

The Effects of Matching Sensory Profile Results to Functional Analysis and Preference Assessment for the in Home Treatment of Aberrant Behaviors in Two Children with Autism Spectrum Disorders

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Abstract *This study investigated integrating functional analysis and sensory profile results into an intervention for aberrant behavior within two different sensory profile categories (i.e. sensory seeking and sensory avoiding). Our participants were a two-year-old boy with pervasive developmental disorder and a six-year-old boy with autism. This study attempted to extend the previous literature, which supports the use of stimulus substitutability to relieve problem behaviors maintained by reinforcement. We hoped to expand the selection of substitutable stimuli by combining sensory integrative therapies commonly used for treatment of children with sensory processing disorders and autism with functional analysis outcomes. Using the Sensory Profile, the two participants were assessed for sensory processing deficits and a treatment was matched to the results of a functional analysis. Treatment was implemented for both sensory seeking behaviors (Phase B) and sensory avoiding behaviors (Phase C). The study utilized an ABCBCB reversal design to evaluate the effectiveness of matching intervention to the participant's sensory profile and functional analysis results. The results demonstrated that treatment, which matched functional analysis to a sensory profile, successfully decreased aberrant behavior. Suggestions for future research were made.*

Key Words: *Sensory Processing Disorder, Sensory Profile, Pervasive Developmental Disorder, Autism Spectrum Disorders, Sensory Integrative Therapy, Sensory Seeking, Sensory Avoiding, Aberrant Behavior*

Introduction

The Effects of Matching Sensory Profile Results to Functional Analysis and Preference Assessment for the in Home Treatment of Aberrant Behaviors in Two Children with Autism Spectrum Disorders

The treatment of severe behaviors displayed by persons with developmental disabilities has a rich history (Carr & Durand, 1985; Iwata, Dorsey, Silfer, Bauman, & Richman, 1994; Pelios, Morren, Tesch, & Axelrod, 1999). At this time, treatment based on the principles found within the behavior analysis literature has the most empirical support (Hagopian, Fisher, Thibault, Acquistio, & LeBlanc, 1998; Iwata et al, 1994; Northrup, Wacker, Sasso, Cigrand, Cook, DeRaad, 1991). Specifically, the most empirical support is found in treatment based on the results of a functional analysis (Derby, et. al., 1997; Harding, Wacker, Berg, Cooper, Asmus, Mlela, & Muller, 1999; Berg, Peck, Wacker, Jay, McComas, Richman, & Brown, 2000).

However, several other methodologies based on variables typically not assessed via a functional analysis are used (Chen, Rodgers, & McConachie, 2009; Dunn, Saiter, & Rinner, 2002). One such procedure is to conduct a sensory profile (Dunn, et. al., 2002). When this approach is used, treatment is matched to the sensory deficits or excesses exhibited by the child. For example, if a child is found to have sensory seeking behaviors within the sensory profile, the treatment would be to provide access to the sensory modality (Dunn, 1999, 2002; Lane, Young, Baker, & Angley, 2010). To date, the integration of these two standard practices has not been attempted.

The diagnosis and evaluation of sensory processing disorder (SPD) has grown enormously in the past few years (Lane et al., 2010). This disorder is often comorbid diagnosis with the autism spectrum disorder (ASD) population (Kern, et. al., 2006); with 44-88 % of children with ASD's reporting sensory processing difficulties (Baranek, 2002; Lane, et. al., 2010). Typically, sensory symptoms are divided into four categories; over-responsivity, under-responsivity, sensory seeking, and sensory avoiding type behaviors (Dunn, et. al., 2002). It is hypothesized that these sensory challenges may be due to poor sensory integration within the central nervous system (Baranek, 2002). Specifically for sensory seeking subtypes, various problem behaviors occur due to the seeking or removal of desired sensory stimuli. Sensory maintained behaviors have been hypothesized to be responsible for restrictive and repetitive stereotyped patterns of behavior in children with autism (Dunn, et. al., 2002).

One of the four underlying mechanisms hypothesized to be responsible for sensory processing disorders is low registration or sensory under-responsive behaviors (Dunn, et. al., 2002). These behaviors are exemplified by the child being uninvolved, uninterested, self-absorbed or passive to what was happening around him/her (Heward, 2013). This is especially when the intensity of the stimulation does not cross the threshold necessary to gain a response. In addition, low registration is characterized by clumsiness and inability to read faces and/or gestures (Dunn, et. al., 2002).

A second mechanism hypothesized to be responsible for SPD is sensation seeking (Dunn, et. al., 2002). These children typically demonstrate a need for an intensive amount of stimulation to elicit a response. In contrast to the passiveness of the under-responsive group, these children are very actively involved in their surroundings. Thus, these children tend to be fidgety and excitable, but may have difficulty with attention and over-activity. Repetitive patterns of behavior are also evident with sensation seeking children. The hypothesis behind the need for repetitive behaviors and over-activity is that these children are seeking stimulation to meet the high threshold internally needed for that modality (Dunn, et. al., 2002). These behaviors can be specific to the type of input the child is seeking; which may include repetitive visual, oral, tactile, auditory, and movement behaviors.

The next category of sensory processing patterns is the sensory sensitivity or over-responsive group. This group has a low threshold for sensory stimuli (Dunn et al., 2002). These children may be over sensitive to auditory, tactile, olfactory, or movement sensations. For example, these children are considered passive and demonstrate a heightened awareness of sensory stimuli. These children often remain in situations the aversive stimuli occur which

consequently results in negative behaviors. Two of the most common areas of sensory over-responsivity are reported to be tactile and auditory. Heightened awareness of sensory stimuli results in this groups' tendency to be particular about task completion, order, organization, and change. This results in rigidity and resistance to change (Dunn, et. al., 2002).

The final group of sensory patterns observed in children with ASD's is sensation avoiding. These children are believed to have low thresholds (i.e. avoids touch, sounds, bright lights, or different textured foods) for sensory stimuli, but show active behavioral responses (Dunn et al., 2002). These children tend to self-isolate which is hypothesized to be due to avoiding presentation of unwanted sensory stimuli. Aberrant behaviors are hypothesized to function as a means to avoid unwanted sensory input. Their behaviors often dictate what kind of clothes they wear, where they will play, and who can assist them in accomplishing daily routines. It is thought that rigidity is also a function of avoiding aversive sensory stimulation (Dunn, et. al., 2002).

Although there are high numbers of ASD individuals reporting sensory processing issues within these four subtypes of sensory patterns, few empirical studies have examined the relationship between sensory symptoms and treatment (Baranek, 2002). Mason and Iwata (1990) conducted a study on the effects of sensory integrative (SI) therapy on self-injurious behavior (SIB). Their investigation suggested that the SI therapy was not effective for treating SIB. A limitation of the study was that the subjects were not identified as having sensory processing disorders prior to being selected to participate in the study. In addition, the therapy used to treat the SIB was not matched to the sensory stimulation believed to be provided to the clients from the SIB. That is, all subjects were given the same intervention, which was multi-sensory consisting of auditory, vestibular, visual, and tactile stimulation provided concurrently which each other (Mason & Iwata, 1990).

Since Iwata's initial investigation of SI, a number of researchers (Goh, Iwata, Shore, DeLeon, Lehrman, Ulrich, & Smith, 1995; Piazza, Adelinis, Hanley, Goh, & Delia, 2000) have attempted to match stimuli provided to the reinforcement provided by the behavior itself. That is, these investigations have attempted to match the stimulation provided by novel stimuli to the stimulation provided by the behavior. For example, Piazza and her colleagues demonstrated that it was more effective to match the hypothesized sensory consequences for the automatically reinforced behavior than to use the preference assessment or arbitrarily chosen stimuli. Similarly, Goh et al. (1995) investigated the effects of matching reinforcers and their substitutability. Their study evaluated the effects of substituting the sensory consequences of hand mouthing with hand-toy contact and toy mouthing. The results of their investigation found that the substitution of the toy in hand was an effective reinforcer that decreased the aberrant behavior in participants whose behavior was automatically reinforced.

