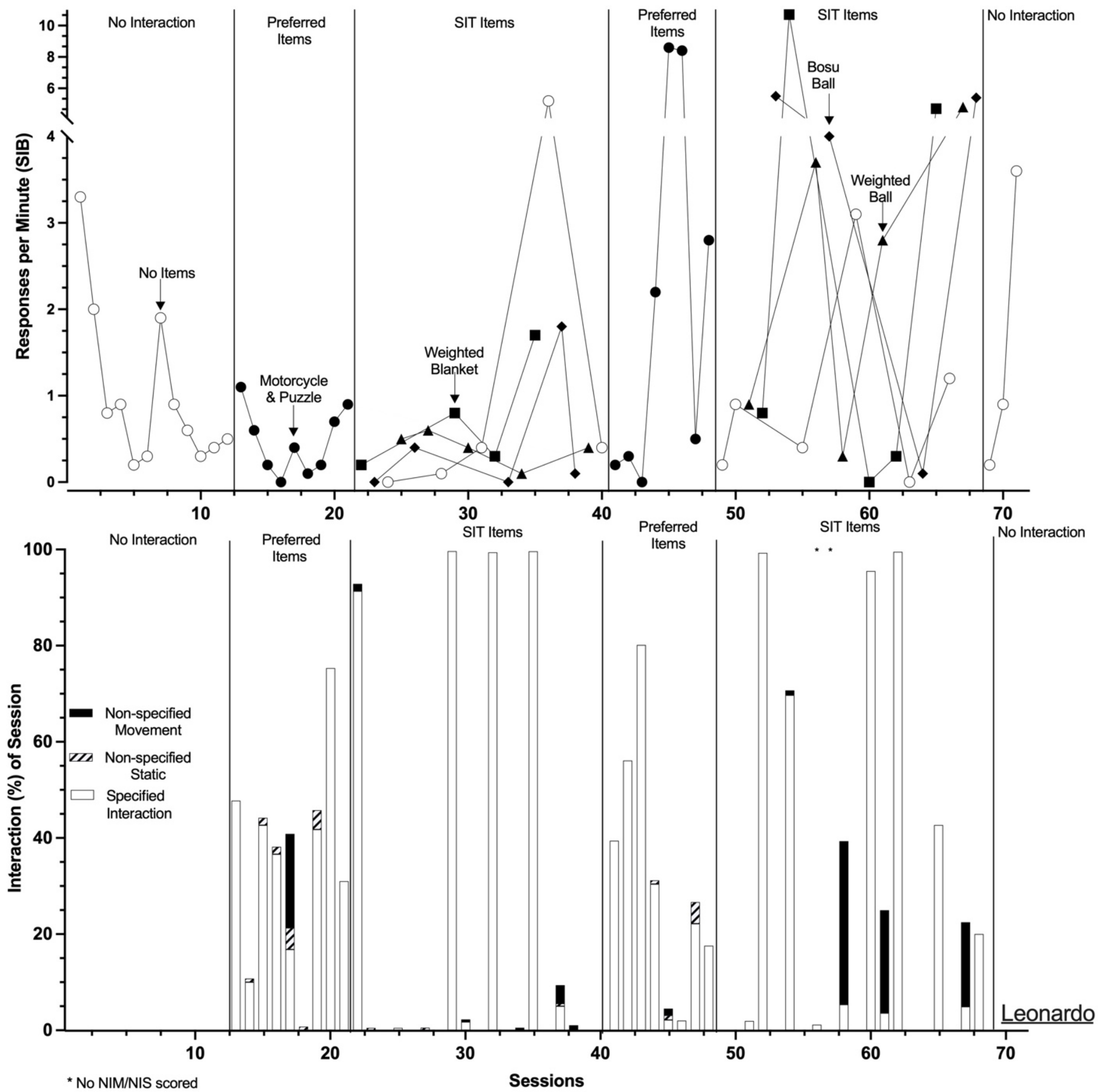
