THE EFFECTS OF SENSORY DIETS ON CHILDREN WITH SENSORY PROCESSING DISORDER

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DEDICATION

This dissertation is dedicated to my parents who encouraged me to set high goals.

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ABSTRACT

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Sensory diets are one of the interventions occupational therapists use in school-based settings to manage manifestations of sensory processing disorder. However, very few studies have investigated the effectiveness of sensory diets, and the results of these studies were mixed (Devlin, Healy, Leader, & Hughes, 2011; Fazlioğlu & Baran, 2008; Lopez & Swinth, 2008). Past studies also had methodological limitations (Case-Smith, Weaver, & Fristad, 2015; Watling & Hauer, 2015). Therefore, this study investigated the effect of sensory diets on children's sensory processing skills, psychosocial skills, and engagement in classroom activities. This study used a single-subject ABCA design. Five children between the ages of five and eleven years participated in the study. The study consisted of an initial baseline phase A_1, the control intervention phase B, sensory diets intervention phase C, and the second baseline phase A_2. Each phase lasted for seven days. The PI videotaped each participant for fifteen minutes each school day during all phases to collect the data. The participants were videotaped during classroom group activities. Visual analysis of the data showed that sensory diets had a positive effect on participants' sensory processing, psychosocial skills, and classroom engagement.

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CHAPTER 1

INTRODUCTION

Occupational therapists enable children with disabilities to participate in school occupations. These occupations can range from academic and non-academic activities to activities of self-maintenance, play, social interactions with peers and teachers, and interactions with school environments (Chandler & Clark, 2013). Nearly 13% of children in public schools receive special education services (National Center for Educational Statistics, 2017). Approximately 40-80% of children with various disabilities and 5-10% of typical children have sensory processing disorder (SPD) (Ahn, Miller, Milberger, & McIntosh, 2004; Ben-Sasson, Carter, & Briggs-Gowan, 2009). SPD impairs children's ability to detect, modulate, interpret, and respond to sensory stimuli from their body (senses of movement and position) and the environment (senses of touch, hearing, vision, taste, and smell). Children with SPD have decreased frequencies, durations, and complexity of adaptive responses; impaired self-esteem and confidence, and decreased fine motor, gross motor, cognitive, and social skills (Parham, & Mailloux, 2013). As a result, SPD affects children's ability to fulfill their roles, carry out routines, and engage in meaningful occupations of play, learning, and social participation, as well as activities of daily living within a school context (Watling, Kuhanek, Parham, & Schaaf, 2018).

Occupational therapists use various interventions based on sensory integration theory (Ayres, 1972) and understandings of sensory processing to manage SPD (Bodison, 2018). Interventions and understandings of sensory processing to manage SPD (Bodison, 2018). Interventions that are based on sensory integration theory and understandings of sensory processing are called sensory-based interventions (SBIs). These interventions are adult-directed and are delivered in children's natural settings. SBIs range from using a compression vest, massaging the body with a soft scrub brush, sitting on a ball, to bouncing on a trampoline (Case-Smith, Weaver, & Fristad, 2015; Watling & Hauer, 2015). A sensory diet intervention is one of the SBIs used by school therapists to manage SPD and facilitate children's engagement in school activities. Sensory diets are composed of exercises and multisensory activities that are tailored for children and provide them sensorimotor experiences to facilitate their participation in daily activities. Although sensory diets are widely used in school-based settings to manage SPD, very few studies have investigated the effectiveness of sensory diets.

Statement of the Problem

Nearly 20% of occupational therapists in the United States work in school settings (American Occupational Therapy Association [AOTA], 2015), and 90% of them use interventions based on sensory integration theory to manage manifestations of SPD (May-Benson & Koomar, 2010). Current educational policies call for schools to provide occupational therapy services in students' natural settings (AOTA, 2018; Chandler & Clark, 2013; Gartin & Murdick, 2005; Maruyama, Coster, & Thomson, 1997). As a result, service delivery models in public schools have shifted from "pull-out" interventions to providing services in children's natural environments, such as classrooms, gymnasiums, and cafeterias (Case-Smith & Holland, 2009; Hong, 2014; Nochajski, 2002; Villeneuve & Hutchinson, 2012). Sensory diets are provided in children's natural environments and are part of their daily routines. Therefore, a sensory diet intervention aligns with the current educational policies and trends. Sensory diets help children process and organize sensory stimuli as well as improve their participation in school activities.

Although SBIs are used in school settings, the literature on the effectiveness of SBIs including sensory diets is lacking. Furthermore, the results of the studies that researched the effect of sensory diets or similar interventions were mixed. These studies also had methodological limitations. These studies failed to use rigorous protocols, standardized assessments or sensitive outcome measures (Case-Smith et al., 2015; Watling & Hauer, 2015). The current healthcare environment calls for evidence-based interventions (AOTA, 2018; Law & MacDermid, 2008) and the lack of conclusive evidence supporting the use of sensory diets affects the acceptance of this intervention by other professionals (Zane, Davis, & Rosswurm, 2008).

Statement of the Purpose

This study hypothesized that sensory diets influenced children's sensory processing skills, psychosocial skills, and engagement in classroom activities. A secondary hypothesis stated that the control intervention of fine motor and visual activities had no effect on children's sensory processing skills, psychosocial skills, and engagement in classroom activities. This study was based on the assumption that sensory diets provide children sensorimotor experiences that meet their sensory needs in terms of the type and intensity of stimuli. Furthermore, this study was based on the assumption that sensorimotor experiences that sensory diets help children with SPD organize sensory stimuli and participate in classroom activities.

Research Questions

1. What is the effect of sensory diets on sensory processing skills in children between the ages of four and 11 years with SPD?
2. What is the effect of sensory diets on psychosocial skills in children between the ages of four and 11 years with SPD?
3. What is the effect of sensory diets on engagement in classroom activities in children between the ages of four and 11 years with SPD?

Assumptions

This study is based on assumptions that children with sensory processing disorder have difficulty organizing sensory stimuli. Sensory diets provide children sensorimotor experiences that meet their sensory needs in terms of the type and intensity of stimuli. The sensorimotor experiences provided by sensory diets help children with SPD organize sensory stimuli and participate in classroom activities.

CHAPTER II

LITERATURE REVIEW

Children's participation in school activities is dependent on various factors, such as school climate, classroom size, teacher support, peer support, classroom structure, and instruction style (Fredricks, Blumenfeld, & Paris, 2004). Sensory processing disorder (SPD) also affects children's participation and their success with school activities (Watling et al., 2018). This literature review discusses sensory processing in relation to three areas. The first area reviews the literature from neuroscience on sensory processing mechanisms used by the brain and the deficits in sensory processing mechanisms in children with SPD. The second area focuses on the role of sensory processing skills and participation in school activities. The last area details the occupational therapy literature on SPD and sensory-based interventions (SBIs).

Neuroscience and Sensory Processing

The brain uses a series of processes to interpret, organize, and integrate stimuli to form a coherent picture of the self and the environment. These schematic representations are the basis for producing appropriate motor, behavioral, and emotional responses. These representations are constantly adjusted in response to newer stimuli (Dunn, 2007). From a neuroscience perspective, sensory integration includes filtering, organizing, and integrating sensory stimuli (Davies & Gavin, 2007). The literature in neuroscience explains sensory processing deficits in children with SPD and the neurological basis for SBIs. Several research studies have investigated the mechanisms involved in processing sensory stimuli. Sensory registration, sensory gating, and multisensory processing are some of the processes involved in making sense of sensory stimuli. Sensory registration helps the brain to consistently respond to a variety of sensory stimuli. Sensory gating is one of the mechanisms used to suppress repeated and irrelevant stimuli (Davies & Gavin, 2007). Multisensory integration refers to combining sensory stimuli from two or more different sensory systems (Stein, 1998; Stein & Rowland, 2011). Sensory gating mechanisms (Davies, Chang, & Gavin, 2009) and multisensory integration follow a developmental course (Brandwein et al., 2012). The maturation of these mechanisms begins early in infancy and lays the foundation for motor and behavioral development (Yeung & Werker, 2013).

Sensory processing mechanisms and the patterns of maturation of sensory gating and multisensory integration mechanisms are different in children with SPD compared to typical children. These differences are even seen in infants. A study using a magnetoencephalography showed that preterm infants have reduced or no activity in secondary somatosensory cortex compared to full-term infants, which may influence their motor development later in life (Rahkonen et al., 2013). Similar findings were reported in children with autism. Children with autism also have a high incidence of SPD (Sinclair, Oranje, Razak, Siegel, & Schmid 2017). Children with autism have decreased cortical activity in a somatosensory area. This decreased activity in the somatosensory area is reported to correlate with tactile (touch) hypersensitivity and the integration of motor responses in children with autism (Marco et al., 2012). These sensory processing deficits seen in children with autism affect their social, communication, and daily living skills (Brett-Green, Miller, Schoen, & Nielsen, 2010; Schaaf et al., 2010). Children with SPD also showed differences in parasympathetic nervous system activity compared to typical children. Children with sensory modulation disorder, one of the subtypes of SPD (Miller, Anzalone, Lane, Cermak, & Osten, 2007), had lower basal parasympathetic nervous system activity and lower parasympathetic nervous activity during auditory sensory challenges compared to typical children (Schaaf et al., 2010).

Sensory gating studies showed differences in sensory gating patterns in children with SPD in comparison to typical children (Brett-Green et al., 2010; Davies et al., 2009; Davies & Gavin, 2007). Deficits in sensory gating patterns affect children's ability to suppress or filter out irrelevant stimuli and to selectively regulate cortical responses to additional sensory stimuli. Due to deficits in sensory gating mechanisms, children with SPD respond inconsistently to repeated stimuli. These findings explain behaviors, such as distraction, impulsiveness, abnormal activity level, emotional liability, and disorganization, seen in children with SPD (Davies et al., 2009; Davies & Gavin, 2007).

Multisensory integration of two or more stimuli is dependent on factors, such as the relevancy of stimuli, intensity of stimuli, cortical attention, and cortical inhibition (Talsma, Senkowski, Soto-Faraco, & Woldorff, 2010; Wallace & Stein, 2007). The spatiotemporal proximity (timing and physical location of the stimuli or neuron activation) of stimuli influences multisensory integration and helps the brain determine the relevancy of sensory stimuli. Stimuli from two or more sensory systems that are in spatiotemporal proximity are enhanced and sent to the higher cortical centers for further processing. In contrast, repetitive stimuli from only one sensory system that are in spatiotemporal proximity are suppressed. Relevant stimuli from two or more different sensory systems are intensified and receive precedence for cortical attention over the sensory stimuli coming from a single sensory system (Stein & Rowland, 2011).

Children with SPD have deficits in multisensory integration. Multisensory integration studies showed the temporal binding window for multisensory integration, a time length during which two or more relevant sensory stimuli are combined, was wider in children with autism compared to typical children (Stevenson et al., 2014). Similar differences are reported in individuals with neurodevelopmental disorders, autism, dyslexia, and schizophrenia (Wallace & Stein, 2007). A wide temporal binding window could contribute to a distorted sensory perception observed in children with these conditions.

SBIs are based on a hypothesis that participation in multisensory activities facilitates organization and integration of sensory stimuli at a neuronal level and triggers neural growth (Watling, Koenig, Schaaf, & Davies, 2011). Animal studies using enriched sensory environments and deprived environments suggested that environments with rich sensory stimuli positively influence on the brain weight, neuronal connections, and the patterns of sensory processing (Lane & Schaaf, 2010; Watling et al., 2011). More recently, a study that provided children with autism multiple opportunities to interact with enriched sensory environments found statistically significant improvements behaviors, and vocabulary. Also, participants showed some improvements in relating to individuals and emotional response (Woo & Leon, 2013). These studies suggested that SBIs might facilitate neural plasticity.

Sensory Processing and School Engagement

Effective sensory processing is essential for participation in school activities and the development of literacy skills. In school settings, students are required to participate in academic as well as non-academic activities. Academic activities include reading, writing, discussing, asking, and answering relevant questions, following instructions, and working independently or in-group settings. Non-academic activities include interactions with peers, interactions with teachers and school staff, participation in peer groups, and participation in extracurricular activities (Junod, DuPaul, Jitendra, Volpe, & Cleary, 2006). Factors affecting students' engagement in school activities is widely researched in education (Fredricks et al., 2004).

The presence of disabilities affects children’s participation in school activities. Children with diagnoses of learning disabilities (Fredricks et al., 2004) and autism (Case-Smith et al., 2015) show low engagement in school activities. Elementary grade children with attention deficit hyperactive disorder (ADHD) showed low passive engagement in math and reading activities compared to typical children. Children with ADHD also showed significantly lower active engagement in math and reading activities than passive engagement (Junod et al., 2006). Children with these disabilities often have concurrent SPD (Ahn et al., 2004), which affects their engagement in school activities (Brown & Dunn, 2010) and academic achievement.

The literature shows that effective sensory processing is necessary for the development of academic skills (Ashburner, Ziviani, & Rodger, 2008; Brown & Dunn, 2010). A longitudinal study found temporal order auditory processing in pre-kindergarten predicted reading abilities in the first-grade students. Additionally, auditory processing abilities correlated with the development of phonological representations, early speech perceptions, and visual temporal processing abilities correlated with letter position encoding, binocular stability, word form perception, and effective saccadic eye movements. These skills are necessary for reading fluency (Hood & Conlon, 2004). Another study reported a strong correlation between dynamic auditory processing and phonological abilities, as well as between dynamic visual processing and orthographic abilities. These skills, along with short-term memory, predicted literacy skills in first graders (Boets, Wouters, Van Wieringen, De Smedt, & Ghesquiere, 2008). Auditory processing deficits are reported in children with language-learning impairments (Heima, Friedman, Keilc, & Benasichb, 2011) and adults with reading disabilities (Amitay, Ahissar, & Nelken, 2002). This literature review suggests auditory processing and visual processing abilities are crucial for the development of reading and visual motor skills. In addition, effective sensory processing is necessary for the development of self-regulation (Robles, Ballabriga, Diéguez, & da Silva, 2012).