Given the success of the matched sensory stimuli provided by Piazza et al. (2000), and Goh et al. (1995) it appears that problem behaviors are used to provide sensory reinforcement that can also be substituted by external stimuli. Thus, for at least one sub-category of SI children, sensory seeking children, the behaviors may be maintained by the response itself.

What is unclear is if the results of a sensory screening profile can help to identify this subgroup of children.

According to Baranek (2002), there is a need for further studies examining sensory integration therapy. This information is necessary for the guidance and intervention planning for children with autism spectrum disorders suffering from sensory processing challenges (Baranek, 2002). Identifying the specific sensory pattern and modality of the subjects and linking those sensory needs to the appropriate intervention may provide the data necessary to support the continued use of sensory integrative therapy for individuals with autism spectrum disorders with co-morbid sensory integration challenges. This study will extend previous research examining the effects of matching functional analysis and sensory profile results to treatments for a two-year-old boy with pervasive developmental disorder and a six-year-old boy with autism.

Method

Participants

Our first participant was “Tim.” Tim was a two-year-old boy who was previously diagnosed by a developmental pediatrician with pervasive developmental disorder at the age of 23 months. He was non-verbal and had a history of aggressive (hitting, biting, throwing, and pushing) and tantrum behaviors (screaming, crying, throwing himself to the floor). He had limited adaptive behaviors; he required assistance with most self-help skills such as dressing, toileting, bathing, and hand washing. He was able to eat and drink independently with limited assistance.

Our second participant, “Evan,” was a six-year-old boy who was previously diagnosed with Autism by a developmental pediatrician at the age of 2 years. Evan’s behaviors included aggression (hitting, pushing, grabbing, kicking, throwing objects at people), tantrums (yelling, screaming, crying, and dropping to the ground), and self-injury (head banging). He was non-verbal and had limited adaptive skills and required assistance with dressing, toileting, eating, bathing, and other daily routine activities.

Settings

All sessions were conducted in the participant’s home with the participant’s parent and the first author. Sessions occurred in the participant’s living room, kitchen, or bedroom. During each session only the participant, researcher, and parent were present. Specific times of the day were sporadic throughout the study and were dependent on the parent and researcher’s availability. No distractive stimuli were present.

Response Measurement and Reliability

Target behaviors were selected based on the parent’s primary behavioral concerns. For Tim, aggression and tantrums served as his primary behaviors measured. Aggression was defined as hitting, biting, pushing, or throwing objects, and tantrums were defined as crying, screaming, and throwing himself on the ground. For Evan, target behaviors were aggression, tantrums and self-injury. Aggression was defined as hitting, grabbing, pushing, or throwing objects at people, tantrums were defined as yelling, screaming, crying, and throwing self to the

ground, and self-injury was defined as banging head against objects. The presence of either topography of behavior for both participants was documented using the 6-s partial interval recording system. All sessions were video-taped and later scored.

Reliability was recorded by a second independent observer during this study. The formula used to determine the inter-observer reliability was calculated by dividing the number of agreements by the sum of agreements and disagreements and multiplying that number by one hundred. During the functional analysis for Tim, inter-observer reliability was collected during 33% of the sessions. Reliability was 94% with a range of 82% to 100%. For Evan's functional analysis, data was taken for 44% of sessions. Reliability was 90% with a range of 60% to 100%. For the preference assessments, reliability was 100% and was collected on 100% of sessions for both the multi-stimulus and forced choice preferences assessment. During the treatment phase, reliability data was collected for 34% of sessions for Tim. The reliability was 93% with a range of 72% to 100%. For Evan, reliability data was collected for 35% of treatment session with a range of 55% to 100%.

Formal Assessment Instruments

The formal assessment tools used in this study were the *Sensory Profile* (Dunn, 1999) and the *Infant Toddler Sensory Profile* (Dunn, 2002). The *Sensory Profile* is a 125-item questionnaire and the *Infant Toddler Sensory Profile* is a 48-item questionnaire completed by a parent or caregiver. The *Infant Toddler Sensory Profile* is a combined questionnaire. One portion is for children birth to 6 months, and the other portion is for children 7 months to 36 months.

Research for the *Sensory Profile* took place over a 6 year span between 1993 and 1999. The research included over 1,200 participants with and without disabilities between the ages 3 and 14 years. For test reliability, Cronbach's coefficient alpha was used and the values for the different sections of the Sensory profile ranged from .47 to .91. The *Infant Toddler Sensory Profile* research took place over a four-year time span between 1998 to 2002. There were 1,500 children who participated in the research containing children with and without disabilities aged birth to 36 months. The coefficient alpha was calculated for both the birth to 6 month age range and the 7 to 36 month age range. The birth to 6 month alpha value ranged from .17 to .83. The 7 to 36 month alpha value was .42 to .86. In addition, in order to standardize the assessment test-retest reliability was conducted 2 to 3 weeks following the initial rating. The correlation coefficient for the test-retest reliability was .86 for the sensory processing sections of the instrument and .74 for the quadrant section of the instrument.

Experimental Design and Procedures

The investigation consisted of a four phase evaluation. First, a functional analysis of problem behavior was conducted based on the work of Iwata et al. (1994). Second, a sensory profile was conducted with a parent of each of the participants using either the Sensory Profile (Dunn, 1999) or the *Infant Toddler Sensory Profile* (Dunn, 2002). Next, preference assessments were conducted. Both participants were given a multiple-stimulus sensory preference assessment (Deleon & Iwata, 1996). Evan also was given a forced choice preference assessment

using the procedure described by Fisher, et al., (1992). During the final phase, we conducted a series of treatment comparisons which evaluated the efficacy of combining the results of the functional analysis and sensory profile. Using an ABCBCB reversal design (Kazdin, 2011), we compared treatments that combined the functional analysis outcomes and the sensory profile outcomes to treatments with contingencies that did not match those evaluations.

Functional Analysis

The functional analysis (Iwata et al., 1994) consisted of four analogue conditions, which were free play, tangible, escape, and attention conditions utilizing a multi-element design (Kazdin, 2011). The duration of each condition was 5 minutes. The analysis was conducted in the participants' home with a parent assisting the primary researcher in the assessment.

Free play. The parent provided attention by interacting with the child during this session. No task demands were placed on the child. In addition, the child was allowed non-contingent access to tangible items. Problem behaviors were ignored or redirected as necessary. This condition served as a control for the conditions providing positive reinforcement (e.g. attention and tangible conditions) or negative reinforcement (e.g. escape condition) for each participant.

Tangible. During this condition, the child was given no demands. The parent remained 1.5 to 3 m from the child. Access to tangible items was removed from the participant. The parent or researcher would prompt the child by saying "my turn" and begin playing with items in the room. Contingent upon aberrant behavior, the parent or researcher would provide 15-20s of access to the tangible item. After the 15-20s access, the item was then removed until the participant engaged in target behaviors.

Attention. The attention condition provided the child with non-contingent access to tangible items and no demands. The parent remained 1.5 to 3m from the child, however no attention was provided to the child. The parent was physically positioned to face away from the child and would move as necessary to maintain this position. Contingent upon aberrant behavior, the parent would provide access to attention for 15-20s or until the aberrant behavior ceased. After the brief attention, the attention of the parent was diverted away from the child.