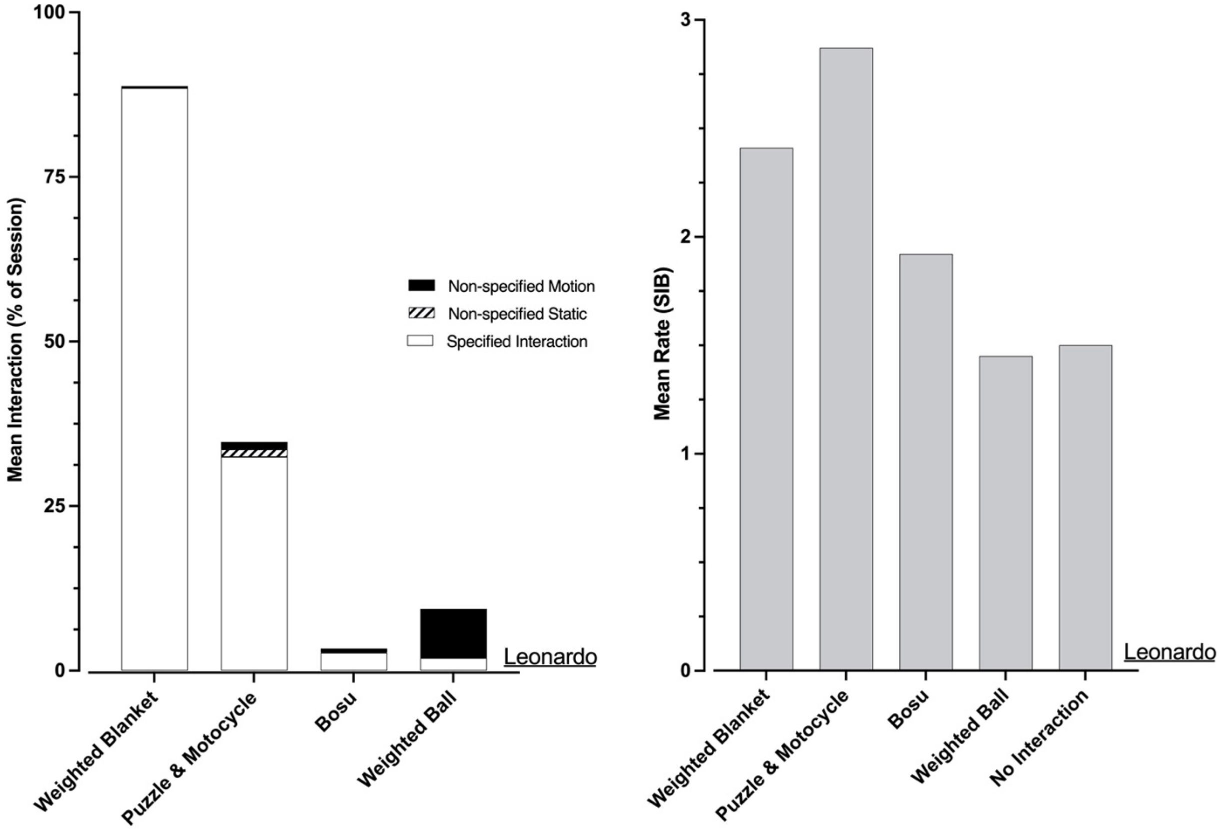