Self-regulation is one of the factors linked to students' academic achievement (DeSantis, Harkins, Tronick, Kaplan, & Beeghly, 2011). Effective sensory processing is essential for developing self-regulation skills. Self-regulation is necessary for the acquisition of competencies needed for academic and non-academic success, and the disruptions in self-regulation skills may lead to maladaptive behaviors (Shields, Cicchetti, & Ryan, 1994). Self-regulation skills begin to develop early in infancy. The physiological regulation seen in infants is the basis for complex self-regulation skills. Self-regulation develops as a result of the maturation of interactions between physiological and behavioral responses (Gouze, Hopkins, LeBailly, & Lavigne, 2009; Shields et al., 1994). Effective sensory processing is necessary for physiological regulation and the generation of appropriate behavioral responses; however, SPD affects the development of self-regulation skills.

Successful participation in school activities and academic performance requires behavioral, cognitive, and emotional engagement (Searle, Miller-Lewis, Sawyer, & Baghurst, 2013). The literature in education focuses mainly on the effortful control and executive attention components of self-regulation (Lonigan, Allan, & Phillips, 2017; Simonds, Kieras, Rueda, & Rothbart, 2007). Effortful control is the ability to inhibit a dominant response in order to use another learned response (Rothbart & Rueda, 2005). Executive attention or attentional control is necessary for effortful control. Attentional control and effortful control influence children’s emotional responses (Simonds et al., 2007).

Several studies have investigated the relationship between effortful control, attentional control, and academic skills. High self-regulation is significantly related to children's academic achievements during pre-kindergarten years and during kindergarten transition periods (McClelland & Wanless, 2012). Effortful control is reported to positively predict classroom participation, school acceptance, and student-teacher relationships in kindergarteners (Valiente, Swanson, & Lemery-Chalfant, 2012). Similarly, pre-kindergarten children's ability to attend, use executive functions, and teachers' perceptions of children's ability to attend are related to the acquisition of literacy skills (Lonigan et al., 2017). Another study found that inhibitory control, effortful control, and working memory components of self-regulation significantly correlated with math skills and early literacy skills in children between the ages of five and seven (Hubert, Guimard, Florin, & Tracy, 2015). Also, low effortful control was associated with impulsivity and anger (Valiente et al., 2012). Abilities, such as executive attention, increase over the age and are associated with children's temperament and social responses (Simonds et al., 2007). These studies underscored the importance of self-regulation for children's academic achievement and the importance of sensory processing for developing self-regulation and early literacy skills.

Occupational Therapy and Sensory Processing

The occupational therapy literature on sensory processing has evolved significantly in the last few decades. The occupational therapy literature acknowledges the role of sensory registration, sensory processing, and integration of sensory stimuli in carrying out meaningful occupations (Bar-Shalita, Vatine, & Parush, 2008; Watling et. al, 2018). SPD affects children's social participation (Baranek et al., 2013; Cosbey, Johnson, & Dunn, 2010; Watson, et al., 2011), play (Benson, Nicka, & Stern, 2006; Cosbey, Johnston, Dunn, & Bauman, 2012; Lawson & Dunn, 2008), school performance (Ashburner, Ziviani, & Rodger, 2008; Brown & Dunn, 2010), participation in activities of self-maintenance (Bar-Shalita et al., 2008), ability to self-regulate (DeSantis, Harkins, Tronick, Kaplan, & Beeghly, 2011; Robles, Ballabriga, Diéguez, & da Silva, 2012), and adaptability (Dar, Kahn, & Carmeli, 2012).

Research in occupational therapy on sensory processing issues, sensory integration, and sensory integrative interventions has increased considerably. However, the literature on the effectiveness of SBIs is limited. SBIs are adult-directed and classroom-based interventions that provide unisensory or multisensory stimuli to improve children's sensory arousal. Sensory arousal is the nervous system's level of alertness to detect and respond to internal and external stimuli (Wilbarger & Wilbarger, 2002). SBIs range from using a compression vest, to sitting on a ball, to bouncing on a trampoline (Case-Smith et al., 2015; Watling & Hauer, 2015). This literature review focused on studies that used sensory diets or activities similar to sensory diets as the intervention.

Seven systematic reviews evaluated the effectiveness of interventions based on sensory integration theory in the last decade. These reviews did not find conclusive evidence supporting the use of SBIs (Barton, Reichow, Schnitz, Smith, & Sherlock, 2015;

Case-Smith et al., 2015; Lang, et al., 2012; May-Benson & Koomar, 2010; Watling & Hauer, 2015; Yunus, Liu, Bissett, & Penkala, 2015; Zimmer, et al., 2012). Very few studies have investigated the effectiveness of SBIs similar to sensory diets. A randomized control trial consisting of 30 participants with a diagnosis of autism between the ages of seven and 11 years reported statistically significant improvements in aversion to touch, off-task behaviors, orientation to sound, stereotypical behaviors, and social communication in children. In this study, a set of 68 predetermined sensory activities was used as an intervention. These activities were provided for 45 minutes, two times per week for 12 weeks. Only five target behaviors out of 15 target behaviors showed statistically significant changes in target behaviors (Fazlioğlu & Baran, 2008).

Further support for the use of interventions similar to sensory diets was reported by a single-subject study by Lopez and Swinth (2008) consisting of three 9-year-old boys with SPD that used five predetermined activities as a group intervention. The intervention was provided for five minutes for nine days. This study reported statistically significant improvements in the duration of aggressive behaviors in 66% of the participants, and 33% of the participants showed statistically significant improvement in the frequency of aggressive behaviors (Lopez & Swinth, 2008). A study by Lin, Min, Chou, and Lin, (2012) reported statically significant improvements in the participants' activity level and foot swinging behavior with the use of sensorimotor activities. This study used a pretest-posttest design consisting of 36 children between the ages of three and six years. The intervention consisting of sensory activities and was provided for two hours each day for eight weeks. The intervention consisted of sensory strategies, such as sitting on a ball chair, rocking, wearing a weighted vest, and applying tactile stimuli using clay, a ball, or tactile ring.

A single-subject study by Van Rie and Heflin (2009) found improvements only in 50% of the participants in the target behavior of correctly responding to the teacher's questions. This study consisted of four participants with a diagnosis of autism between the ages of six and seven years. Sensory strategies used in this study consisted of bouncing on a ball and linear swinging. On the contrary, a single-subject study consisting of four participants with a diagnosis of autism between the ages of six and 11 years that used predetermined and non-customized activities as sensory diets did not find any improvements in participants' self-injurious behaviors compared to a behavioral intervention. Sensory diets in this study were delivered for 15 minutes, six times per day for 10 days. The behavioral interventions were provided for six hours during the behavioral intervention phase (Devlin, Healy, Leader, & Hughes, 2011).

Some studies that investigated the effect of SBIs showed evidence that the effectiveness of SBIs is similar to sensory diets; however, these studies had poor methodologies and lacked rigorous intervention protocols (May-Benson & Koomar, 2010; Watling & Hauer, 2015). Only one study by Fazlioğlu and Baran (2008) was a randomized controlled trial. The assessments used in these studies to determine the presence of SPD, outcome measures, and intervention protocols varied significantly (May-Benson & Koomar, 2010; Watling & Hauer, 2015). Also, outcome measures used in these studies may have evaluated the nature of sensory processing issues rather than assessing the change in sensory processing skills and therefore, lacked sensitivity to interventions (Pfeiffer, May-Benson, & Bodison, 2018). The lack of explanation of intervention protocols, use of non-standardized outcome measures, and variations in intervention protocols impede the replication of these interventions in clinical settings or for research purposes (Case-Smith et al., 2015; Watling & Hauer, 2015). Sensitive outcome measures are essential to detect changes and determine the effect interventions (Pfeiffer, et.al, 2018; Schaaf et al., 2014). Although individuals differ in their behavioral and emotional responses and the intensity of responses to sensory stimuli, very few studies have used individualized goals to assess children's diverse responses to sensory stimuli. Since sensory diets continue to be widely used in school-based settings, a rigorous study was needed to investigate the effect of sensory diets.

Theoretical Models

Sensory integration theory (Ayres, 1972) was proposed 50 years ago. This theory proposed the existence of a link between neurological processes and behavior. Sensory integration theory postulates that sensory integration, the neurological process of organizing sensations from the body and the environment, influenced individuals' functioning within the environment. Furthermore, the theory states that enhanced sensorimotor experiences in the context of activity improve the ability of the brain to organize and integrate sensations (Ayres, 1972).

Based on sensory integration theory, neuroscience research, and occupational therapy literature on sensory processing, newer nomenclature and models have been proposed to explain SPD and guide occupational therapy interventions (Dunn, 2007; Dunn, 2008; Miller, Anzalone, Lane, Cermak, & Osten, 2007). This section discusses Dunn's Model of Sensory Processing (Dunn, 2007), which was used to understand the nature of sensory processing deficits seen in children with SPD. This section also discusses the theoretical rationale and key components of sensory diets. The impact of SPD on children's participation in classroom activities and the development of adaptive responses are discussed using the Occupational Adaptation theory (Schkade & Schultz, 1992; Schultz & Schkade, 1992).

Dunn's Model of Sensory Processing

Dunn's model (2007) proposes that individuals' neurological thresholds for sensory stimuli and preferred self-regulation strategies influence their motor, behavioral, and emotional responses. A neurological threshold is a point at which a neuron or a sensory system is activated, are on a continuum, and differ for each sensory system. Self-regulation strategies are also on a continuum and range from passive to active self-regulation strategies. The interaction of the neurological thresholds and self-regulation strategies leads to four sensory processing patterns. Individuals with sensation seeking or seeker patterns have high neurological thresholds and use active self-regulation strategies. These individuals actively seek and engage in activities that provide intense sensory stimuli. Individuals with sensation avoiding or avoider patterns have low thresholds and use active self-regulation strategies. These individuals avoid activities that provide certain types of sensory stimuli. Individuals with sensory sensitivity or sensor patterns have low thresholds and use passive self-regulation strategies. These individuals dislike certain type of sensory stimuli and as a result, readily respond to some activities. Individuals with low registration patterns have high thresholds and use passive self-regulation strategies. As a result, these individuals take longer to respond to certain type of sensory stimuli (Dunn, 2007).

Rationale for Sensory Diet

Patricia Wilbarger (1995) proposed the concept of sensory diets. The sensory diet intervention is derived from the principles of sensory integration theory and sensory processing theory. This intervention is based on the assumptions that individuals need certain types of sensorimotor experiences to stay alert and organized, and to effectively participate in their daily lives. Children with SPD have extreme sensory processing patterns and seek intense sensorimotor experiences that interfere with their daily activities (Dunn, 2007). A sensory diet provides controlled sensory input in the context of activities that are embedded within children's daily routines throughout a day to improve their participation in occupations. Timing, intensity, duration, and type of sensory stimuli are the key elements of sensory diets (Wilbarger & Wilbarger, 2002).

A sensory diet is tailored around a child's sensory processing patterns, the impact of SPD on occupations and routines, and the child's preferences. Activities are selected, and a schedule is developed in collaboration with family members or teachers.

This intervention is also based on the assumption that sensations have a latency effect and influence the brain only for a certain period. Therefore, sensory diets are repeated frequently to prepare a child to participate in occupations or to support adaptive functioning (Wilbarger & Wilbarger, 2002). Sensory diets used in this study incorporated these elements.

Occupational Adaptation Theory

Occupational Adaptation theory is one of the occupation-based theories used by occupational therapists to guide interventions (Schkade & Schultz, 1992; Schultz & Schkade, 1992). This theory can be used to understand the impact of SPD on children's occupational functioning within a school context. This theory incorporates readiness activities as a part of an intervention. Sensory diets can be considered as readiness activities under the umbrella of Occupational Adaptation theory.

Occupational Adaptation theory views occupation and adaptation as an integrated concept and proposes that occupational adaptation is necessary for meeting everyday occupational challenges. Occupational adaptation is seen as an ongoing process that occurs as a result of interactions of a person with the environment and is the process that helps individuals to adapt to constantly changing needs of the environment (Schkade & Schultz, 1992; Schultz & Schkade, 1992). Play, education, leisure, social participation, and self-care activities are children's main occupations in a school context (AOTA, 2014). Children continuously interact with a school context through participation in school occupations. This ongoing interaction is the foundation for occupational adaptation, motor, cognitive, and psychosocial development in children. Occupational adaptation occurs when a child produces a successful occupational response (motor, behavioral, or emotional response) to meet an occupational challenge. The child's press for mastery and environmental press from a school context interact to generate an occupational challenge (demand to act or engage in an activity). An occupational response is generated to meet the occupational challenge.

Adaptive response mechanisms determine the use of adaptive energy, adaptive response behavior, adaptive response mode, and the composition of the adaptive gestalt used to generate the occupational response. Adaptive response mechanisms are the internal mechanism that an individual unconsciously uses to produce an occupational response. Adaptive energy is the limited amount of energy available to an individual during his lifetime. Adaptive response behaviors are the behaviors, such as primitive, transitional, and mature, that an individual uses when faced with an occupational challenge. Adaptive response modes are the strategies an individual relies on when he/she faces an occupational challenge, and these modes range from existing, modified, and new. Adaptive gestalt is made up of motor, cognitive, and psychosocial systems. An individual uses a combination of these systems to produce an occupational response. An occupational response is a motor, behavioral, or emotional response. Each occupational response is evaluated and integrated with the person subsystem, which is composed of motor, cognitive, and psychosocial subsystems. This integration of the occupational response with the person system influences the child's future occupational functioning (Schkade & Schultz, 1992; Schultz & Schkade, 1992).

Engagement in school occupations requires a rich reservoir of occupational responses. A child's ongoing successful interaction with the environment, occupational adaptation, an experience of relative mastery, and the development of adaptive capacity enrich this reservoir (Schkade & Schultz, 1992). Intact sensory processing mechanisms are necessary for forming an accurate representation of the self and the environment, which is a basis for generating appropriate occupational responses. Children with SPD have deficits in interpreting, organizing, and integrating sensory stimuli. SPD affects children's interactions with the environment and the understanding of environmental demands. Children with SPD use immature adaptive modes, behaviors, and adaptive gestalt to produce occupational responses. Children with SPD have difficulty evaluating and integrating the feedback from the occupational responses. These children may have limited experience of the relative mastery (an individual's perception and experience of success in response to an occupational demand). As a result, SPD affects their future interactions with the environment and the development of adaptive capacity. It is proposed that sensory diets help children organize sensory stimuli and interpret the environmental press correctly. Consequently, sensory diets can facilitate positive interactions with the environment and provide children with opportunities to respond with a balanced gestalt, experience relative mastery, and develop adaptive capacity (Dunn, 2007).