Escape. The escape condition placed a task demand on the child. For Tim the task was cleanup and drawing. For Evan the task was completing a puzzle and reading a book. The parent or primary researcher presented the task using a three step prompting procedure. The sequence began with a verbal prompt, followed by the adult modeling the behavior, and finally hand-over-hand physical guidance to complete the task. The child was not provided praise for completing the task, rather the task was continually presented throughout the condition or until aberrant behavior occurred. Contingent upon aberrant behavior, the task was removed and the child was provided a break from the activity for 15-20s or until problem behaviors ceased. The cycle was repeated following the break.

Infant Toddler Sensory Profile and Sensory Profile.

The Infant Toddler Sensory Profile (Dunn, 2002) has two age range options which were a birth to 6 months section and a 7 to 36 month section. The participant's age determined the use

of the 7 to 36 month portion of the assessment tool which consisted of 48 items. There were five options to choose from in order to respond to each item: almost always (5pts), frequently (4pts), occasionally (3pts), seldom (2pts), and never (1pt). The primary researcher read each of the 48 statements to the parent and marked the appropriate response provided by the parent. After the 48 items had a response, the researcher then used the summary score sheet that corresponded with the assessment tool to determine results of the assessment. The items were categorized into four quadrants which included low registration, sensation seeking, sensory sensitivity, and sensation avoiding. The raw scores were placed in the 7-36 month sections due to the age of the participant. After totaling the raw scores in each section, the researcher then marked the score along a continuum ranging from probable difference that for scores that were less than others, to typical performance, and finally probable or definite differences that were more than others. In addition to the Quadrant scores, scores were totaled for the Sensory Processing section in the same manner as described above in the 7-36 month section for each of the six sensory processing sections. These sections included general processing, auditory processing, visual processing, tactile processing, vestibular processing, and oral sensory processing.

Sensory Profile.

The Sensory Profile (Dunn, 1999) consisted of 125 items. There were the same five options for responses to each item as described above with the same point allowance. The primary researcher read each item of the sensory profile to the participant's parent and marked the corresponding response provided by the parent. Following the administration of the 125 items, the primary researcher totaled scores from each item on the corresponding item in the Sensory Profile Summary Score Sheet. The two sections of the *Sensory Profile* were the factor summary and the section summary. The factor summary included nine different factors. The raw score was totaled and then transferred to a continuum which included a range of typical performance, then probable difference, and finally definite difference. The section summary was broken down into three categories: sensory processing, modulation, and behavior and emotional responses. As described above, raw scores were totaled for each item under the subsection and transferred to the continuum of typical performance, probable difference, or definite difference.

Sensory preference assessment. Sensory preference was assessed using two different forms of preference assessments. A multiple-stimulus preference assessment (Deleon & Iwata, 1996) and a forced-choice preference assessment (Fisher et al., 1992) were conducted to determine a hierarchy of preference to various sensory items.

Multiple-stimulus preference assessment. During the multiple-stimulus preference assessment (Deleon & Iwata, 1996) latency data (Derby et al., 1995) was collected for the amount of time each participant played with each sensory item prior to engaging in aberrant behavior or terminating play with the item. During this assessment the items from five sensory systems were presented on a table in the home of each participant. The categories included tactile, proprioception, vestibular, visual, and auditory. We did not include oral or olfactory items in this assessment. The child was able to choose items freely from the group of items on

the table. Once the child selected an item, data was collected by starting a timer. When the child terminated play or engaged in any target behaviors, the timer was stopped. Data were collected on five trials for each item. Once each participant engaged with the item for five trials, the item was removed from the group of items presented. If the participant did not freely engage with an item, the researcher would attempt to present the item to the participant. If the attempt failed, the researcher would record 0s.

Various items were selected from the five sensory systems. Tactile items for Tim included a bin of dry beans, life like animal toys, sticky hands, and a vibrating bird. Items in the vestibular system included a roller board, and for proprioception a hop ball was presented. Auditory items for Tim included a piano, noise tube, harmonica, and castanets. Visual items included a puzzle, a light up spinning toy, a light up top, a magnifier, a light saber, light up ball, 3-D bookmarks, and a view-finder.

Evan was presented with tactile items including life like animal toys, a vibrating bird, and a tactile ball. The vestibular items used were a swing and a skate board. For proprioception, a large exercise ball was presented. The visual items for Evan included a view finder, a kaleidoscope, a top, a light up ball, a light saber, and a top with lights. The auditory items used were a piano, a wind whistle, a slide whistle, and castanets.

Forced choice preference assessment. A forced preference assessment was conducted for only Evan due to the parent report of extreme aberrant behaviors maintained by access to food. The forced-choice preference assessment was conducted using the procedure used by Fisher et al, 1992. Eight highly preferred edible items were selected based on parent report. Items selected were semi-sweet chocolate chips, root beer soda, cheddar cheese, peppermint candy, curly French fries, maraschino cherries, popsicle, and barbeque potato chips. Items were presented in pairs which were chosen randomly using premade cards until all items were presented with each other. The data collectors would mark the item chosen when Evan would reach for one of the items presented. Once all items were presented with each other, the number of times each item was selected was totaled. A tie-breaker was conducted if two items were chosen the same amount of times. Two items were equally chosen. Those items were the chocolate chips and French fries as well as the barbeque potato chips and peppermint candy. Evan's high preferred item was the French fries, his medium preferred item was the peppermint candy, and the low preferred item was the popsicle. Figure 5 illustrates the results of Evan's forced choice preference assessment.

Baseline and Interventions

For intervention, a series of treatment conditions were compared which matched the results obtained within the previous functional analysis, sensory profile, and sensory preference assessment evaluations. Thus, four distinct treatment conditions were compared with an initial baseline within a ABCBCB design (Kazdin, 2011).

Baseline Phase (A). For each participant, baseline conditions consisted of three 5 min sessions for each sensory seeking and sensory avoiding comparison evaluations. For the sensory seeking condition, the participant was placed at a table and allowed brief access to the item. For

Tim, he was given 1min access to items identified as most preferred via the preference assessment. For Evan, he was given access to his most preferred food item. Following the brief access, the item was removed from the participant. Access to that item would be provided to the participant contingent upon the participant engaging in aberrant or behaviors. If target behaviors occurred, 30s access to the item was provided for Tim, and another one inch portion of French fry was provided to Evan. This cycle was repeated for the remainder of the 5 min condition.

For the sensory avoiding conditions, the participants were able to move around their home freely. The researcher would present the auditory item to the participant. Contingent upon aberrant behavior, the item was removed from the participant for 30s. If aberrant behavior continued, the stimuli would not be presented. Once aberrant behaviors were terminated, the researcher would then re-present the stimuli to the participant. This cycle would also be repeated for the remainder of the 5 minute session.

Sensory seeking match treatment. Within the sensory seeking matched treatment, the participants were provided access to either tangible items or edibles based on the results of the functional analysis, sensory profile, and preference assessments. For both participants, the condition began with access to the item identified to be a match between the assessments. One minute was provided for tangible items and one portion of the edible item. Following the exposure to the items, the items were removed and a “please” card was presented to the participants. Access to the item was provided contingent upon the emission of a mand (touching the “please” card). The researcher prompted the participants verbally to touch the card to gain access to the tangible or edible items. Contingent upon touching the “please” card, either 30s of access for the tangible item, or one portion of the edible item was provided to the participant. Following the access, the researcher removed the item and access was provided contingent upon touching the “please” card. These steps continued for the remainder of the 5 min session.