Figure 4

Leonardo's Averages of Overall Interaction and Responses per Minute of SIB



The left graph represents average interaction in percent of sessions with the corresponding interaction type on the *Y* axis. The right graph represents average responses overall on the *Y* axis. The *X* axis on both graphs represent each of the respective items.

CHAPTER 4

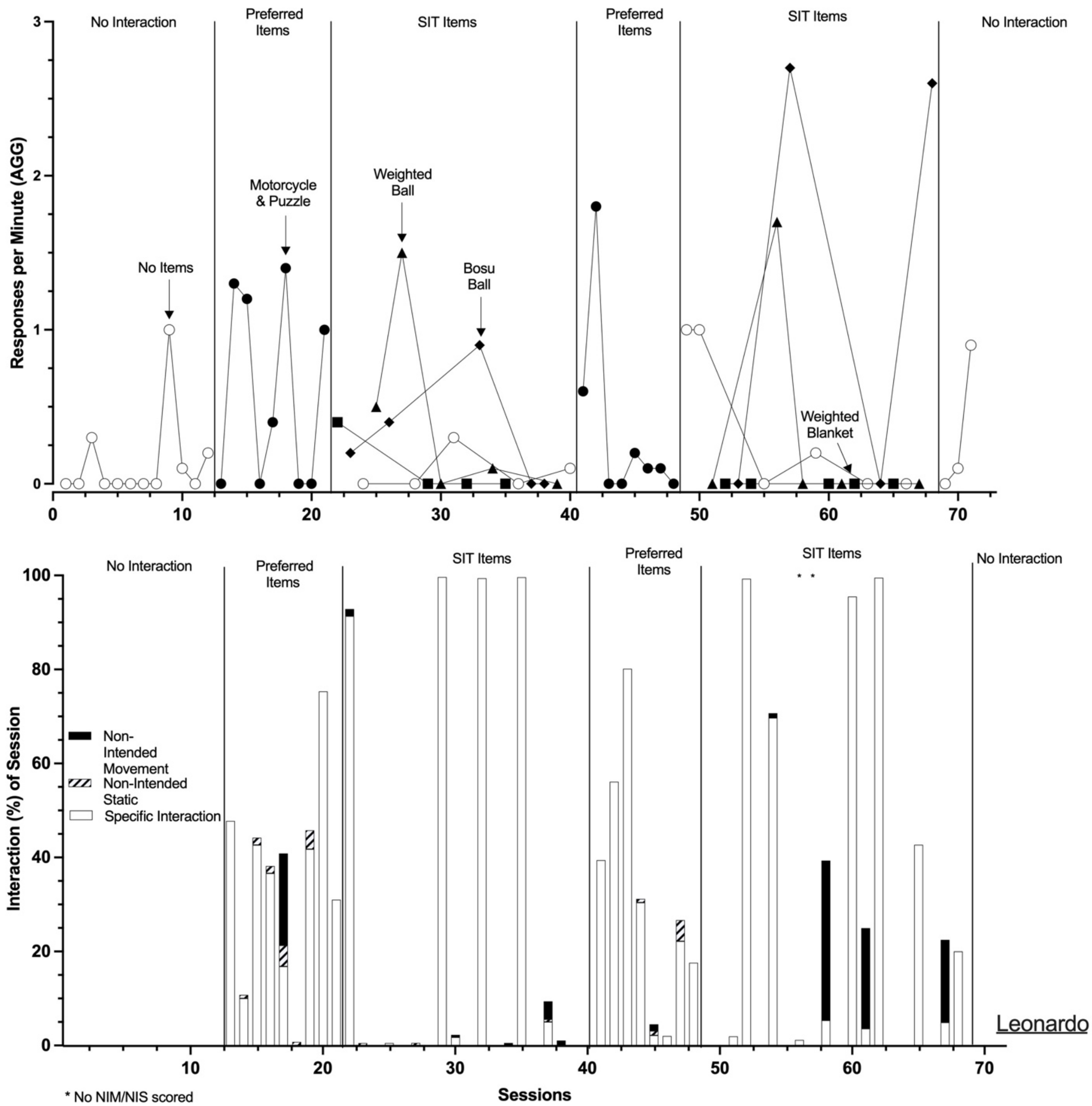
DISCUSSION

Overall, based on the results SIT items were ineffective or counter-therapeutic effects. Interaction among the given stimuli were variable among SIT items and typically higher among preferred items. Though, the specified interaction among SIT items were high in some cases, specified interaction may not be critical component of a SIT treatment package. Given these results, there are several important implications. First, this study emphasizes the importance of collaborating with other disciplines. Behavior analysis will often refer to automatic or non-socially maintained problem behavior as behavior that is maintained by access to sensory stimulation. OTs will often use SIT to alter the sensory system based on what they hypothesize the individual's body is "seeking" or "avoiding" (Baeanek et al, 2007). In the current study, the IDT described each participant's SIB to their assigned OT. The OT then hypothesized if the problem behavior was "seeking behavior" or "avoidant behavior". For example, Leonardo's OT prescribed a weighted ball to engage Leonardo in "heavy work." This was to address Leonardo's "seeking input" of stretching and contracting muscles (proprioception), which Leonardo's SIB was hypothesized to product. Though OT and behavior analyst share some of the same terminology, such as "sensory," they do not have the same meaning across disciplines. When collaborating in a team environment, it is important to have conversations about how behavior analyst can work with OTs to systematically analyze the effects of SIT. It is also important to discuss how behavior analyst analyze behavior in the form of environmental consequences as OT does not analyze behavior in this way. A combination of different approaches could facilitate both the development of effective treatments and further information on how and why a specific item reduces SIB. This has several benefits. First, by understanding whether the treatment effect is due to “matched” stimulation or competing stimulation, more precise intervention are possible. Second, by evaluating the treatment in a controlled environment, both the OT and behavior analyst may be more confident that the treatment will succeed in the everyday environment.