CHAPTER III

METHODOLOGY

This study investigated the effect of sensory diets. This chapter details the methods and procedures used to investigate the effect of sensory diets.

Purpose

The study investigated the effect of sensory diets on sensory processing skills, psychosocial skills, and engagement in classroom activities in children between the ages of five and 11 years.

This study was based on the assumptions that sensory diets provide children sensorimotor experiences that meet their sensory needs in terms of the type and intensity of the stimuli. These sensorimotor experiences help children with SPD organize sensory stimuli effectively and consequently, improve their participation in classroom activities.

Research Questions

1. What is the effect of sensory diets on sensory processing skills in children between the ages of four and 11 years with SPD?
2. What is the effect of sensory diets on psychosocial skills in children between the ages of four and 11 years with SPD?
3. What is the effect of sensory diets on engagement in classroom activities in children between the ages of four and 11 years with SPD?

Hypotheses

The following hypotheses were tested:

1. Sensory diets change children's sensory processing skills as determined by changes in participants' target behaviors in the area of sensory processing skills.
2. A control intervention has no effect on children's sensory processing skills as determined by changes in participants' behaviors in the area of sensory processing skills.
3. Sensory diets change children's psychosocial skills as determined by changes in participants' target behaviors in the area of psychosocial skills.
4. A control intervention has no effect on children's psychosocial skills as determined by changes in participants' target behaviors in the area of psychosocial skills.
5. Sensory diets change children's engagement in classroom activities as determined by changes in participants' target behaviors in the area of engagement in classroom activities.
6. A control intervention has no effect on children's engagement in classroom activities as determined by changes in participants' target behaviors in the area of engagement in classroom activities.

Research Design

The effect of sensory diets was investigated using a single-subject design as this research design is deemed suitable alternatives to group experimental designs when a large homogeneous sample is unavailable (Kratochwill & Levin, 2014; Lane, Ledford, & Gast, 2017). Variations in SPD manifestations and the presence of known and unknown concurrent diagnoses, such as autism, attention deficits and hyperactive disorder, learning disabilities, or genetic disorders, makes the sample of children with SPD heterogeneous (May-Benson & Koomar, 2010). Therefore, a single-subject ABCA design was used to investigate the effect of sensory diets on dependent variables of sensory processing skills, psychosocial skills, and engagement in classroom activities. Participants in this study served as their own control (Byiers, Reichle, & Symons, 2012; Portney & Watkins, 2000), and the results were used to draw conclusions about the effect of sensory diets under a controlled condition.

An alternate control intervention design was used to control for participants response bias to the primary investigatory (PI). A non-therapeutic control intervention was used as a placebo to determine if sensory diets and not the interactions between the PI and participants caused changes in participants' sensory processing skills, psychosocial skills, and classroom engagement. Single-subject withdrawal studies are based on the assumption that the effect of an intervention is reversible (Byiers et al., 2012). Since the results of a pilot study conducted by Pingale, Fletcher, and Candler (Submitted) showed the effect of sensory diets lasted through the second baseline phase, the non-therapeutic control intervention was administered during the first intervention phase (B). The study consisted of an initial baseline phase (A_1), which was followed by a control intervention phase (B). The control intervention included non-therapeutic (without a therapeutic goal) fine motor and visual motor activities. The second intervention phase of the sensory diet (C) was followed by the second baseline phase (A_2) Each phase lasted for seven school days to accommodate a recommended number of data points to reduce time-related factors, such as motivational influences, and to capture the trend and stability of the data (Portney & Watkins, 2000). Additionally, the length of each phase ensured completion of all phases without a major interruption due to a school vacation.

Participants

A convenience sample of the first five children between the ages of four and 11 years who attended pre-kindergarten through grade four level special education or regular education classes at an urban public school district in New Jersey and met the eligibility criteria were recruited for this study. This age range was selected for the study as a stronger correlation was reported between SPD and adaptive behaviors in younger children than with adolescents and adults (Kern et al., 2007; Lane, Young, Baker, & Angley, 2010). Furthermore, the proposed age range ensured the availability of the necessary sample size for this study. The following eligibility criteria were used to screen potential participants:

Inclusion criteria. The inclusion criteria ensured alignment with the research questions. The inclusion criteria included:

- Children between the ages of four and 11 years and attending pre-kindergarten through fourth grade

- Children eligible for occupational therapy services under the special education eligibility criteria or under section 504 of the Rehabilitation Act of 1973-subpart D. This subpart of section 504 ensures children with disabilities who do not meet the eligibility criteria for special education services and are placed in general education classrooms receive the necessary support and related services (such as occupational therapy) to fully participate in general education classrooms.
- Children who scored in the Definite Difference range (+ 2 SD) or Probable Difference (+ 1 SD) ranges on two or more sections or quadrants on the Sensory Profile-2, Teacher Questionnaire (SP-2 Teacher Questionnaire; Dunn, 2015) were included in this study

Exclusion criteria. This exclusion criteria ensured alignment with the research questions. The exclusion criteria included:

- Children with medical concerns, such as cardiac conditions, posing risk to participate in resistive (strenuous) gross motor activities or children who used mobility devices were excluded from the study as these conditions may have hindered their participation in sensory diet activities.
- Children who were on medications, such as stimulants, anti-anxiety or anti-convulsive medications were excluded from the study as these medications may influence the clinical representation of SPD and interfere with the study outcomes.

- Children who were currently receiving sensory diets or received sensory diets six months prior to the beginning of the study were excluded from the study to control for confounding.

Instruments

The SP-2 Teacher Questionnaire (Dunn, 2015) was used to determine the participants' eligibility to participate in the study. This is a standardized questionnaire used to assess children's sensory processing patterns in the context of home, community, and school. SP-2 questionnaires are normed on children from the ages 3-14 years. Test-retest reliability of SP-2 Teacher Questionnaire is between a moderate to excellent range (r = .66-.93) and interrater reliability is in a moderate to excellent range (r = .70-.90) (Dunn, 2015). The concurrent validity of the SP-2 Teacher Questionnaire was established against the first version of the Sensory Profile (Dunn, 1999) found showed a moderate correlation between similar constructs. The Behavioral Symptom Index of the Behavior Assessment System for Children-2 Teacher Questionnaire (Reynolds & Kamphaus, 2004) has a high correlation with the Registration and Avoiding Quadrant scores of SP-2 Teacher Questionnaire. Problem Behavior scale of the Social Skills Improvement System Teacher Questionnaire (Gresham & Elliott, 2007) has a high correlation with all SP-2 Teacher Questionnaire scores with the exception of scores on the Seeking quadrant. Also, Academic Competence scores are only associated with the Auditory, Visual, and Movement processing scores. The overall score of the Cognitive/Behavior Tasks of the School Functional Assessment (Coster, Deeney, Haltiwanger, & Haley, 1998) significantly correlates with the School Companion Sensory Profile for children from 4th through 6th grade. Also, Cognitive/Behavior tasks moderately correlate with the Touch processing, Behavior, Avoiding, and School Factor 4, and highly correlate with the Auditory Processing, Registration, and School Factor 3 (Dunn, 2015).

Two scales of the Behavior Assessment System for Children-3 (BASC-3) (Reynolds, Kamphaus, & Vannest, 2015), Teacher Questionnaire (TRS) and Student Observation System (SOS), were used to collect information about participants' adaptive behaviors, maladaptive behaviors, and their impact on participants' engagement in classroom activities. BASC-3 is a comprehensive set of rating scales and forms used to collect information about a child's adaptive and maladaptive behaviors and emotions that may affect his/her school participation. This instrument is normed on children between the ages of 2-22 years. TRS contains 105-165 items describing specific behaviors that are rated on a four-point scale ranging from, "Never" to "Almost Always". TRS provides composite scores for Adaptive Skills, Behavioral Symptom Index, Externalizing Problems, and Internalizing Problems. Internal consistency of the TRS ranges from (r = .86-.90). Test-retest reliability of TRS ranges from (r = .86-.94) and the interrater reliability ranges from (r = .70-.84). The validity based on evidence structure shows positive correlations within clinical scales and within adaptive scales are negative correlations between clinical and within adaptive scales.

Factor analysis shows moderate to excellent factor loading for the clinical scales, adaptive scales, content scales, and composite scores. The concurrent validity of TRS is established against assessments that measure similar constructs. Corresponding scales of Achenbach System of Empirically Based Assessment Teacher Report Rating Form (Achenbach & Rescorla, 2013) show moderate to high correlation with composite scales and clinically scales of TRS. Similarly, Conners' Rating Scales (Conners, 2001) that measure similar constructs show high correlations with TRS. The discriminant validity for attention deficit hyperactive disorder, autism, anxiety, and learning disability is in a moderate range (Reynolds et al., 2015).

The SOS is one of the scales of the BASC-3 that is used to collect frequency of a child's adaptive and maladaptive behavior during classroom activities. It is a structured assessment that guides classroom observations. SOS is constructed based on the expert judgement and analysis of underlying behavior themes of the BASC-3. Each 15-minute observation period is divided into 30 observations consisting of three-second observation intervals that are followed by 27 second intervals for documenting observations. The Fleiss Kappa estimates were calculated to find interrater reliability, which ranged from 44% to 100%. The lowest agreement was seen on the Work on School Subject and Inattention behaviors (Reynolds et al., 2015).

The PI developed an intake form (see Appendix A) to document information from classroom observations and teacher interviews. The information about participants' daily routine, interests, classroom behaviors, and participation was collected from classroom observations and teacher interviews. The PI developed an intervention fidelity form (see Appendix B) to maintain an audit trail of activities used during intervention phases and participants' responses to activities.

Target behaviors. The PI, in collaboration with the classroom teacher, identified three target behaviors related to sensory processing skills, psychosocial skills, and classroom engagement as the primary outcome measures. These target behaviors were selected prior to the study. Since manifestations of deficits in sensory processing skills impact children's participation in school occupations, measuring changes in manifestations of sensory processing skills and in children's participation in school occupations affected by sensory processing skills is necessary to determine the effectiveness of the intervention (Pfeiffer, et.al, 2018). Sensory processing skills (Ashburner et al., 2008) and psychosocial skills (Suldo, Gormley, DuPaul, & Anderson-Butcher, 2014) are necessary for successful participation in classroom occupations. Therefore, three target behaviors for sensory processing skills, psychosocial skills, and engagement in school activities were used as the primary outcome measures.

Review of each item of SP-2 Teacher Questionnaire, classroom observations, and teacher interviews were used to determine target behaviors in the area of sensory processing skills. Classroom observations, teacher interviews, and review of BASC-3 scale items were used to determine target behaviors in the area of psychosocial skills. Teacher interviews and classroom observations were used to determine target behaviors for engagement in classroom activities.

Procedures

Texas Woman's University Institutional Review Board approved this study in September 2017. In accordance with the IRB procedures, the PI sent recruitment letters containing information about the study to all parents with children between the ages of 4-11 years, who attended a pre-kindergarten through grade four level special education or regular education class at the designated school and who received school-based occupational therapy. The script of the recruitment letter can be found in Appendix C. Parents expressed their interest for their child to participate in the study by contacting the classroom teachers or the PI. A signed informed consent form was obtained from parents prior to screening children for the eligibility to participate in the study. A verbal assent was collected from the eligible participants. Informed consent form is displayed in Appendix D. Children were screened for the inclusion and exclusion criteria.

Participants

A convenience sample of the first 5 children who met the eligibility criteria was recruited for the study. Participation in the study was voluntary. No participants dropped out of the study.

Participant 1. Participant 1 was a five years and seven months old boy who attended a kindergarten level learning language disability class. The SP-2 results showed Participant 1 had difficulty processing auditory, visual, movement, and tactile stimuli. He exhibited seeker, avoider, sensor, and bystander sensory processing patterns. His sensory processing skills affected his behavioral organization and participation in school activities. He engaged in sensory seeking behaviors, such as stretching and fidgeting, interruptive behaviors, such as talking about irrelevant topics or repeating scripts from television shows, and inattentive behaviors, such as tuning himself out from the classroom activities. He also had frequent emotional outbursts for no apparent reason and showed high distractibility. He moved slowly and struggled to finish his work on time.

Participant 1 scored in the at-risk category on the Social Skills Composite of the BASC-3. His scores on the Behavioral Control Index, Withdrawal, Atypicality, Attention Problems were clinically significant. Additionally, his score on the Developmental Social Disorder Scale was clinically significant, score on the Executive Functioning was in the at-risk category, and his score on the Attention Control Index was elevated. Participants' BASC-3 scores with 95% confidence intervals are displayed in Appendix E.

Participant 2. Participant 2 was a seven years five months old boy who attended a grade two level language learning disability level I class. The SP-2 results indicated Participant 2 had difficulty processing auditory, visual, tactile, and movement stimuli. He exhibited seeker, avoider, sensor, and bystander sensory processing patterns. His sensory processing skills affected his behavioral organization and participation in school activities. He engaged in fidgeting and sought excessive movements by leaving his desk during classroom activities. He needed frequent redirections to attend to tasks. He verbally interrupted the class and had difficulty controlling impulses.

Participant 2 scored in the clinically significant category on the Functional Communication, Atypicality, School Problems, Learning Problems, and Attentional Problems scales of the BASC-3. His scores on the Behavioral Symptoms Index, Developmental Social Disorder Scale, Executive Functioning, and Hyperactivity scales were in the at-risk category. His scores on the Executive Functioning Index and Behavioral Control were elevated, and his score on the Overall Attention Control Index was in the extremely elevated range.

Participant 3. Participant 3 was a five years and two months old boy with a diagnosis of autism. He attended a kindergarten level special education class consisting of children with autism. According to SP-2 results, Participant 3 had difficulty processing auditory, visual, tactile, and movement stimuli. He exhibited seeker, avoider, sensor, and bystander sensory processing patterns. His sensory processing skills affected his behavioral organization and school participation. He engaged in fidgeting in his seat and leg swinging during tabletop activities. He had difficulty standing or sitting still. Environmental visual and auditory stimuli distracted him. A classroom aide was assigned to him. He required extensive redirections from the teacher or classroom aide to engage in school activities. He often sought attention from adults and children in the room by reaching out to them or laughing for no apparent reason.