Sensory seeking non-match treatment for Tim phase (C). After the sensory seeking match treatment phase, a reversal phase consisting of a sensory seeking non-match treatment was implemented. During these sessions, the participants were placed at the same table and provided the same items as described above. One minute of access was provided for tangible items, and one portion was provided for edible items. At the beginning of the session, the researcher removed access to the item provided the participants with a “break” card. If the participant manded using the “break” card, access to the item was not provided. When the participant touched the “break” card, the researcher would say “all-done.” Contingent upon the presence of target behaviors, access to the item was provided, 30s for tangible items and one portion for edible items. After brief access, the item was removed and the “break” card was presented. Access was again provided contingent upon the presence of target behaviors. These steps were repeated for the remainder of the 5 min session.

Sensory avoiding match treatment. Following baseline for the sensory avoiding conditions described above, a sensory avoiding match treatment was implemented using the results of the functional analysis, sensory preference assessment, and Sensory Profile. This avoiding match treatment used auditory stimuli. At the beginning of the condition, the

researcher presented both participants with auditory items and the “break” card. The researcher provided a verbal prompt of “if your all done, touch the break card.” The verbal prompt was repeated every 10s or until the participant touched the “break” card. If the participants did not touch the break card, the researcher used a three-step prompt procedure to encourage the participant to play with the auditory item. The three-step prompt began with a verbal prompt, followed by a model from the researcher, and finally hand over hand assistance. Contingent upon touching the “break” card, the participants were given a 30s break from the auditory item. After the 30s break the auditory item and “break” card were presented again and these steps were repeated for the remainder of the 5 minute session.

Sensory avoiding non-match treatment. The sensory non-match condition used auditory items and the “please” card. Tim was presented with the auditory item and the “please” card. If the participant touched the “please” card, the researcher would say “you want it” and prompt the child to play with the auditory item. The item was presented using the three-step prompt as described above. The auditory item was removed contingent upon the presence of target behaviors. If the participants engaged in target behaviors, the researcher removed the auditory items for 30s. Following the 30s removal of the item, the researcher presented both the auditory item and the “please” card. These steps were repeated for the remainder of the 5 min session.

Results

The results of the functional analysis for Tim (top panel) and Evan (bottom panel) are shown in Figure 1. During the tangible condition, Tim’s rate of aberrant behavior averaged 24% with a range of 10-30%. His rate within the escape conditions was an average of 15% with a range of 0-34%. During the attention conditions, Tim’s average rate of target behaviors was 7% with a range of 0-18%. The control or free play conditions had an average rate of 1% with a range of 0-4%. The results of Tim’s functional analysis suggest a tangible and escape function for aberrant behavior. The results for Evan’s functional analysis suggested an escape and attention function. The average rate of aberrant behaviors during escape conditions were 41% with a range of 34-48%. During the attention conditions, the average rate of aberrant behaviors was 23% with a range of 8-36%. For the tangible conditions, the average rate of aberrant behaviors was 2% with a range of 0-4%. Finally, for the control condition, the average rate of aberrant behaviors was 1% with a range of 0-2%.

Functional Analysis

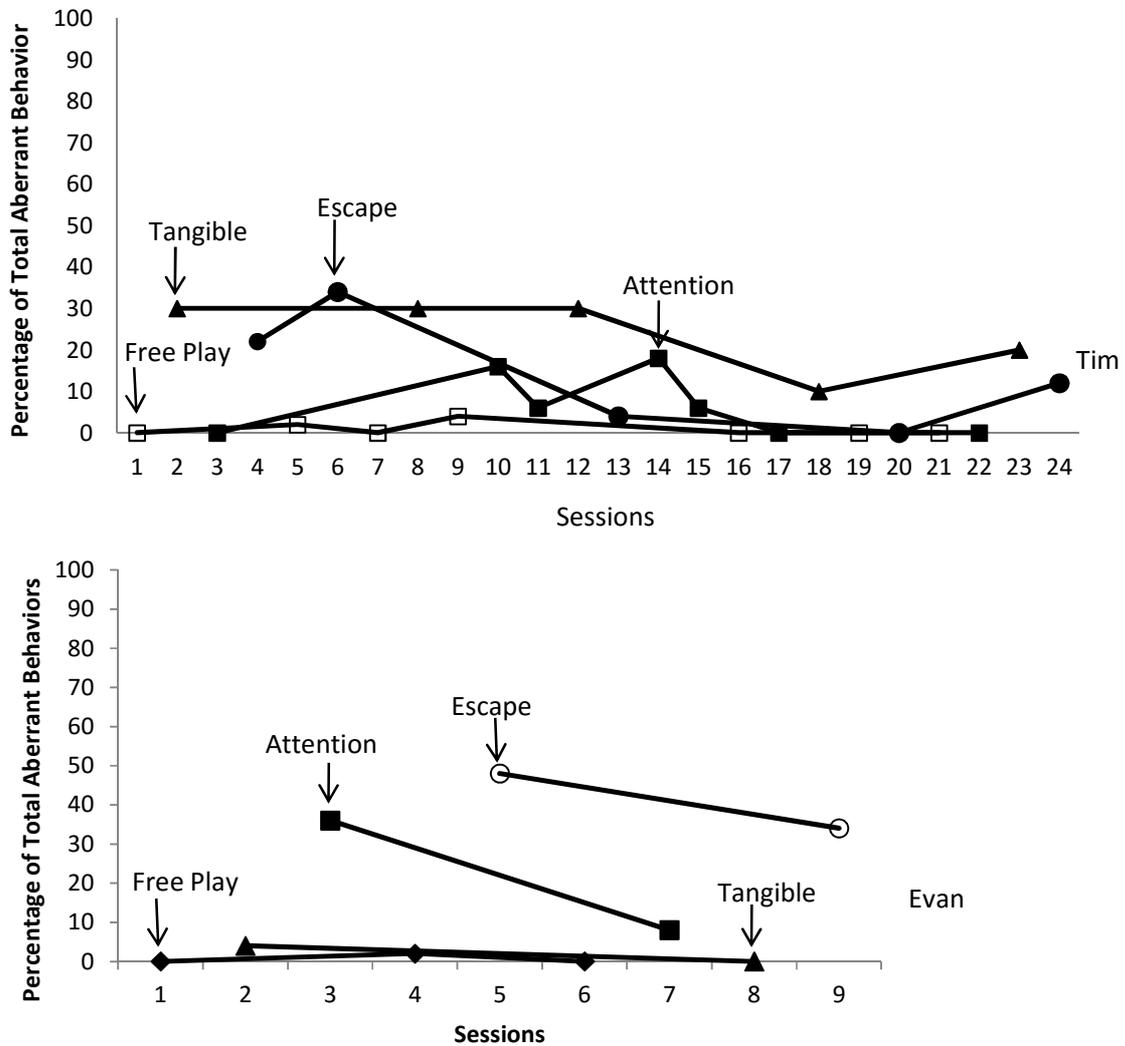


Figure 1. Percentage of total target behaviors during the Functional Analysis for Tim (top panel) and Evan (bottom panel).

Figure 2. Latency duration of time spent engaged with each sensory item for Tim.