Second, regardless of conceptual orientations, the results of this study demonstrate the importance of function-based, rather than topography-based, treatments. For example, Leonardo’s OT prescribed “heavy work” based on the topography of his SIB. Overall, SIT with both participants produced variable effects on SIB. At best, SIT had minimal to no effect on SIB. At worst, some SIT items made SIB worse. For example, Leonardo used the Bosu ball to bounce and head bang at a higher frequency. Additionally, some SIT items altered other forms of problem behavior. For example, because Leonardo was also referred to the specialized clinic for aggression, we recorded aggression during this analysis. Figure 5 depicts Leonardo’s aggression during the evaluation with SIB. The phase labels represent the phase in effect for SIB. Based on these data, it appears the Bosu ball and weighted ball (SIT items) increased Leonardo’s aggression relative to no items being present. An FA of Leonardo’s aggression indicated his aggression was socially maintained. Without this analysis, the prescription of the Bosu ball and weighted blanket for Leonardo’s topography of SIB made both the targeted behavior (SIB) and an untargeted behavior (aggression) worse, a countertherapeutic effect. One possibility is that the Bosu ball and weighted blanket, in the conditions of SIB, were unpleasant and Leonardo engaged in problem behavior to escape or avoid these items. This could be seen with an increase of SIB during these conditions. Another possibility is the presence of people in the room when these two items were present signaled the potential removal of the items and evoked problem behavior to prevent their removal. This would suggest that these items that access to these items could have maintained through the development of these tangible items. Although these possibilities are speculative, a focus on function, rather than topography, could be beneficial because a focus on function would increase the likelihood one would detect no effect or negative effects.

Figure 5

Leonardo's Aggression during SIB Evaluation



Total sessions along the X-axis (73 sessions). The dependent variable of responses per minute of aggression is depicted on the left *Y*-axis. The bottom graph the *Y* axis depicts the second dependent variable with percent of session of overall interaction.

Because the items selected would not be hypothesized to have a sensory connection to problem behavior but rather either matching stimulation or competing, it may be easier to change items if the desired clinical effect is not found. Further, a focus on function would allow for a more precise determination of the function of each of these items. If an item was effective, one could more precisely separate matched effects from competing item effects. That is, because problem behavior has observable properties, one could determine whether the item was likely producing similar sensory input as problem behavior, which could suggest a “matched stimulation,” effect. Although this “sensory input” seems similar to the OT’s hypothesis, the “sensory input,” is focused on observable responses rather than putative internal processes and states. This could allow for manipulation of the items, to further determine the specific location of stimulation. For example with Leonardo, if the Bosu ball provided similar stimulation to the internal motivation of his SIB, one could provide the Bosu ball when Leonardo had to be stationary. This could isolate the potential matched effects on SIB by providing a specific source of stimulation. If SIB was higher when Leonardo was stationary, this could provide evidence that vestibular input was the primary sensory stimulation produced by his SIB. The explanation of the OT’s hypothesis is similar to behavior analysis pre-functional analysis (before 1982). According to Carr (1977) the most popular hypotheses of the development of SIB included different types of motivations such as positive reinforcement hypothesis, negative reinforcement hypothesis, self-stimulation hypothesis, organic hypothesis, and psychodynamic hypothesis. Carr also stated that inconstancies in treatment of SIB, typically operant based conditioning principles (Bachman, 1972; Baumeister & Rollings, 1976; Frankel & Simmons, 1976; Johnson & Baumeister, 1978; Romanczyk & Goren, 1975; Schroeder, Schroeder, Rojahn, & Mulick, 1981; Smolev, 1971), due to lack of understanding variables that produce or maintain SIB.

Third, this study further supports past research that there is variable efficacy on reducing challenging behavior with sensory techniques. Overall, the effects of SIT items on Michelle's SIB was non differentiated from the effects of preferred items, even though Michelle's specific interaction was higher with sensory items. However, the SIT items produced an increase in Leonardo's SIB. Further, for Leonardo, the SIT item that produced the highest levels of specific interaction, the weighted blanket, also produced the second highest mean rate of SIB. These results are similar to those of Mason and Iwata (1990) and Devlin et al. (2010), both of whom found SIT items, at best, had no effect, and at worst, produced higher levels of problem behavior. Although I cannot fully account for why some SIT items produced a negative clinical effect, there are several possibilities related to "matched" stimulation and competing stimuli (e.g., Piazza et al., 2000; Rapp et al., 2004). For example, for Michelle, the SIT items scooter board and weighted blanket increased rates of problem behavior whereas the vibration produced a reduction in problem behavior relative to no items. It is possible that the vibration produced the same or similar stimulation SIB produced on Michelle's hands. Alternatively, it is possible that holding the vibrating animal produced a reinforcer that competed with the simulation produced by SIB or precluded the emission of SIB.