The BASC-3 results showed that Participant 3 scored in the clinically significant category on the Adaptive Skills Composite, Functional Communication, Social Skills, Withdrawal, and Developmental Social Disorder Scales. His scores on the Adaptability, Behavioral Symptom Index, Atypicality, Attention Problems, Executive Functioning Scale, and Resilience Scale were in the at-risk category. His score on the Overall Executive Functioning Index was elevated, and his score on the Attention Control was in an extremely elevated range.

Participant 4. Participant 4 was a seven years and five months old child with a diagnosis of autism. He attended a grade two level special education class consisting of children with autism. SP-2 results indicated Participant 4 had difficulty processing auditory, visual, and movement stimuli. He exhibited avoider, sensor, and bystander sensory processing patterns. His decreased sensory processing skills significantly affected his behavioral organization and consequently, his participation in classroom activities. He fidgeted with his clothes and objects in the vicinity and was distracted by extraneous visual stimuli. He got frustrated easily and engaged in interruptive behaviors by calling to others, laughing inappropriately, repeating others, and showing aggressive behaviors towards teachers and classroom aides. A classroom aide was assigned to him to encourage him to participate in classroom activities.

Participant 4 scored in the clinically significant category on the Functional Communication, Behavioral Symptom Index, Withdrawal, Atypicality, Developmental Social Skills, and Anger Control scales of the BASC-3. His scores on the Adaptive Skills Composite, Leadership, School Problems Composite, Learning Problems, Attention Problems, Emotional Self-Control Scale, Negative Emotions Scale, Resilience, Executive Functioning Scale, Externalizing Problems, Aggression, and Hyperactivity were in the at-risk category. His scores on the Overall Executive Functioning Index and Problem-Solving Index were extremely elevated and scores on the Behavioral Control Index and Emotional Control Index were elevated.

Participant 5. Participant 5 was a ten years and ten months old boy with a diagnosis of learning disability and communication impairment who attended a grade four level special education class. This class consisted of children with multiple disabilities, such as learning disability, cognitive disability, communication impairment, autism, or attention deficit hyperactivity disorder. SP-2 results indicated that Participant 5 had difficulty processing auditory, visual, tactile, and movement stimuli. He exhibited seeker, avoider, sensor, and bystander sensory processing patterns. His decreased sensory processing skills affected his behavioral organization and participation in classroom activities. He sought excessive movements and was fidgety in the seat. He constantly sought the teacher's attention and acknowledgement. His exaggerated verbal expressions and self-talk interrupted class activities and annoyed his classmates.

Participant 5 scored in the clinically significant category on the Functional Communication, Atypicality, School Problems, Attention Problems, and Executive Functioning scale of the BASC-3. His score on the Adaptive Skills Composite, Behavioral Symptom Index, Learning Problems, Externalizing Problems, and Hyperactivity were in the at-risk category. His scores on the Overall Executive Functioning Index, Attention Control, Behavioral Control, and Problem Solving Index were extremely elevated.

Interventions

The PI, an occupational therapist with the Sensory Integration and Praxis Test certification and more than 15 years of experience in treating children with sensory processing issues, observed participants in different school contexts and collected information about participants' abilities to regulate sensory arousal levels, preferred sensory patterns, and responses to sensory stimuli during various classroom activities. Participants' scores and the analysis of SP-2 Teacher Questionnaire, BASC-3 Teacher Questionnaire, teacher interviews, and classroom observations were used to evaluate participants' sensory processing issues, psychosocial skills, and performance areas impacted by sensory processing issues. The information was also used to determine the need for sensory diets, develop sensory diets, and to develop sensory diet schedules.

Sensory diets were developed based on the framework proposed by Wilbarger (1995). Sensory diets consisted of an activity plan tailored for each participant to facilitate their sensory processing skills throughout a school day. The PI selected activities for sensory diets based on participants' interests, developmental age, and neurological thresholds for sensory stimuli, preferred sensory strategies, and responses to sensory stimuli during various classroom activities. Activities used to provide a combination of vestibular (movement), proprioceptive (joint position), or tactile (touch) stimuli within a classroom setting included bouncing on a ball, bear walking, throwing a weighted ball, pushing a ball, pulling a textured blanket, and making a body sandwich. For example, bear walking on a textured mat provided vestibular, proprioceptive, and tactile stimuli. Similarly, bouncing on a ball provided vestibular and proprioceptive stimuli. The selected activities were embedded in participants' routines to deliver vestibular, proprioceptive, and tactile stimuli, or a combination of sensory stimuli. Sensory diet administration schedules were determined based on participants' classroom schedules, activity demands, responses to sensory stimuli during classroom activities, and variations in their sensory arousal level. Each sensory diet session lasted for five to seven minutes.

A non-therapeutic control intervention consisted of age-appropriate fine motor and visual activities with no therapeutic goal. Activities included coloring, construction toys, puzzles, and mazes. Participants were asked to select activities from a set of 8-10 activities. The duration and schedule for the control intervention matched with each participant's sensory diet schedule.

The PI delivered interventions to each participant within the classroom three times a day. The PI maintained an audit trail of activities used as a part of the intervention and participants' responses to activities using the intervention fidelity form. Participants continued to receive school-based occupational therapy as stated in their individualized education plans.

Data Collection

The PI and research team members collected data from 1/2/2018 to 2/15/2018. To collect the data, the PI or a research team member videotaped each participant for fifteen minutes during a classroom group activity each school day during all phases (for

28 days in total). One research team member was a behavior therapist and six research team members were occupational therapy graduate students.

The group context for Participants 1 and 2 included a morning circle activity. This group context consisted of verbal interactions and motor activities. During verbal interactions, students answered classroom teacher's questions or engaged in counting, mental math, phonics, and spelling activities. During group time, students also completed writing activities, completed daily journals, or wrote on white boards. Additionally, they participated in other academics that required use of manipulatives such as using scissors for cutting and using blocks or sticks for counting. Students worked independently during these activities and if needed, asked the teacher for assistance.

A group context for Participant 3 composed of a classroom group during which students participated in fine motor and visual motor activities. The classroom teacher provided instructions to the entire class, and the participant along with other students worked on their worksheet or a project assigned to them. The classroom aide assigned to participant 3 facilitated his participation in activities by providing him additional verbal and physical cues. A group context for Participant 4 consisted of a classroom group during which students participated in a fine motor and visual motor activities. The classroom teacher provided instructions to the entire class. The classroom aide assigned to Participant 4 facilitated his participation in activities by providing him additional verbal cues, physical cues, and motor assistance. For Participant 5, the group context included a classroom group comprised of fine motor or visual motor activity. During classroom group, the classroom teacher provided instructions to the entire class, and participants along with other students worked on their worksheet or a project assigned to them.

Research team. PI recruited seven research team members to assist with data collection. After obtaining permission from the Special Education department supervisor, the PI asked the Special Education department staff for volunteers. One on-site staff volunteered as a research team member to assist the PI with videotaping participants. The PI contacted occupational therapy schools to recruit additional research team members, and six occupational therapy graduate students were recruited as off-site research team members.

All recruited research team members completed the Human Subject Research training and were approved by Texas Woman's University Institutional Review Board. The PI conducted a 30 minute training session on data collection and documentation procedures for off-site research team members and videotaping procedures for the on-site research team member. Video clips from YouTube featuring children playing or performing academic activities were used for the training. The PI and off-site research team members watched video clips later to document frequencies and durations of target behaviors. Off-site research team members who collected data by watching participants' video clips were blind to their clinical and demographic information.

Reliability of the data. At least 20% of the randomly selected video clips were used to establish a 90% interrater agreement. Intraclass correlation coefficient (ICC) was calculated to determine the interrater agreement. ICC of ≥ .90 was accepted. The PI watched all video clips in a random order and documented the frequency or duration of each target behavior for each participant. Research team members watched video clips independent of the PI. These clips were also selected randomly. After reviewing each video clip, the PI and research team members discussed discrepancies in the data and clarified the criteria for target behaviors that did not yield ICC of ≥ .90. The PI and research team members collaboratively clarified the operational definitions of the target behaviors if necessary. Only definitions for Participant 1 and Participant 3 needed additional clarifications. Research team members continued to review additional video clips if ICC was below .90 for more than three consecutive video clips. Research team member reviewed additional video clips until ICC reached ≥ .90 for six consecutive video clips. Research team members reviewed eight video clips for Participant 1 and Participant 2. They reviewed eleven video clips for Participant 3 and six video clips for Participant 4 and six video clips for Participant 5. In total, research members reviewed 39 video clips.

Ethical Issues

Ethical issues were considered for this study. Informed consents were obtained from parents and verbal assent was obtained from each child prior to screening them for the eligibility to participate in this study. During the study, precautions were taken to minimize injuries, discomfort, and boredom. Participants were encouraged to indicate discomfort during intervention activities. Participants did not show any visible signs or expressed boredom during the intervention phase. No child was harmed during the course of this study. To avoid distractions during videotaping, the PI and research team member remained passive participants in the classrooms. Similarly, interventions were administered in classroom corners away from the instructional area to minimize distractions.

Identifiable Data Protection

Information about participants' name, age, gender, grade, and parents' contact information was collected for the study. Participants were videotaped. This information was stored in a locked cabinet and was on a password-protected computer at the PI's office. Additionally, video files were stored on a password-protected cloud storage account. The physical data will be shredded and thrown away and the electronic data will be permanently deleted in four years.

Data Analysis

As recommended in the literature (Olive & Smith, 2005; Portney & Watkins, 2000), visual analysis was used as the primary data analysis method to determine the effect of sensory diets. Data for each participant for each target behavior was plotted by the phase. Within phases and across phases visual analysis was conducted for the variability, level, and trend. Variability in the data was determined by calculating a range of the data for each phase. To determine a trend of the data, a celeration line for each phase for each participant was plotted using a split-middle line technique. A trend is the direction of the change in the target behavior data (Portney & Watkins, 2000). Slopes of the celeration lines were calculated. Table 1 details slopes of the celeration lines.

Research hypotheses were tested by analyzing adjacent phases for changes in levels. Changes in levels of target behaviors were determined by plotting mean lines for each phase for each target behavior. A change in a level refers to a change in the value or magnitude of a performance of a dependent variable (Portney & Watkins, 2000). The mean or average values of target behaviors for adjacent phases, A_1-B, B-C, C-$A_{2,}$ were compared for this study.

Celeration lines for phases A_1, B, and C were extended into the adjacent phases to project trends across phases. Since the trend analysis based only on the direction of a celeration line can be misleading (Portney & Watkins, 2000), binomial tests were conducted to determine the statistical significances of changes in the outcome measures. The binomial tests were conducted by counting data points on or above the extended celeration lines for phases B and C. The data points on or below the celeration lines were counted for binomial test for phase A_2. A binomial test result below .10 was considered significant. The visual analysis for stability, results of the binomial test, and changes in the mean levels of target behaviors were used to determine the effect of sensory diets.

CHAPTER IV

RESULTS

This study investigated the effect of sensory diets on children's sensory processing skills, psychosocial skills, and classroom engagement. The effect of sensory diets was investigated using a single-subject ABCA design. This study consisted of phase A_1 as an initial intervention phase, phase B as a control intervention phase, phase C as a sensory diet intervention phase, and phase A_2 as the second baseline phase. Hypotheses that sensory diets positively change children's sensory processing skills, psychosocial skills, and classroom engagement were tested. Additionally, hypotheses that a control intervention of fine motor and visual motor activities had no effect on children's sensory processing skills, psychosocial skills, and classroom engagement were tested. Three individualized target behaviors in the areas of sensory processing skills, psychosocial skills, and classroom engagement were used as the primary outcome measures.

Visual Analysis

Visual analysis was the main method used to determine the effect of sensory diets on measured outcomes for sensory processing skills, psychosocial skills, and classroom engagement. This section provides details of the visual analysis. The PI visually analyzed the plotted data for the stability, trend, and level for each participant. The within phase analysis of the data showed high variability for all participants for all phases. Only the data for Participant 1 for sensory processing skills during phase A_1 and the data for psychosocial skills during phase A_2 exhibited stability. Also, the data for Participant 3 and Participant 4 for psychosocial skills during phase A_1 showed stability. Slopes of the celeration lines for each phase were calculated for the within phase trend analysis. Table 1 details slopes of the celeration lines for each phase for each participant.

Table 1

Slopes of the Celeration Lines

Participants	Sensory Processing Skills				Psychosocial Skills				Classroom Engagement			
	A_1	B	C	A_2	A_1	B	C	A_2	A_1	B	C	A_2
P1	45.0	-64.0	-23.0	1.3	-2.3	4.0	0.8	-4.3	28.0	6.7	-16.0	-6.3
P2	-29.0	-18.0	-53.3	13.8	2.9	6.5	0.0	0.2	-24.5	20.0	1.5	17.0
P3	-0.6	10.0	-23.3	-33.6	-3.0	0.0	2.1	0.0	-28.3	3.8	10.0	-8.5
P4	9.5	35.0	11.7	-18.3	-0.3	3.0	-1.3	0.3	-19	-1.0	-35.0	8.0
P5	-1.0	36.0	-16.0	19.0	0.2	1.6	-4.0	1.0	-5.0	6.5	-18.0	46.0

Participant 1

Figure 1 shows plotted data for sensory processing skills for Participant 1 and Table 2 shows the means of the target behaviors and results of binomial tests for Participant 1.

Sensory processing skills. Review of each item of SP-2 Teacher Questionnaire, classroom observations, and teacher interviews were used to identify a target behavior for sensory processing skills. The sensory seeking behavior of un-purposeful movement was identified as a target behavior in this area. This target behavior was operationalized as the duration of un-purposeful movements when the participant was touching his body parts including the other hand, face, hair, nose, and objects in the vicinity without a specific purpose. Additionally, the duration of stretching, running fingers on the objects, moving objects back and forth on a table, and pulling his body parts or clothes were considered sensory seeking behaviors. Movements of using fingers to clean his mouth, writing responses in the air or on the table with the teacher, tapping fingers on a number line to indicate responses, and using fingers to form alphabet signs while responding to the teacher were not considered sensory seeking behaviors.