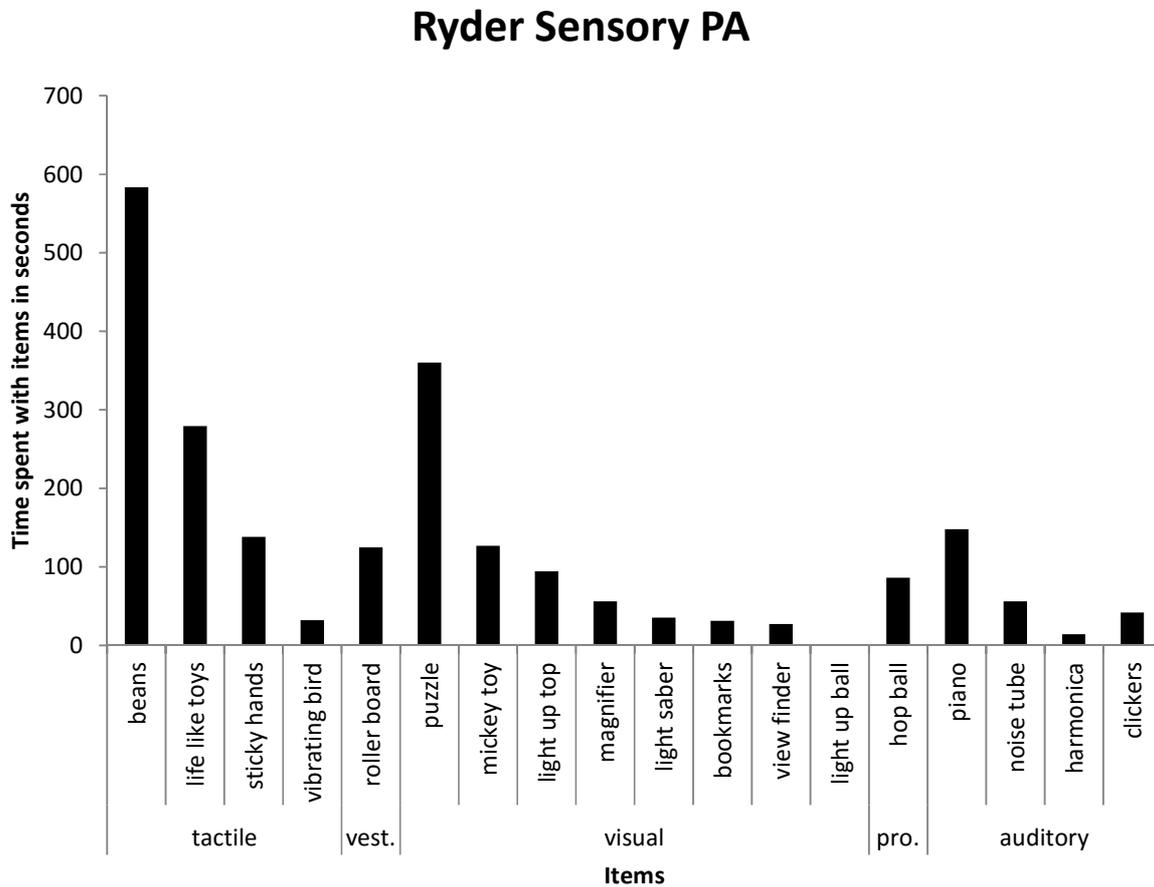


Figure 3. Latency duration of time spent engaged with each sensory item for Tim.

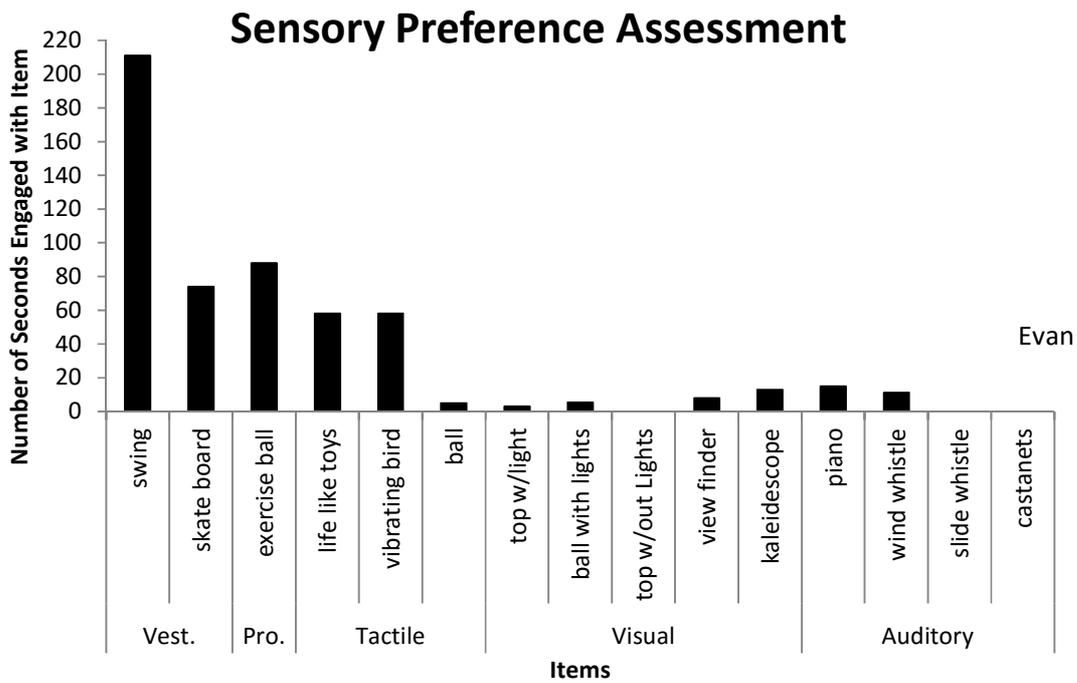


Figure 4. Preference assessment outcomes Evan.

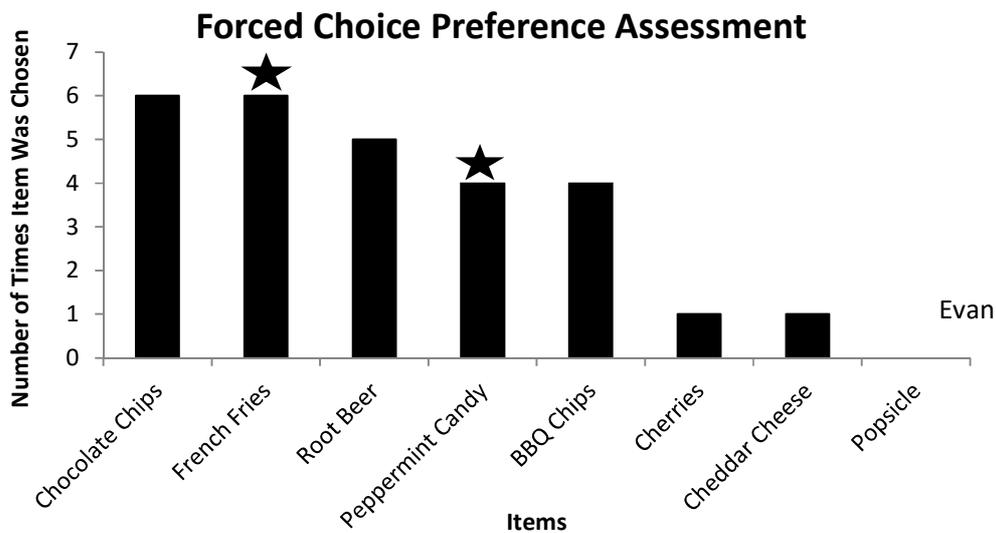


Figure 5. Percent of sensory seeking for Tim.