Fourth, this study extends to the research that interaction type may be a factor in competing-stimulation interventions for problem behavior. For example, Piazza et at. (2000) only measured engagement based on the participants using the item as specific. In the current study, I measured three types of interaction: specific, non-specified static, and non-specified motion. I found that specific interaction was not the only interaction time that produced a reduction in SIB. For example, Michelle's highest specific interaction was with the vibration SIT item. It is important to note that the specific interaction for SIT item of vibration/dog was low response effort, as the specific interaction was to simply hold the item. However, Michelle's had similar non-specified interaction with the coloring (her preferred item) and both items produced similar reduction in SIB. With the coloring, Michelle would move the paper back and forth between her fingers or hold the coloring paper in her lap. With coloring, a combination of the three types of interaction produced a clinically significant reduction in SIB. Leonardo, however, showed mainly specific interaction with all the items (except weighted ball) but none of the items produced a clinically significant reduction in SIB. Taken together, Although researchers (e.g., Pizza et al., 2000; Rapp et al., 2004) have shown that demonstrated specific interaction with items is what may displace problem behavior, this study provides evidence that competing or matched stimuli could have effects even when not used in a manner specific by the researcher or clinician.

Despite these promising results, there were some limitations to this study. First, I did not systematically identify "matched" stimuli. The SIT items were assumed, by the OT, to produced similar, or "matched" stimulation to SIB. This may make the identification of items highly dependent on the history and skillset of the OT. Future researchers should compare items identified by an OT with items identified by a more standardized assessment, such as the Sensory-Profile 2 for adults. Second, I did not complete a competing stimulus assessment. Therefore, I may have found a more substantial effect with preferred items had I used items identified using a competing-stimulus assessment (e.g., Piazza et al., 2000). Although the purpose of this study was to evaluate items identified by an OT, future researchers could use a competing-stimulus assessment, rather than a preference assessment, to increase the likelihood of obtaining a clinically significant effect.

Third, I did not analyze the effects of SIB after SIT was implemented. Previous researchers have found that problem behavior decreases only after SIT sessions were completed (e.g., Green et al., 2003; Sandler et al., 2007; Urwin et al., 2005). Therefore, I may have missed the potential benefits of SIT by not measure SIB immediately after SIT sessions ended. Because SIT sessions are typically used as an antecedent procedure to satiate the sensory system (Kimball 1999), this antecedent effect may be best evaluated by measuring SIB in subsequent sessions. Antecedent effects on behavior could be due to the occasioning of reinforcement or punishment maybe upcoming. SIT is also theorized to have an additive effect throughout sessions. This study also did not analyze the effects of these treatments throughout the day in the client's home after sessions were completed. Throughout the day any effects of the SIT could have shown after the session was completed, we did not look at the long-term effect. Although Aryes (1972/1974) did not specifically include a timeline of ideal "integration" through SIT. In a recent review May-Benson (2010) analyzed 12 studies and studies ranged in "doses" of interventions of SIT range in frequency of intervention from one to five times per week, session duration varied from 30 – 60 min, and length of studies ranging from 10 weeks to one year. This review also discusses this as a limitation to research on SIT. With the variability in effectiveness with interventions that include SIT the variation of "doses" of interventions could also contribute to the effectiveness of the intervention itself for a practitioner cannot conclude weather positive or negative effects based on the "adequate amount" of intervention needed. The timeline presented in the current study ranged from a year to a year and a half of analysis.

Fourth, Leonardo's interdisciplinary team implemented a weighted blanket outside this evaluation. This may have influenced those effects of the SIT item of the weighted blanket. Weighted blanket uses deep touch pressure through proprioceptive input to manage anxiety, sensory modulation, or physiological disorders (Chen et al., 2011). With the implementation of the weighted blanket at the client's home (usually used during sleep and during times that he was watching TV) may have previously satiated the body from that type of input, decreasing the efficacy, due to overuse of the item.

Finally, as previously discussed, Michelle's SIB was multiply maintained by social positive reinforcement and automatic reinforcement. We conducted all of Michelle's conditions with no staff present. In her previous treatments, Michelle regularly requested attention from the therapist. It is possible that if a therapist was in the room during SIT items and preferred items I may see an increased reduction in SIB due to another component (access to social positive reinforcement) being added as additional reinforcement. Alternatively, I may have seen an increase in SIB, because although the therapist was present, they would not respond. We did not analyze if a therapist present had an effect in this study.