Table 2

Participant 1 Means and Binomial Test Results

Target Behaviors	Mean A_1	Mean B	pA_1B	Mean C	pBC	Mean A_2	pCA_2
Sensory Processing Skills	487.00	479.57	.06*	248.71	1.00	387.86	.01*
Psychosocial Skills	21.00	32.57	1.00	9.57	.01*	20.43	.2
Classroom Engagement	289.14	260.57	.01*	108.14	.01*	231.71	.01*

Note. *$p < .10$

The data for Participant 1 for measured outcomes for sensory processing skills showed high variability during all phases. Although the binomial test result was significant for phases A_1B ($p = .06$), the change in the mean level from phase A_1 (M =

487.00) to phase B (M = 479.57) was very small. Only a slight change in the mean level between phase A_1 and B obscures the effect of control intervention. Phase B showed a decelerating trend (*slope* = -64.0), which continued during phase C (*slope* = -23.0). A noteworthy decrease in the mean level of sensory seeking behaviors from phase B to C (M = 248.71) suggests sensory diets positively influenced sensory seeking behaviors. Participant 1 also showed a strong withdrawal effect as evidenced by an increase in the mean level of sensory seeking behaviors from phase C to A_2 (M = 387.86) and the significant binomial test result for a change between phases CA_2 (p = .01).

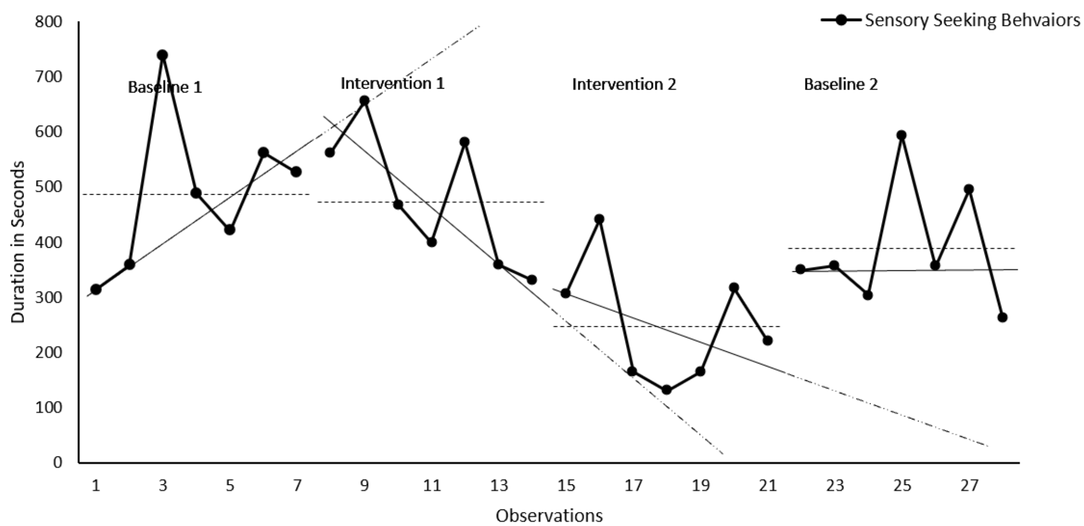

Figure 1. Participant 1 Sensory Processing Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Psychosocial skills. Based on classroom observations, teacher interviews, and the review of items of the BASC-3, inappropriate behavior was identified as a target behavior in the area of psychosocial skills. This target behavior was operationalized as the frequency of behaviors when the participant was laughing or talking to himself, waving fingers without a purpose, looking at fingers while pointing or waving them, mimicking the teacher or peers using hand gestures, and making exaggerated facial expressions. In addition, engaging in appropriate talking, repeating peers' verbatim, and instructing peers were considered as inappropriate behaviors. Incidences when the participant used gestures of pointing fingers appropriately to follow a lesson, write responses in the air or on a table, tapped his fingers on a number line, and smiled in response to a praise from the teacher were not considered inappropriate behaviors.

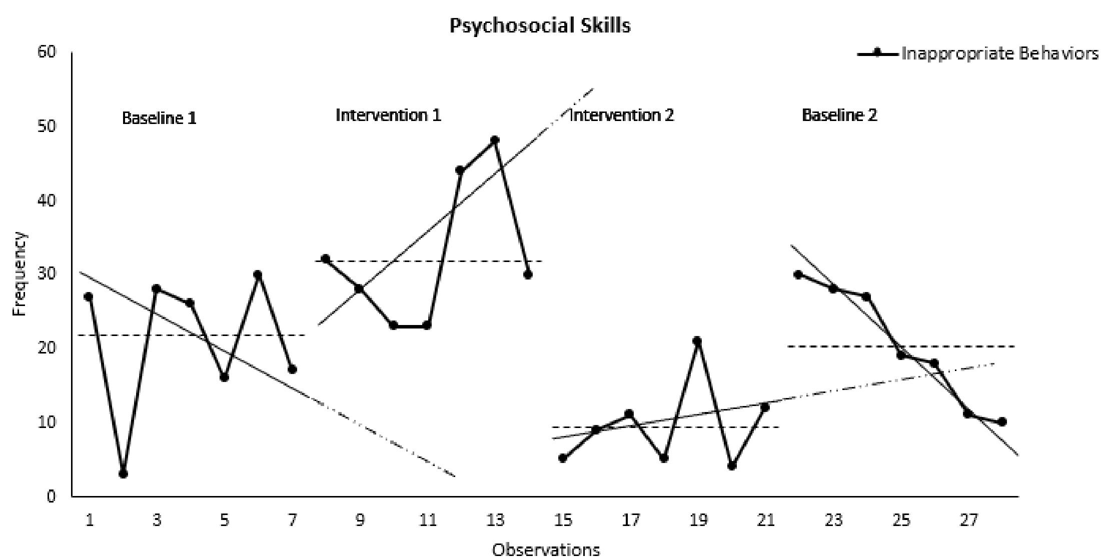

Figure 2. Participant 1 Psychosocial Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Figure 2 shows plotted data for psychosocial skills for Participant 1. The data for Participant 1 for psychosocial skills were variable during all phases; however, it continued to stabilize as the study progressed. A decelerating trend was noted during phase A_1 (*slope* = -2.3). The mean level of inappropriate behaviors increased from phase A_1 (*M* = 21.00) to B (*M* = 32.57) with a shift to a sharp ascending trend (*slope* = 4.0). The binomial test result for a change between phases A_1B (p = 1.00) was not statistically significant, which challenges the effect of the control intervention on inappropriate behaviors for Participant 1. A lower acceleration rate during phase C (*slope* = 0.8), a substantial decrease in the mean level from phase B to C (M = 9.57), and the significant binomial result for phases BC (p = .01) imply sensory diets had a positive effect on inappropriate behaviors exhibited by Participant 1. The mean level increase from phase C to phase A_2 (M = 20.43) suggests that Participant 1 responded to the withdrawal of sensory diets.

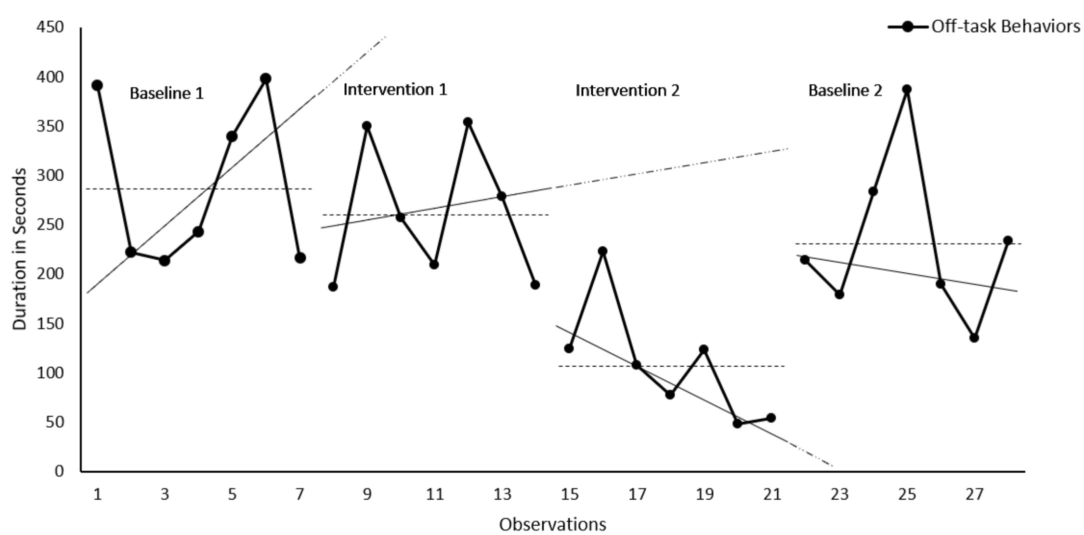

Figure 3. Participant 1 Classroom Engagement Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Classroom engagement. Based on the teacher interview and classroom observation, off-task behavior was identified as the target behavior in the area of classroom engagement. This target behavior was operationalized as a duration of looking at people or objects other than the task materials or the teacher when she was instructing or a peer who was responding to the teacher. Additionally, the participant was considered off-task when he tuned himself out from the environment or engaged in inappropriate behaviors or altercations with peers. The participant was not considered off-task if he was waiting for the teacher's instructions after completing the assigned task that required manipulatives such as blocks, scissors, or writing tools.

Figure 3 illustrates plotted data for classroom engagement for Participant 1. The data for classroom engagement for Participant 1 showed an increase in variability during phase A_2 and relative stability during intervention phase C. The mean level of off-task behaviors changed only slightly from phase A_1 (M = 289.14) to B (M = 260.57). The data continued with an accelerating trend from phase A_1 (*slope* = 28.0) to phase B (*slope* = 6.7). The trend then changed to a decelerating trend during phase C (*slope* = -16.0), which continued during phase A_2 (*slope* = -6.3). The mean level change from phase B to C (M = 108.14) was also noteworthy. The significant binomial test result for a change between phases BC (p = .01) and a shift to a decelerating trend from phase B to C (*slope* = -16.0) clearly indicate that off-task behaviors for Participant 1 responded positively to sensory diets. An increase in the mean level upon the withdrawal of sensory diets from phase C to phase A_2 (M = 231.71) and the significant binomial test result for a change between phases CA_2 (p = .01) suggest participant showed a withdrawal effect.

Participant 2

The means of target behaviors and binomial test results for Participant 2 are shown in Table 3. Visual analysis of the data for Participant 2 is discussed below.

Table 3

Participant 2 Means and Binomial Test Results

Target Behaviors	Mean A_1	Mean B	pA_1B	Mean C	pBC	Mean A_2	pCA_2
Sensory Processing Skills	576.57	566.57	.99	409.71	.94	653.71	.01*
Psychosocial Skills	15	18.57	.06*	4.57	---	10.57	.06*
Classroom Engagement	208.43	194.43	1.00	78.71	.01*	170.00	.06*

Note. *$p < .10$, --- binomial test could not be conducted

Sensory processing skills. Based on the review of each item of SP-2 Teacher Questionnaire, classroom observations, and teacher interviews, sensory seeking behavior of un-purposeful movement was identified as a target behavior in the area of sensory processing skills and was operationalized as the duration when the Participant 2 was tapping or moving objects or fingers without a specific purpose, walking fingers on the body or table while looking at them, and moving or rubbing his hands or fingers over a body part. The durations of pulling on body parts or clothes, touching his body parts including hands, face, or hair, and pushing the elbow into the other arm or table were also considered sensory seeking behaviors.

Figure 4 displayss plotted data for sensory processing skills for Participant 2. The data for Participant 2 for measured outcomes for sensory processing skills showed high variability during phases B, C, and A_2. The mean level of sensory seeking behaviors changed slightly from phase A_1 (M = 576.57) to B (M = 566.57) and then a considerable drop from phase B to C (M = 409.71). The data presented a decelerating trend during phases A_1 (*slope* = -29.0), B (*slope* = -18.0), and C (*slope* = -53.3). However, a high deceleration rate during phase C and a notable change in the level from phase B to C suggest sensory seeking behaviors of Participant 2 responded to sensory diets. However, high variability in the data cloud the effect of sensory diets. An increase in the mean level from phase C to A_2 (M = 653.71), a shift to an accelerating trend (*slope* = 13.8) upon the withdrawal of sensory diets, and the significant binomial result for phases CA_2 (p = .01) suggest Participant 2 showed a strong withdrawal effect.

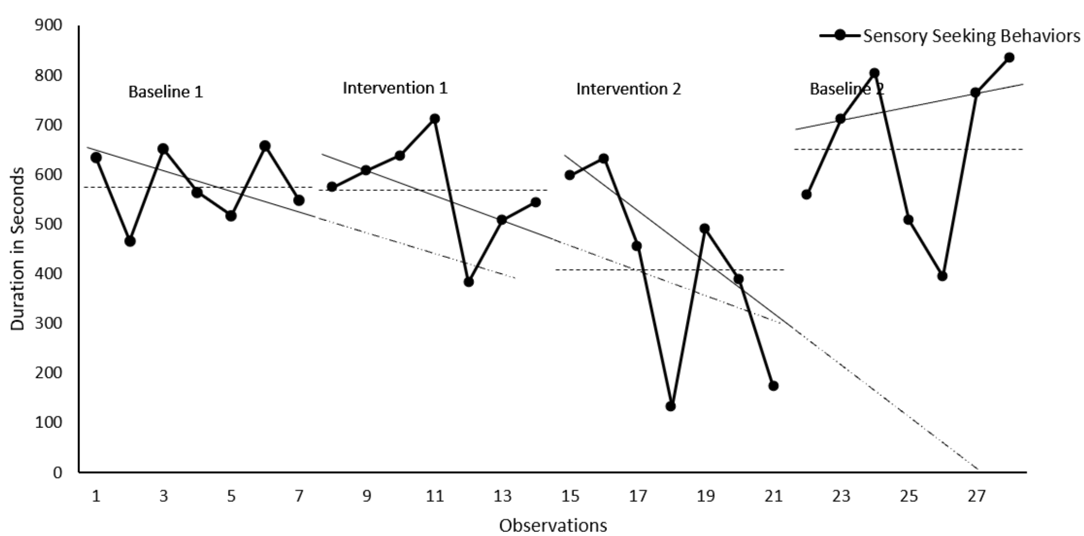

Figure 4. Participant 2 Sensory Processing Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Psychosocial skills. Based on classroom observations, teacher interviews, and review of items of the BASC-3, the verbal interruption was identified as a target behavior for psychosocial skills and was operationalized as a frequency of verbal interruptions when repeating others' verbal expressions, saying "hmm," repeating teacher's instructions, calling the teacher to inform her what he was doing or should be doing, and giving instructions to other students.