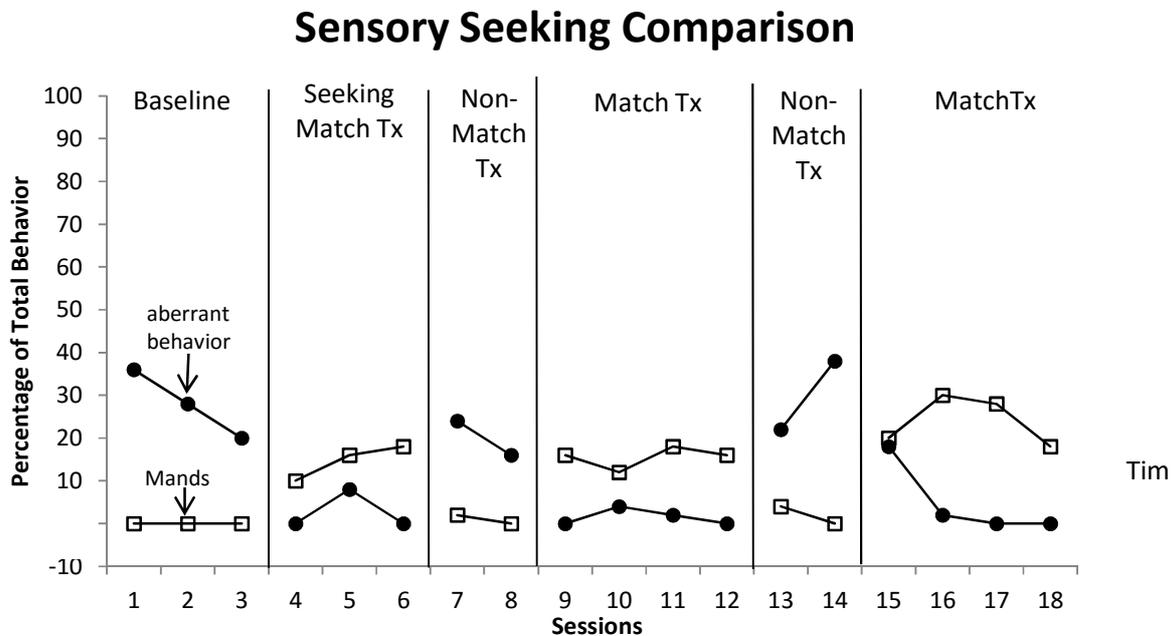


Figure 6. Percentage of aberrant and mand behaviors across assessment conditions during sensory seeking intervention for Tim

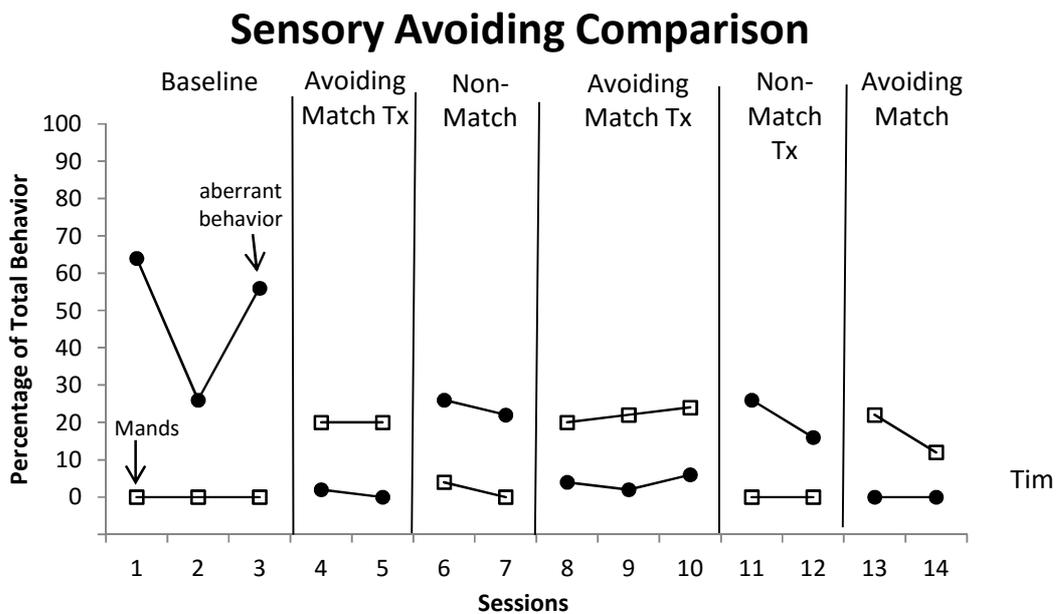


Figure 7. Percentage of aberrant and mand behavior across conditions during sensory seeking comparisons for Evan.

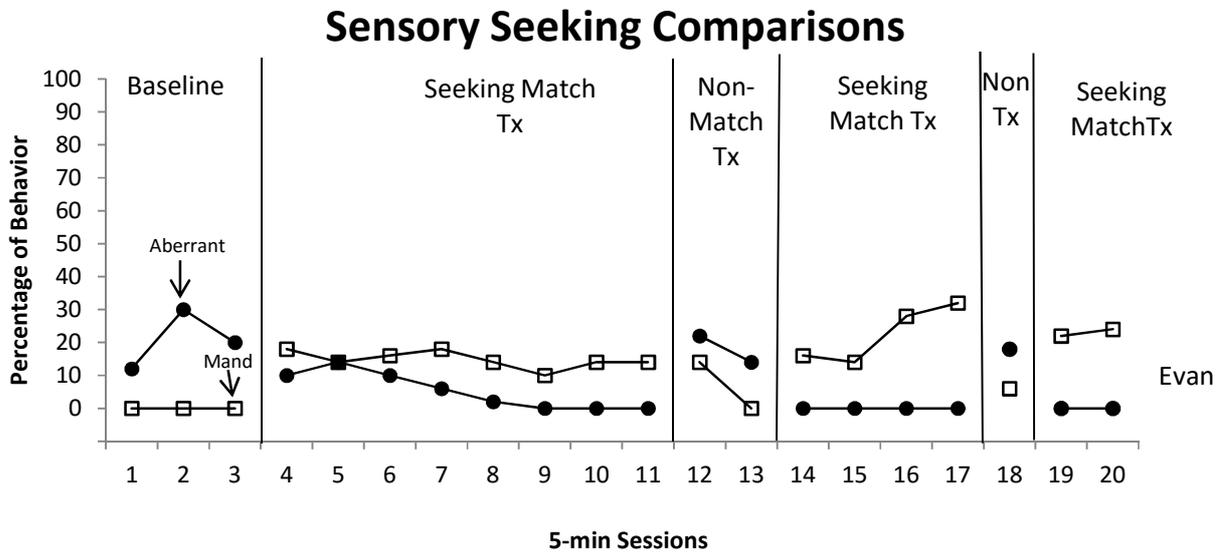


Figure 8. Percentage of aberrant and mand behavior across conditions during sensory avoiding comparisons for Evan.