SIT is a common procedure among children with sensory processing disorders (Urwin et al., 2005). SIT is rarely evaluated with adults with IDD, an underserved, marginalized population. Overall, this study suggests that SIT is limited in efficacy with adults with IDD with automatically maintained SIB. The limited efficacy may be, in part, due to the length of time each participant has engaged in problem behavior. Participants were not exposed to SIT items before this evaluation, as time went on the overall interaction with the items did increase as the sessions continued. Interaction was an important variable for this study to conclude that specific interaction with an item may not be component that is competing with the Individual's SIB.

Future research needs to be explored with SIT in the means of a behavioral point of view, specifically how occupational therapist implement SIT that is also beneficial to the individuals function of the behavior. The theory about sensory integration is a hypothesis, and further research needs to be conducted on the physiological processes that develop through each of the milestones that are met through the levels of sensory integrative theory.

APPENDIX

ADDITIONAL TABLES

Table A.1

Specific Use of SIT per Occupational Therapist

Item	Use
Vibrating dog	Holding animal
Weighted blanket	On the body
Scooter board	Movement caused with the arms or the feet by either sitting on scooter or pushing it back and forth
Tactile board	Manipulating fingers across the different sections of the board
Bosu Ball	To either stand or sit on the bosu ball causing moving to a persons body
Weighted ball	To roll or bounce ball
Jiggler	To hold or bite on the jiggler
Rocking chair	Sitting on rocking chair and move body back and forth

Table A.2

Michelle's Detailed Topography of Problem Behavior and Specific Interaction for Each Item

<table>
<tr><th>SIB</th><th colspan="2">Specific Interaction</th></tr>
<tr><td rowspan="4">Hand Bite: Anytime that Michelle encloses teeth/mouth around hand and anytime.
Leg Hit: Michelle hits her legs with an audible sound.</td><td>Preferred Item</td><td>Coloring:
Start: When Michelle is touching the paper with coloring utensil point causing motion for 3 sec (Start 3 sec when Michelle is removing cap off of marker, if changing colors still counts as specific)
End: When Michelle is not touching the paper with coloring utensil point causing motion for 3 sec.</td></tr>
<tr><td rowspan="3">Sensory Items</td><td>Scooter Board:
Start: When Michelle is pushing scooter board with arms or legs and causes motion for 3 sec
End: When Michelle not causing motion for 3 sec</td></tr>
<tr><td>Vibrating Dog:
Start: When Michelle is holding the dog (hand cupping the dog or holding with other body part) for 3 sec
End: When Michelle is not holding the dog for 3 sec</td></tr>
<tr><td>Weighted Blanket:
Start: When Michelle has weighted blanket on her legs for 3 sec
End: When Michelle does not have the weighted blanket on her leg for 3 sec</td></tr>
</table>

Table A.3

Leonardo's Detailed Topography of Problem Behavior and Specific Interaction for Each of Item

<table>
<tr><th>SIB</th><th colspan="2">Specific Interaction</th></tr>
<tr><td rowspan="4">• Head SIB: Anytime Leonardo hits his head on a hard surface making an audible sound.

• Bite: Contact between his teeth and skin.

• Body Hit: Hits himself with closed fist with force.

• Knuckles: Hits himself in the eyes/eye area with his knuckles.

• SIB – O: Hits any hard surface with the back of his wrists with force, and hits knee into hard surface with audible sound.</td><td>Preferred Items</td><td>Puzzle and Motorcycle:
• Start: When 257 is touching to causes movement to the puzzle or motorcycle for 3 sec
• End: When 257 is not causing movement to the puzzle or motorcycle for 3 sec</td></tr>
<tr><td rowspan="3">Sensory Items</td><td>Weighted ball:
• Start: When 257 is engages in an action that moves the weighted ball 3 sec
• End: When 257 is not engaging in an action that moves the weighted ball for 3 sec</td></tr>
<tr><td>Bosu Ball:
• Start: When 257 stands or sits on bosu ball for 3 sec
• End: When 257 is not standing or siting on the bosu ball for 3 sec</td></tr>
<tr><td>Weighted Blanket:
• Start: When 257 has weighted blanket on his legs for 3 sec.
• End: When 257 has one or both legs not completely under blanket for 3 sec</td></tr>
</table>

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