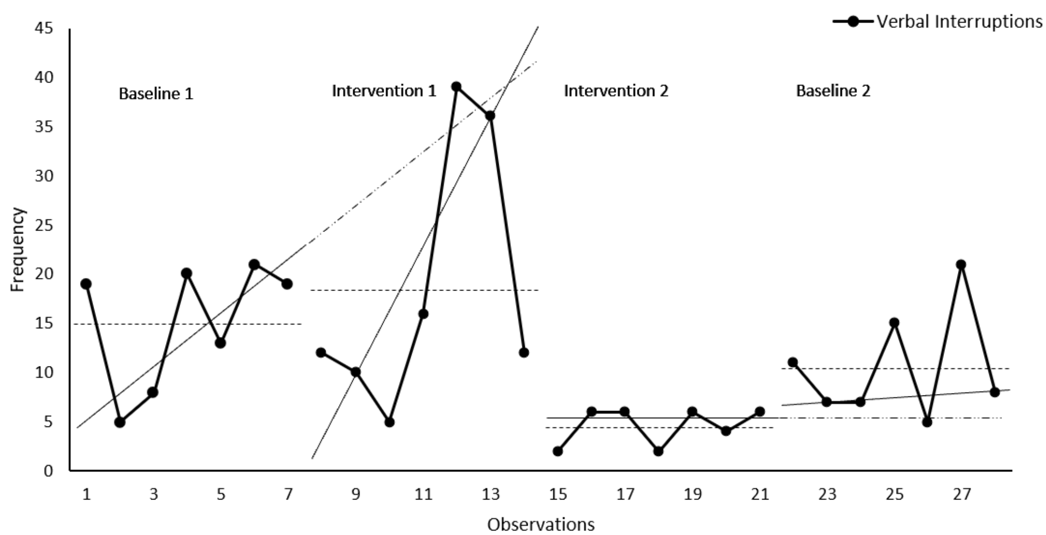

Figure 5. Participant 2 Psychosocial Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Data variability was high during phase B and was low during phase C. Figure 5 displays plotted data for psychosocial skills for Participant 2. Although the binomial test result was significant for phases A_1B, (p = .06), the mean level of verbal interruptions increased from phase A_1 (M = 15.00) to B (M = 18.57). Phase B (*slope* = 6.5) also continued with a sharp accelerating trend. A considerable decrease in the mean level of verbal interruptions from phase B to C (M = 4.57), a non-crossing celeration line for phase B, and a lack of trend for phase C (*slope* = 0.0) suggest sensory diets had a positive effect on the frequency of verbal interruptions for Participant 2. An increase in the mean level from phase C to A_2 (M = 10.57), a slight accelerating trend (*slope* = 0.2) during phase A_2, and the significant binomial test result for a change between phases CA_2 (p = .06) indicate that Participant 2 also exhibited a withdrawal effect.

Classroom engagement. Teacher interviews and classroom observations were used to determine the target behaviors in the area of classroom engagement. An off-task behavior was identified as a target behavior in the area of classroom engagement. This target behavior was operationalized as the duration of looking at people or objects other than the task materials or the teacher when she was instructing. Also, Participant 2 was considered off-task if he tuned himself out from the environment or engaged in verbal interruptions and disruptive behaviors. Participant 2 was not considered off-task if he finished his motor task and was waiting for further instructions. However, any inappropriate behaviors, verbal interruptions, and incidences of tuning himself out after the completion of the task were considered as off-task behaviors.

Plotted data for classroom engagement for Participant 2 is presented in Figure 6. The data for Participant 2 for off-task behaviors showed high variability during all phases with the relative stability during phase C. The mean level of off-task behaviors decreased slightly from phase A_1 (M = 208.43) to B (M = 194.43). However, the trend shifted to an accelerating trend during phase B (*slope* = 20.0). A considerable decrease from phase B to C (M = 78.71), a significant binomial test result for a change between phases BC (p = .01), a decline in variability in the data during phase C, and a drop in rate of acceleration of off-task behaviors from phase B to phase C (*slope* = 1.5) suggest sensory diets had a positive effect on off-task behaviors. An increase in the mean level upon the withdrawal of sensory diets from phase C to A_2 (M = 170.00), an accelerating trend (*slope* = 17.0), and a significant binomial test result for a change between phases CA_2 (p = .06) imply Participant 2 showed a withdrawal effect.

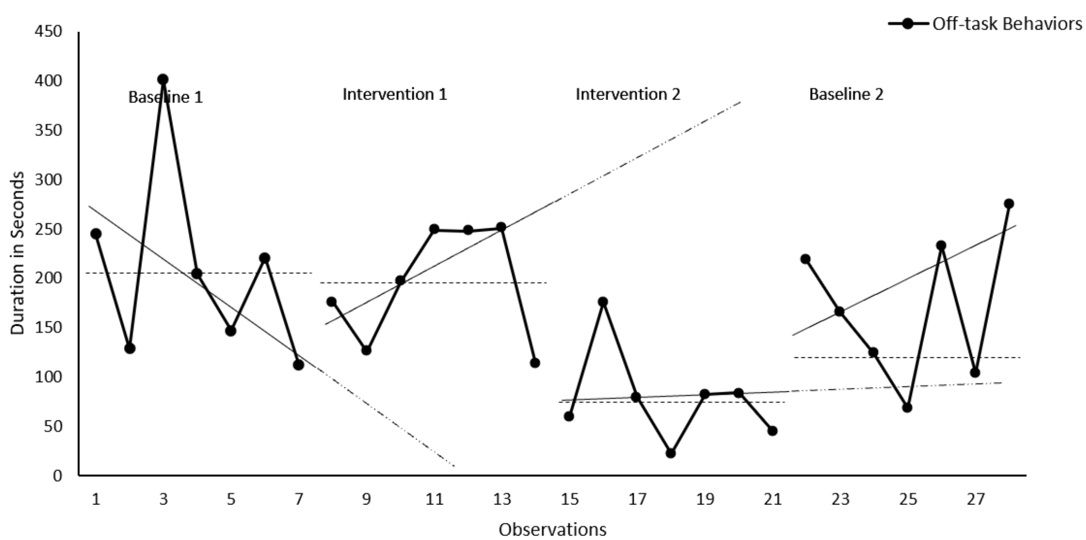

Figure 6. Participant 2 Classroom Engagement Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Participant 3

The data for Participant 3 were plotted for each target behavior and visually analyzed. Table 4 displays the means of target behaviors for each phase and binomial test results for Participant 3.

Sensory processing skills. Based on the review of each item of SP-2 Teacher Questionnaire, classroom observations, and teacher interviews, fidgeting in his seat was identified as a target behavior in the area of sensory processing skills for Participant 3. This target behavior was operationalized as a duration of tapping feet, moving a leg or a part of the leg back and forth, side to side, or up and down. Also, the duration of rotating the trunk side to side, or moving the pelvis back and forth or side to side one or more times were considered sensory seeking behaviors. The duration of the pelvis shifting back and forth or a leg movement when the participant reached for an object across the table were not considered sensory seeking behaviors.

Table 4

Participant 3 Means and Binomial Test Results

Target Behaviors	Mean A_1	Mean B	pA_1B	Mean C	pBC	Mean A_2	pCA_2
Sensory Processing Skills	291.86	274.29	.23	163.86	.01*	182.29	.01*
Psychosocial Skills	18.86	19.14	1.00	7.00	.01*	6.14	1.00
Classroom Engagement	322.71	272.29	1.00	197.00	.01*	228.29	.94

Note. *p < .10

Figure 7 shows plotted data for sensory processing skills for Participant 3. Visual analysis of the data for Participant 3 displayed high variability during all phases. The trend shifted from a decelerating trend during phase A_1 (*slope* = -0.6) to an accelerating trend during phase B (*slope* = 10.0). Also, the mean level of sensory seeking behaviors decreased only slightly from phase A_1 (M = 291.86) to B (M = 274.29), suggesting the control intervention did not have an effect on sensory seeking behaviors. However, a decrease in the mean level from phase B to C (*M* = 163.86) was considerable, and phase C (*slope* = -23.3) also showed a decelerating trend. These findings suggest sensory diets had an effect on sensory seeking behaviors for Participant 3. These findings are corroborated with a significant binomial test result for a change between phases BC (p = .01). An increase in the mean level of sensory seeking behaviors from phase C to A_2 (*M* = 182.29) was almost non-existent. However, binomial test result for a change between CA_2 (p = .01) was significant.

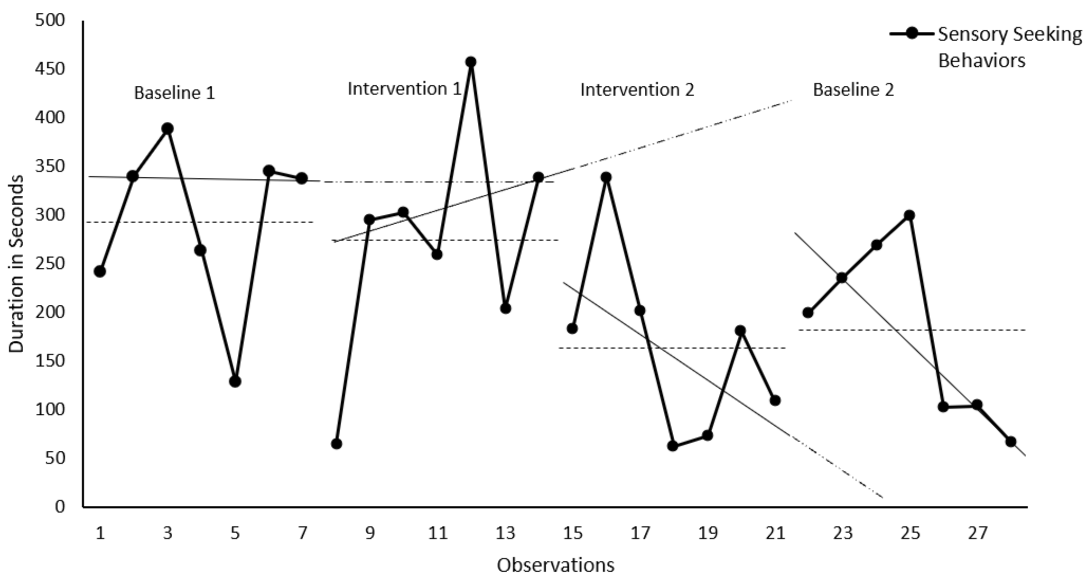

Figure 7. Participant 3 Sensory Processing Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Psychosocial skills. Based on classroom observations, teacher interviews, and review of items of the BASC-3, interruptive behavior was identified as a target behavior in the area of psychosocial skills for Participant 3. This behavior was operationalized as a frequency of looking at an aide or a child sitting next to him along with laughing, reaching out with stretched hands or leaning body towards them with an open mouth, laughing excessively without an apparent reason, and copying peers' actions.

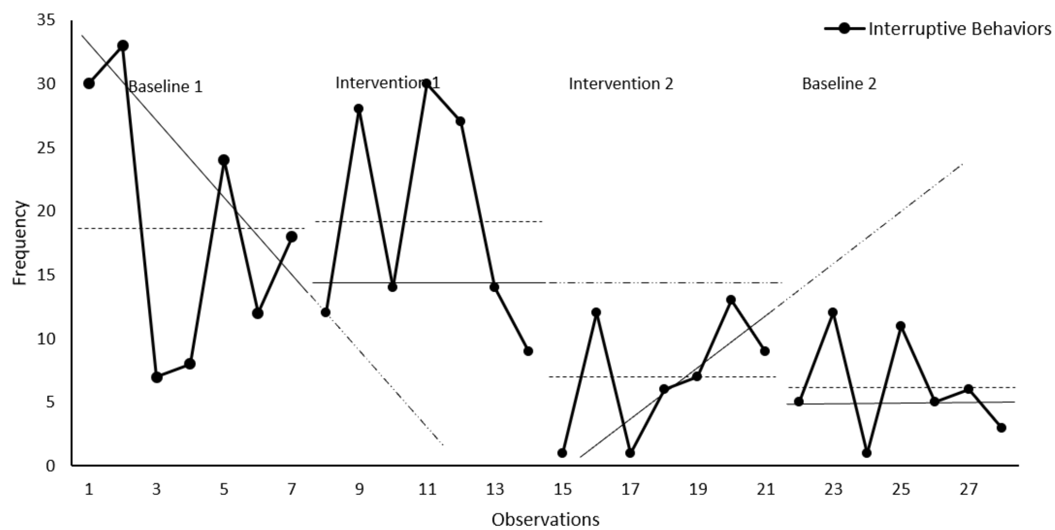

Figure 8. Participant 3 Psychosocial Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Figure 8 shows plotted data for psychosocial skills for Participant 3. An increase in the mean level of interruptive behaviors for Participant 3 from phase A_1 (M = 18.86) to B (M = 19.14) was non-existent, and the trend shifted from a decelerating trend from phase A_1 (*slope* = -3.0) to no trend during phase B (*slope* = 0.0). These findings along with a lack of significant binomial test result for a change between phases A_1B (p = 1.00) suggest control intervention did not have an effect on interruptive behaviors displayed by Participant 3. Phase C exhibited a slight accelerating trend (*slope* = 2.1). However, a considerable decrease in the mean level of interruptive behaviors from phase B to C (M = 7.00) and a significant binomial test result for a change between phases BC (p = .01) suggest sensory diets had an effect on interruptive behaviors. Phase A_2 showed no trend (*slope* = 0.0), and a change in the mean level from phase C to phase A_2 (M = 6.14) was non-existent. Also, overlapping data points between phases C and A_2 imply the effect of sensory diets lasted through the withdrawal phase.

Classroom engagement. Based on the teacher interviews and classroom observations, off-task behavior was identified as a target behavior in the area of classroom engagement. This target behavior was operationalized as the duration of looking at people or objects other than the task materials or the teacher when she was instructing and tuning himself out from the environment. Looking at others or objects in the room after completing the task was not considered off-task behavior. However, engagement in inappropriate behaviors and withdrawal from the environment when the participant was waiting for the teacher's instruction were considered off-task behaviors.