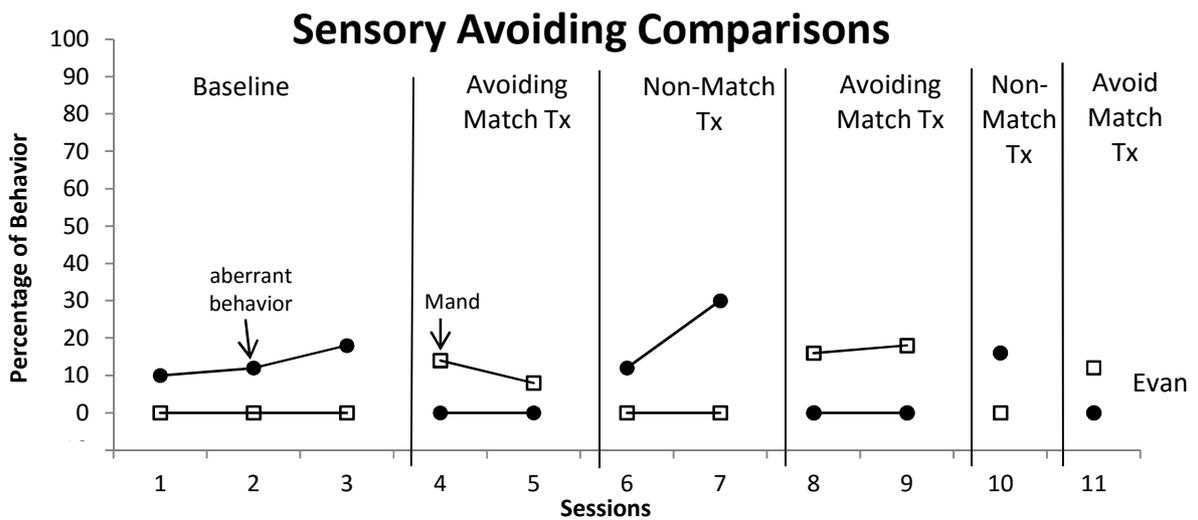


Table 1. Infant Toddler Sensory Profile Quadrant Summary for Tim

Quadrant	Quadrant Raw Score Total	Less Than Others ←		Typical Performance	→ More Than Others	
		Definite Difference	Probable Difference		Probable Difference	Definite Difference
1. Low Registration (7-36 months)	46/55	**	55	54-----x	45-----43	42-----11
2. Sensation Seeking (7-12)	/70	70-----44	43-----36	35-----19	18-----14	**
2. Sensation Seeking (13-18)	/70	70-----46	45-----38	37-----20	19-----14	**
2. Sensation Seeking (19-24)	/70	70-----50	49-----42	41-----25	24-----16	15-----14
2. Sensation Seeking (25-30)	33/70	70-----50	49-----43	42-----x--27	26-----19	18-----14
2. Sensation Seeking (31-36)	/70	49-----42	58-----49	48-----28	24-----18	17-----14
3. Sensory Sensitivity (7-36)	39/55	**	55-----53	52-----41	40-x-----36	35-----11
4. Sensation Avoiding (7-36)	40/60	**	60-----57	56-----45	44-----x-39	38-----12
Low Threshold Raw Score Total						
Low Threshold	79/115		115-----108	107-----87	86-----x-77	76-----23

Table 2 Infant Toddler Sensory Profile Sensory Processing Section Summary (7-36 months) for Tim

Sensory Processing Section	Quadrant Raw Score Total	Less Than Others ←		Typical Performance	→ More Than Others	
		Definite Difference	Probable Difference		Probable Difference	Definite Difference
A. General Processing	No section raw score total for the General Processing Section					
B. Auditory Processing (7-36)	29/50	50-----48	47-----44	43-----35	34-----31	30-x-----10
C. Visual Processing (7-36)	18/35	35-----32	31-----28	27-----20	19-x-----16	15-----7
D. Tactile Processing (7-24)	/75	75-----68	67-----62	61-----48	47-----42	41-----15
D. Tactile Processing (25-36)	54/75	75-----72	71-----65	64-----x-51	50-----44	43-----15
E. Vestibular Processing (7-36)	16/30	30-----27	26-----24	23-----18	17-x-----15	14-----6
F. Oral Sensory Processing (7-12)	/35	35-----68	32-----30	29-----21	20-----17	16-----7
F. Oral Sensory Processing (13-18)	/35	**	35-----32	31-----23	22-----19	18-----7
F. Oral Sensory Processing (19-24)	/35	**	35-----33	32-----24	23-----20	19-----7
F. Oral Sensory Processing (25-30)	24/35	**	35-----33	32-----25	x-----22	21-----7
F. Oral Sensory Processing (31-36)	/35	**	35-----34	33-----25	24-----21	20-----7

Factor	Factor Raw Score Total	Typical Performance	Probable Difference	Definite Difference
1. Sensory Seeking	31/85	85-----63	62-----55	54-----x-----17
2. Emotionally Reactive	25/80	80-----57	56-----48	47-----x---16
3. Low Endurance/Tone	34/45	45-----39	38-----36	35-x-----9
4. Oral Sensory Sensitivity	17/45	45-----33	32-----27	26-----x-----9
5. Inattention/Distractibility	18/35	35-----25	24-----22	21----x-----7
6. Poor Registration	22/40	40-----33	32-----30	29---x-----8
7. Sensory Sensitivity	12/20	20-----16	15-----14	13-x-----4
8. Sedentary	19/20	20-x-----12	11-----10	9-----4
9. Fine Motor/Perceptual	3/15	15-----10	9-----8	7-----x

Table 3 Sensory Profile Factor Summary for Evan

Table 4 Sensory Profile Section Summary for Evan

Sensory Processing	Section Raw Score Total	Typical Performance	Probable Difference	Definite Difference
A. Auditory Processing	24/40	40-----30	29-----26	25-x-----8
B. Visual Processing	13/45	45-----32	31-----27	26-----x---9
C. Vestibular Processing	30/55	55-----48	47-----45	44----x-----11
D. Touch Processing	37/90	90-----73	72-----65	64----x-----18
E. Multisensory Processing	23/35	35-----27	26-----24	x-----7
F. Oral Sensory Processing	20/60	60-----46	45-----40	39-----x-19
Modulation				
G. Sensory Processing Related to Endurance/Tone	34/45	45-----39	38-----36	35-x-----12
H. Modulation Related to Body Position and Movement	26/50	50-----41	40-----36	35-----x-----10
I. Modulation Related to Movement Affecting Activity Level	25/35	35-----x-23	22-----19	18-----7
J. Modulation of Sensory Input Affecting Emotional/Responsiveness	5/20	20-----16	15-----14	13-----x-4
K. Modulation of Visual Input Affecting Emotional Responses and Activity Level	8/20	20-----15	14-----12	11----x-----4
Behavior and Emotional Responses				
L. Emotional/Social Responses	37/85	85-----63	62-----55	54----x-----17
M. Behavioral Outcomes of Sensory Processing	10/30	30-----22	21-----19	18-----x---6
N. Items Indicating Thresholds for Response	6/15	15-----12	11-----10	9-----x-----3

The results for the *Infant Toddler Sensory Profile* (Dunn, 2002) show that Tim had a probable difference in sensory sensitivity and sensation avoiding. These results also show a definite difference in general processing and a probable difference in visual processing,

vestibular processing, and oral sensory processing. *The Sensory Profile* (Dunn, 1999) factor results for Evan show a definite difference in sensory seeking, emotionally reactive, low endurance/tone, oral sensory sensitivity, inattention/distractibility, poor registration, sensory sensitivity, and fine motor perceptual. The sensory processing section of the *Sensory Profile* show a definite difference in auditory processing, visual processing, vestibular processing, touch processing, multisensory processing, oral sensory processing, sensory processing related to endurance/tone, modulation related to body position and movement, modulation of sensory input affecting emotional/responsiveness, emotional/social responses, behavioral outcomes of sensory processing, and items indicating thresholds for response. Tables 1 and 2 illustrate the results of the *Infant Toddler Sensory Profile* and the *Sensory Profile* respectively.

The results of the preference assessment phase of this study are shown in Figures 2, 3, and 4. Figure 2 shows the multi-stimulus preference assessment for Tim. Based on these results, Tim's highly preferred sensory item was tactile. Tim engaged with a tactile item for an average of 258s with a range of 32-583s. The next preferred class of sensory stimuli for Tim was vestibular processing. Only one item was presented and the average amount of time spent with this item was 125s. For visual items, Tim engaged with these for an average of 91s with a range of 0-360s. The proprioceptive category also only contained one item which was a hop ball. The average engagement for that item was 86s. Finally, the auditory items were the lowest preferred items with an average engagement time of 52s and a range of 0-148s. Figure 3 shows the results of Evan's multi-stimulus preference assessment. Evan's highly preferred sensory item was vestibular, which was the swing and skateboard. He engaged with these items for an average of 143s with a range of 74-211s. For the proprioceptive item, which was an exercise ball, he engaged with it for an average of 88s. The next items of preference for Evan were the tactile items. He engaged with these items for an average of 40s with a range of 5-58s. Visual items were a low preferred class of sensory stimuli with an average engagement time of 6 seconds and a range of 0-13s. Auditory items were also low preferred with an average engagement time of 6 seconds and a range of 0-15s. Auditory items were chosen as the low due to the number of items Evan engaged with for 0s. One visual item had an average of 0s and two auditory items had an average of 0s. Figure 4 shows the results of Evan's forced choice preference assessment. Evan's high preferred items were the chocolate chips and French fries, both items were chosen 6 times during the assessment. When a tie-breaker was conducted, the French fries were chosen. There was also a tie between the medium preferred items of peppermint candy and barbeque chips, both were chosen four times. The peppermint candy was selected during the tie-breaker between those two items. There was a tie between the cherries and cheddar cheese, but because Evan chose each item once, these were not the lowest scoring items. A tie breaker was not conducted for the cherries and cheddar cheese. Evan's low preferred item was the popsicle. He did not select this item any time it was paired with another item. Therefore, we documented French fries as Evan's high preferred item, peppermint candy as his medium preferred item, and the popsicle as his low preferred item.

Figures 5 and 6 illustrate the results of the sensory seeking and sensory avoiding treatment comparisons for Tim. Figure 5 shows aberrant behavior decreased from a rate of 36% during the baseline conditions to a rate of 0% during sensory seeking match condition (B). In the sensory seeking non-match condition (C) behaviors increased to 38%. The mean rate of total aberrant behavior during baseline was 28% with a range of 20% to 36% and manding was 0%. During the sensory seeking match treatment condition (B), the mean rate of total aberrant behavior was 3% with a range of 0% to 18% and mean for manding was 18% with a range of 10% to 30%. For the sensory seeking non-match treatment condition (C), the mean rate of aberrant behavior was 25% with a range of 16% to 38% and the mean for mands was 2% with a range of 0% to 4%. Figure 6 illustrates the sensory avoiding intervention conditions. During baseline, target behavior levels were as high as 64%, decreased to 0% during the sensory avoiding match condition (B), and went back up to 26% during the sensory avoiding non-match condition (C). The mean rate of aberrant behaviors during baseline was 49% with a range of 26% to 64% and manding was 0%. The mean rate of aberrant behaviors during the avoiding match condition was 2% with a range of 0% to 6% and the mean for manding was 12% to 24%. The mean rate of aberrant behaviors during the non-match conditions were 23% with a range of 16% to 26% and the mean rate for manding was 1% with a range of 0% to 4%.

Figure 7 depicts the rate of aberrant behaviors and mands for sensory seeking intervention for Evan. This figure shows aberrant behaviors decreased from 30% during baseline, to 0% during the sensory seeking match conditions (B), and back to 22% during the sensory seeking non-match conditions (C) of the study. The mean rate of aberrant behaviors during baseline was 21% with a range of 12% to 30% and manding behaviors were 0%. The mean rate of aberrant behaviors during the match conditions was 3% with a range of 0% to 14% and the mean rate for mand behaviors was 18% with a range of 10% to 32%. The mean rate of aberrant behaviors during the non-match phase was 18% with a range of 14% to 22% and the mean rate of mand behaviors was 7% with a range of 0% to 14%. Figure 8 illustrates the rate of aberrant behaviors and mands for sensory avoiding interventions for Evan. For this intervention, aberrant behaviors during baseline were as high as 18%, during the sensory avoiding match conditions (B) aberrant behaviors decreased to 0%, and increased to 30% during the sensory avoiding non-match conditions (C). The mean rate of aberrant behaviors during baseline was 13% with a range of 12% to 18% and mands were at 0%. During the treatment match conditions, aberrant behaviors were at 0% and mands had a mean of 14% with a range of 8% to 18%. During the non-match conditions, aberrant behaviors had a mean of 19% with a range of 12% to 30%, mand behaviors were 0%.

Discussion

The findings from this study clearly illustrate the effectiveness of matching function of aberrant behavior to sensory profile results in children with autism spectrum disorders. When the intervention included a match between functional analysis, the sensory profile, and sensory preference assessment results of the child, total aberrant behavior decreased. When the intervention did not match the sensory profile, sensory preference, and functional analysis of the

child, total aberrant behaviors increased to similar levels seen during baseline. The results of this study support the continued use of sensory-based therapy with the ASD population when matched to the results of a functional analysis. Further research replicating the results of this study are needed examining other areas indicated using the sensory profile. This information is crucial in order to support the continued use of sensory-based therapy in school settings as well as in occupational therapy.

Tim's functional analysis (FA) found that one of the functions of his target behaviors was tangible. In addition, his multi-stimulus sensory preference assessment showed his highest preference to be tactile items. Furthermore, his Infant Toddler Sensory Profile (ITSP) resulted in typical performance for tactile processing. So, for Tim's sensory seeking comparison, tactile stimuli were chosen. In addition to the sensory seeking set of comparison, sets of sensory avoiding comparisons were also created based on Tim's assessment results. The results from the FA showed a second function of escape that matched the results of the ITSP of sensory avoiding behaviors. His multi-stimulus sensory preference assessment had auditory items as his lowest preferred items. In addition, there was a probable difference in the scores for auditory processing on the ITSP. Therefore, the sensory stimuli used in the set of sensory avoiding comparisons were auditory stimuli. Combining these assessments into an intervention, was successful in decreasing Tim's overall target behaviors.

Evan's Sensory Profile (SP) resulted in a sensory seeking definite difference. His multi-stimulus sensory preference assessment had a high preference for vestibular movement. In addition, his forced-choice preference assessment resulted in a high preference for curly French fries. His functional analysis however did not show a tangible function. For the sensory seeking comparison conditions, oral sensory was selected due to parent report of aberrant behaviors toward seeking food. The functional analysis reported escape as a function for target behaviors. The low preferred sensory item on the multi-stimulus preference assessment was auditory items. The Sensory Profile found a definite difference in auditory processing. Combining all of the above assessments, a sensory avoiding comparison was created utilizing auditory stimuli. Evans treatment conditions, which matched the results of these assessments, was successful in decreasing target behaviors.

Strengths of this study include the matched sensory stimuli to the participants to standardized measurement tool of the sensory profile (SP). By conducting the SP, the therapist is able to match the SI therapy to the child's individual sensory needs. This is important not only for therapists and teachers to consider but also researchers attempting to illustrate the effectiveness of this intervention. In addition to using an assessment for identifying sensory concerns, the study utilized a functional analysis to determine function of aberrant behavior. Combining the functional analysis, forced choice preference assessment along with the Sensory profile provided sufficient information in determining an appropriate intervention that increased appropriate minds for both access and removal of sensory items.

In addition, this study also provides extension to the previous studies conducted by Mason & Iwata (1990). By providing a match between the sensory consequences of the

behavior, sensory integrative therapy decreased the aberrant behaviors which may also be effective in treatment for aberrant behaviors related to sensory stimuli. The stimulus substitutability research conducted by both Piazza, et. al., (2000) and Goh, et. al., (1995) was also extended by utilizing the sensory profile as a tool to determine the type of stimulation to substitute in order to decrease inappropriate behavior.

Limitations to this study include the lack of data behind the effects on on-task behavior when exposed to preferred sensory stimuli. Further research may look at the effects of task completion on children with SPD and Autism with SI therapy and without SI therapy. This would ensure that the therapy is indeed serving a functional role in a child's academic and adaptive abilities.

Sensory based therapy is an effective treatment for aberrant behaviors in children with ASD's when the therapy matches function of the behavior with the results of the Short Sensory Profile and forced choice preference assessment. These findings allow for more research to be conducted in this area and provide a systematic way to determine the need for SI therapy and what substitution is necessary in order to decrease the aberrant behaviors associated with everyday complications that result from sensory processing disorder.

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