The data for Participant 3 for classroom engagement showed high variability across all phases. Figure 9 presents plotted data for classroom engagement for Participant 3. A decelerating trend was noted during phase A_1 (*slope* = -28.3). Although phases B (*slope* = 3.8) and C (*slope* = 10.0) also exhibited accelerating trends, the mean level of off-task behavior increased from phase A_1 (M = 322.71) to phase B. The mean level then decreased considerably from phase B (M = 272.29) to C (M = 197.00). Also, the binomial test result was significant for a change between phases BC (p = .01), suggesting off-task behaviors exhibited by Participant 3 responded to sensory diets.

However, Participant 3 did not show a strong withdrawal effect for off-task behaviors, which was evidenced by only a slight increase in the mean level from phase C to A_2 (M = 228.29).

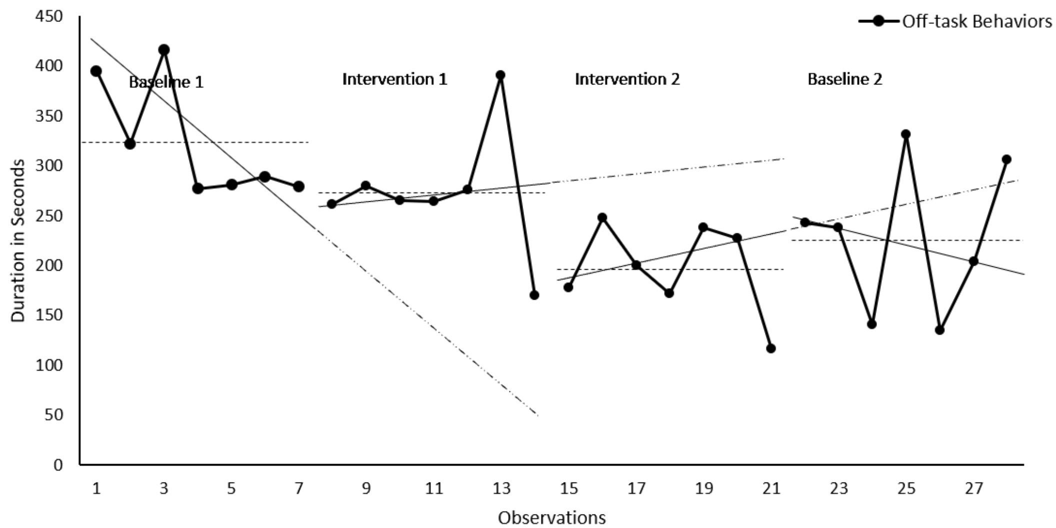

Figure 9. Participant 3 Classroom Engagement Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Participant 4

The data for Participant 4 was plotted and visually analyzed. Table 5 presents the means of target behaviors and binomial test results for Participant 4.

Sensory processing skills. Based on the review of each item of SP-2 Teacher Questionnaire classroom observations, and teacher interviews, a duration of the sensory seeking behavior of un-purposeful movement was identified as a target behavior for Participant 4. This target behavior was operationalized as a duration when the participant was tapping or moving objects without a specific purpose, rolling or sliding his face or body parts on the table, moving his hands or fingers over body parts, and pulling on body parts or clothes.

Table 5

Participant 4 Means and Binomial Test Results

Target Behaviors	Mean A_1	Mean B	pA_1B	Mean C	*p*BC	Mean A_2	pCA_2
Sensory Processing Skills	394.14	370.71	.23	236.86	.06*	249.57	.94
Psychosocial Skills	20.43	23.57	.50	14.14	.01*	25.29	.01*
Classroom Engagement	329.86	299.29	.99	212.29	0.23	296.29	.01*

Note. *$p < .10$

Figure 10 displays plotted data for sensory processing skills for Participant 4. The data for Participant 4 showed high variability during all phases. The mean level of sensory seeking behaviors decreased slightly from phase A_1 (*M* = 394.14) to B (*M* = 370.71); however, the drop was noteworthy from phase B to phase C (*M* = 236.86). A significant binomial test result for a change between phases BC ($p = .06$) and a decrease in the slope from phase B (*slope* = 35.0) to phase C (*slope* = 11.7) suggest the sensory diets had an effect on sensory seeking behaviors. The mean level slightly increased from phase C to A_2 (*M* = 249.57), possibly due to a single data point. This finding suggests that Participant 4 did not demonstrate a withdrawal effect for sensory diets.

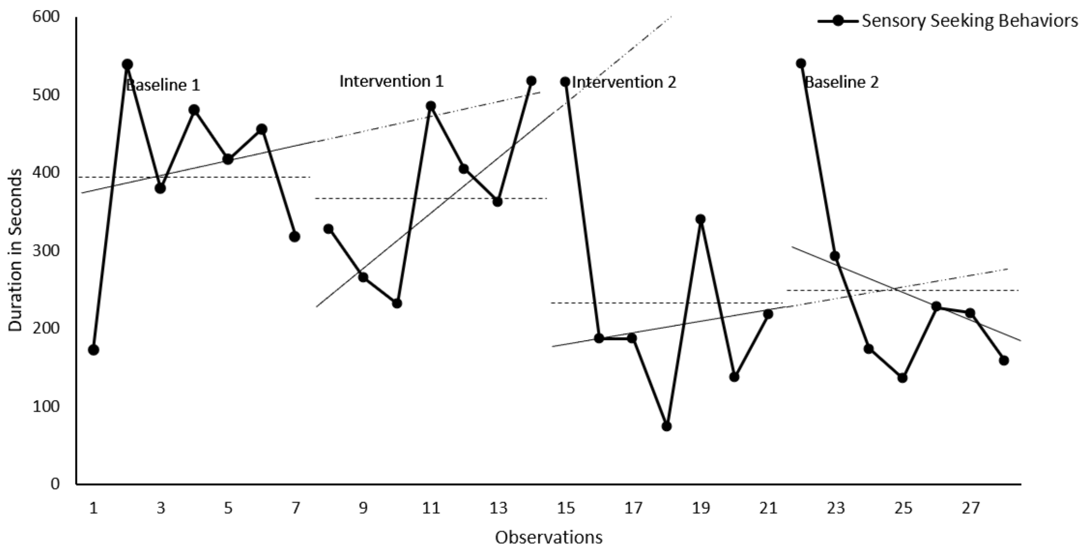

Figure 10. Participant 4 Sensory Processing Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Psychosocial skills. Based on classroom observations, teacher interviews, and review of items of the BASC-3, an interruptive behavior was identified as a target behavior in the area of psychosocial skills and operationalized as a frequency of copying child's actions, rolling or squinting eyes, laughing inappropriately, and laughing for no reason while looking at another child. Also, calling the teacher or an aide to inform them "It's lunchtime" or his actions and giving instructions to others were considered interruptive behaviors. Verbal interruptions, such as making "Shh!", hissing, or disapproval sounds; engaging in verbal arguments with the teacher or an aide; grabbing, hitting, or pushing hand movements toward the classroom aide; and staring at the aide with disapproval or anger were also considered interruptive behaviors.

The data for measured behaviors for psychosocial skills for Participant 4 showed high variability across all phases, especially during phase B. Figure 11 presents plotted data for psychosocial skills for Participant 4. The mean level of interruptive behaviors increased from phase A_1 (M = 20.43) to B (M = 23.57) with a shift from a slight decelerating trend during phase A_1 (*slope* = -0.3) to an accelerating trend during phase B (*slope* = 3.0). Phase B also showed an increase in variability of the data. The mean level then decreased from phase B to C (M = 14.14) with a change to a decelerating trend during phase C (*slope* = -1.3). These findings along with a significant binomial test result for a change between phases BC (p = .01) indicate sensory diets changed interruptive behaviors of Participant 4. A mean level increase from phase C to A_2 (M = 25.29) and a significant binomial test result for a change between phases CA_2 (p = .01) suggest Participant 4 demonstrated a strong withdrawal effect.

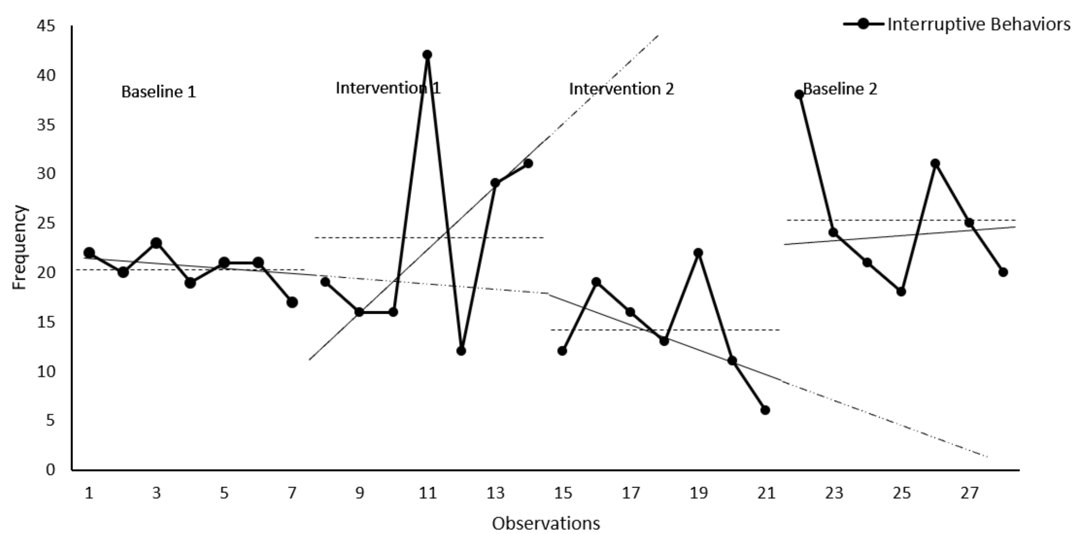

Figure 11. Participant 4 Psychosocial Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Classroom engagement. Teacher interviews and classroom observations were used to determine the target behaviors in the area of classroom engagement. Off-task behavior was identified as a target behavior for classroom engagement and operationalized as a duration of looking at people or objects other than the task materials or his teacher when she was instructing and tuning himself out from the environment. The duration between the end of an instruction to getting a utensil or performing a task and engagement in inappropriate behaviors was also included in the duration of off-task behavior. The duration after completing the task when Participant 4 looked at other objects or students while waiting for the teacher's instructions was excluded from the duration of off-task behavior.

Data for Participant 4 for classroom engagement showed high variability during all phases. Figure 12 presents plotted data for classroom engagement for Participant 4. The mean level of off-task behaviors decreased from phase A_1 (M = 329.86) to B (M = 299.29). A continued decrease in the mean level from phase B to C (M = 212.29) and a sharp change in the rate of deceleration trend from phase B (*slope* = -1.0) to phase C (*slope* = -35.0) suggest sensory diets had a positive effect on off-task behaviors exhibited by Participant 4. However, data variability and multiple overlapping data points across all phases obscure the effect of sensory diets. A mean level increase from phase C to A_2 (M = 296.29) and a significant binomial test result for a change between phases CA_2 (p = .01) imply participant showed a possible withdrawal effect to sensory diets.

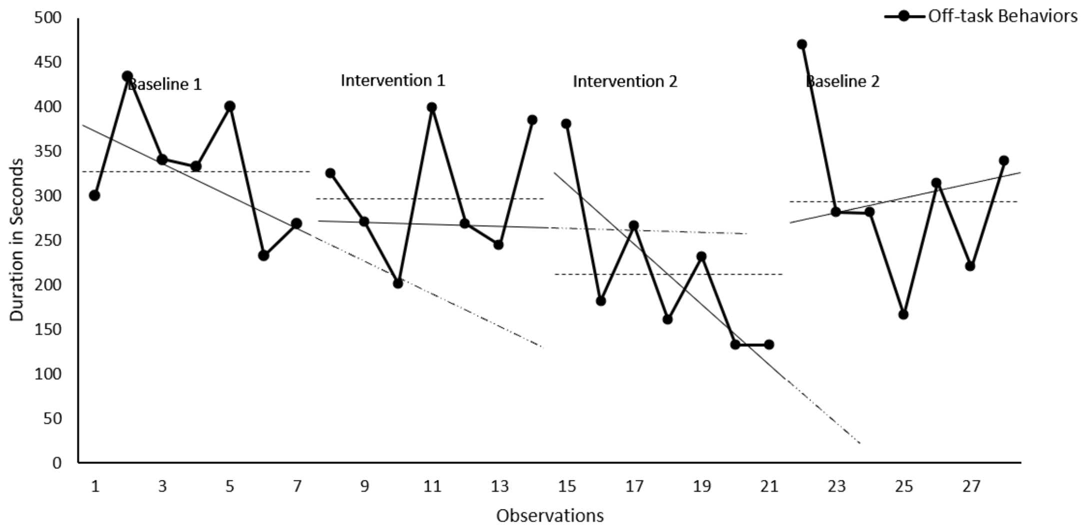

Figure 12. Participant 4 Classroom Engagement Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Participant 5

The data for Participant 5 was plotted for each phase and visually analyzed.

Table 6 details the means of target behaviors and binomial test results.

Table 6

Participant 5 Means and Binomial Test Results

Target Behaviors	Mean A_1	Mean B	pA_1B	Mean C	pBC	Mean A_2	pCA_2
Sensory Processing Skills	318.14	219.57	.50	316.57	.01*	316.43	.23
Psychosocial Skills	44.14	38.57	.23	24.29	.01*	35.57	.01*
Classroom Engagement	278.43	237.00	.77	149.86	.01*	305.86	.01*

Note. $*p < .10$

Sensory processing skills. Based on the review of each item of SP-2 Teacher Questionnaire, classroom observations, and teacher interviews, the sensory seeking behavior of fidgeting in his seat was identified as a target behavior for Participant 5 for sensory processing skills. This target behavior was operationalized as a duration of moving legs or part of a leg up and down, side to side, back and forth, moving the trunk back and forth or side to side, or moving a chair forward or backward more than one time.

Figure 13 presents plotted data for Participant 5 for sensory processing skills. The data for Participant 5 for sensory seeking behaviors showed high variability during all phases. The mean level of sensory seeking behaviors decreased from phase A_1 (*M* = 318.14) to B (*M* = 219.57) with a shift to an accelerating trend during phase B (*slope* = 36.0). A single outlier during phase A_1 may have led to change in the mean level from phase A_1 to B. The mean level then increased from phase B to C (*M* = 316.57) and showed no change from phase C to A_2 (*M* = 316.43). The trend also changed from an accelerating trend from phase B to a decelerating trend during phase C (*slope* = -16.0). The binomial test result was significant for a change in phases BC (p = .01). However, high variability in the data, the presence of outliers in both phases B and C, and the lack of level change during the withdrawal phase indicate the control intervention and sensory diets did not have an effect on sensory seeking behaviors.

Psychosocial skills. For Participant 5, the interruptive behavior was identified as a target behavior in the area of psychosocial skills. This target behavior operationalized as a frequency of clapping, self-talking, and using expressions, such as “Ok!”, “Sigh!”, “Woo hoo!”, “Woo!”, “Aah!”, “Oh yeah!”, “I am done.”, “That’s it!”, and “What?”. In addition, the frequency of answering when Participant 5 was not called by the teacher, repeatedly calling to the teacher or an aide to check his work or receive reassurance, repeating his teacher’s part of the sentence or the entire sentence, and calling his teacher or a classroom aide to inform them of his actions were included in the interruptive behaviors. The incidences of instructing peers and purposefully dropping objects on the floor were also considered as interruptive behaviors.

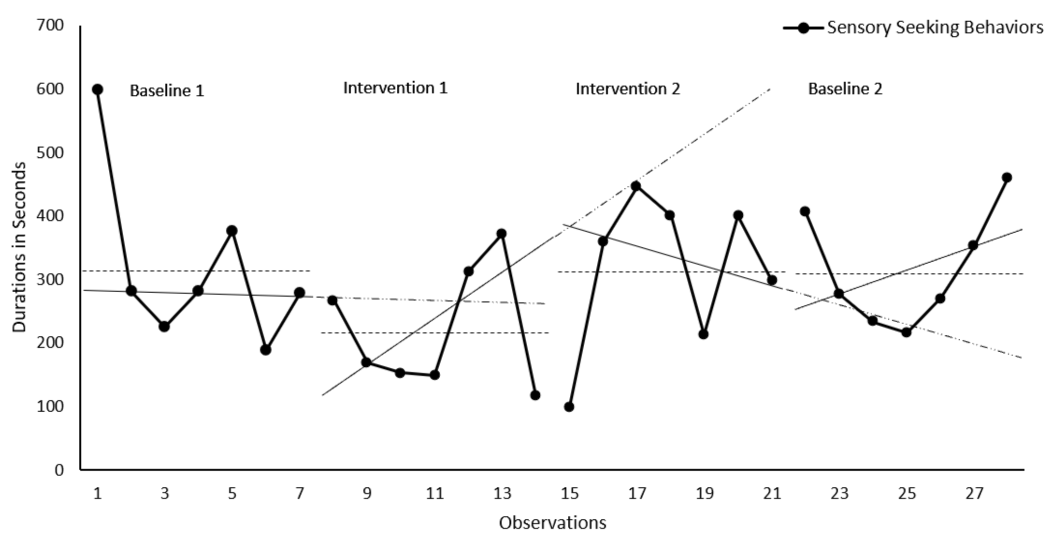

Figure 13. Participant 5 Sensory Processing Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Figure 14 displays plotted data for psychosocial skills for Participant 5. Visual analysis showed high variability in data for measured outcomes for psychosocial skills across all phases. The mean level of interruptive behaviors decreased slightly from phase A_1 (M = 44.14) to B (M = 38.57). The level then decreased from phase B to phase C (M = 24.29). The change from an accelerating trend during phase B (*slope* = 1.6) to a decelerating trend during phase C (*slope* = -4.0) and the significant binomial result for phases BC (p = .01) suggest interruptive behaviors presented by Participant 5 changed with sensory diets. Additionally, an increase in the mean level from the C to A_2 (M = 35.57) and a significant binomial test result for a change between a change between phases CA_2 (p = .01) suggest Participant 5 exhibited a withdrawal effect. However, the variability in the data and multiple overlapping data points obscure the withdrawal effect.

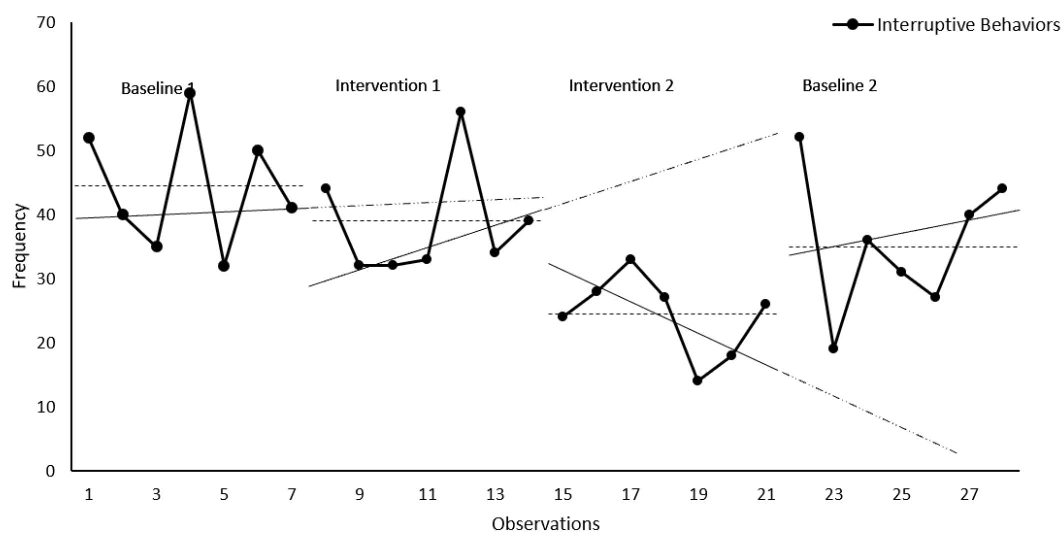

Figure 14. Participant 5 Psychosocial Skills Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Classroom engagement. Teacher interviews and classroom observations were used to determine the target behaviors in the area of classroom engagement. Off-task behavior was identified as a target behavior in the area of classroom engagement. This behavior was operationalized as the duration during which the participant was looking at people or objects other than the task materials or his teacher when she was instructing and the duration of tuning himself out from the environment. The duration between the end of an instruction to getting a utensil or performing a task and engagement in inappropriate behaviors were included in the off-task behaviors. The duration after completing the task when the participant looked at other objects or students while waiting for teacher's instructions was not considered as off-task behaviors. Figure 15 presents plotted data for classroom engagement for Participant 5.

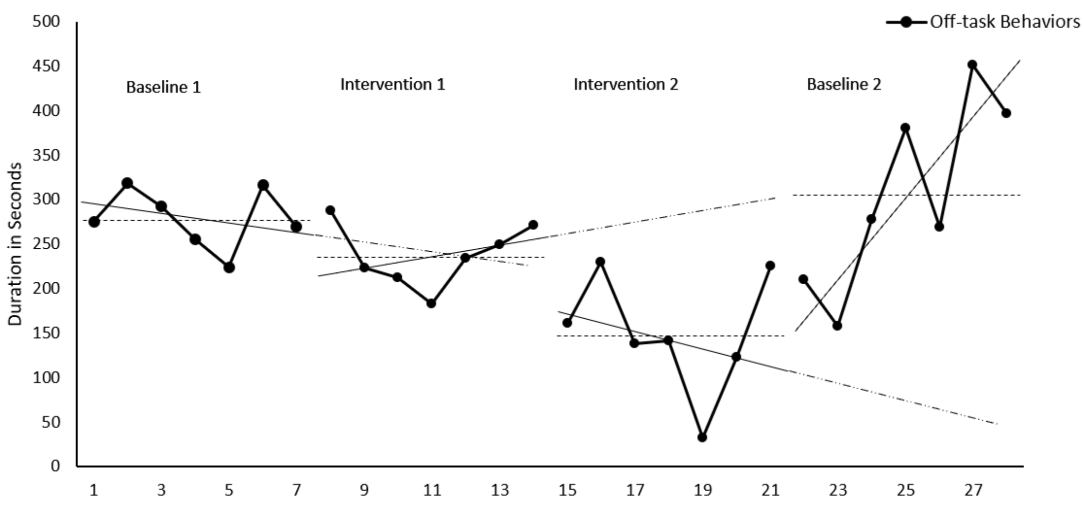

Figure 15. Participant 5 Classroom Engagement Data. Dotted lines represent mean lines, solid lines indicate celeration lines, and dot-dash lines denote extended celeration lines.

Data for Participant 5 for off-task behaviors showed high variability across all phases with a relatively lower variability during phase B. The mean level of off-task behavior decreased from phase A_1 (M = 278.43) to B (M = 237.00). However, the trend changed from a decelerating trend during phase A_1 (*slope* = -5.0) to an accelerating trend during phase B (*slope* = 6.5). The mean level of off-task behaviors continued to decrease from phase B to C (*M* = 149.86) with a shift to a decelerating trend (*slope* = -18.0). These findings along with the significant binomial test result for a change between phases BC (*p* = .01) suggest sensory diets had a positive effect on off-task behaviors. An increase in the mean level from phase C to A_2 (*M* =305.86) upon the withdrawal of sensory diets, an accelerating trend during phase A_2 (*slope* = 46.0), and a significant binomial test result for a change between phases CA_2 (*p* = .01) imply Participant 5 showed an increase in off-task behaviors upon withdrawal of sensory diets.

Summary

In summary, visual analysis of the plotted data for all three target behaviors suggests all participants responded to sensory diets. However, the control intervention did not show an effect on target behaviors. Results of visual analysis with reference to each hypothesis are summarized below.

Hypothesis 1. Hypothesis 1 stated that sensory diets change children's sensory processing skills. Sensory seeking behaviors were used as the outcome measures in the area of sensory processing skills. All participants showed a positive change in the outcome measures for sensory processing skills. Four participants displayed favorable changes in slopes of celeration lines and changes in the mean levels from control intervention to sensory diets intervention phases. Also, binomial test results between control intervention and sensory diet intervention phases were significant for three participants. Two participants demonstrated a notable increase and one participant presented a slight increase in the mean levels of the measured outcomes for sensory processing skills upon the withdrawal of sensory diets. Binomial test results between sensory diets intervention phases and second baseline phases were significant for four participants. The results of the study show sensory diets positively changed four participants' measured outcomes for sensory processing skills. Therefore, Hypothesis 1 is accepted.

Hypothesis 2. For the effect of the control intervention, the mean levels of the sensory seeking behaviors for all participants displayed little to no change from a baseline to control intervention phase. Additionally, changes in slopes of the celeration lines were unfavorable. Only one participant showed a significant binomial result between a baseline and control intervention phase. However, a decrease in the mean level from the baseline to the control intervention phase for this participant was very small. Hypothesis 2 stated that a control intervention has no effect on children's sensory processing skills. The results suggest that control interventions did not show statistically significant or consistent changes in sensory processing skills for most participants. Therefore, Hypothesis 2 is accepted.

Hypothesis 3. This hypothesis stated that sensory diets change children's psychosocial skills. Maladaptive behaviors were used as the outcome measures in this area. Measured outcomes for psychosocial skills for all participants responded positively to sensory diets. All participants displayed favorable changes in the mean levels and four participants showed favorable changes in slopes of the celeration lines from control intervention to sensory diets intervention phases. Binomial test results between control intervention and sensory diets intervention phases were significant for all participants. Furthermore, the binomial test results between the sensory diets intervention and baseline phases were significant for three participants. Only Participant 3 did not demonstrate a considerable increase in inappropriate behaviors upon the withdrawal of sensory diets. Based on these findings, Hypothesis 3 is accepted.

Hypothesis 4. The results imply that mean levels of the measured outcomes for psychosocial skills for all participants either slightly increased from baseline to control intervention phases or remained the same. Also, slopes of the celeration lines exhibited unfavorable changes for four participants. Only one participant showed a statistically significant change in behaviors between the baseline and control intervention phase. However, the mean level of behaviors for this participant increased from the baseline to control intervention phase. Therefore, Hypothesis 4 that stated that a control intervention has no effect on children's psychosocial skills is accepted.

Hypothesis 5. This hypothesis stated that sensory diets change children's classroom engagement. Off-task behaviors were used as the outcome measures in this area. Measured outcomes for classroom engagement responded positively to sensory diets. All participants showed a notable decrease in the mean levels from control intervention to sensory diets intervention phases. Two participants exhibited a clear increase in the mean levels of the off-task behaviors upon the withdrawal of sensory diets. Two participants showed a possible withdrawal effect and one participant did not show any withdrawal effect. Binomial test results between control intervention and sensory diets intervention phases were significant for three participants. Similarly, binomial test results between the sensory diets intervention and second baseline phases were significant for all participants. Based on these results, Hypothesis 5 is accepted.

Hypothesis 6. All participants showed little to no decrease in the mean levels of the measured outcomes for classroom engagement. Four participants exhibited unfavorable changes in slopes of the celeration lines. Only one participant presented a significant binomial test result between a baseline and control intervention phase. However, the trend for this participant shifted from a decelerating trend during the baseline phase to an accelerating trend during the control intervention phase. Based on these findings the control intervention did not have an effect on outcome measures related to classroom engagement. Hypothesis 6 stated that a control intervention has no effect on children's classroom engagement. Therefore, Hypothesis 6 is accepted.

CHAPTER V

DISCUSSION

The purpose of this study was to investigate the effects of sensory diets on children's sensory processing skills, psychosocial skills, and classroom engagement. This study was based on a hypothesis that sensory diets change children's sensory processing skills, psychosocial skills, and classroom engagement. In addition, the study was also based on a hypothesis that the control intervention composed of fine motor and visual motor activities has no effect on children's sensory processing skills, psychosocial skills, and classroom engagement.

The results of show that sensory diets positively changed target behaviors in the areas of sensory processing skills (sensory seeking behaviors), psychosocial skills (maladaptive behaviors), and classroom engagement (off-task behaviors). The findings suggest that the control intervention had no effect on these target behaviors. Also, participants showed differences in their responses to the withdrawal of sensory diets.

Sensory diets positively changed all three target behaviors for all participants with the exception of Participant 5. Participant 5 exhibited positive changes only on target behaviors related to psychosocial skills and classroom engagement. Participant 2 showed a robust response to sensory diets. Also, target behaviors for all participants in the areas of psychosocial and classroom engagement displayed stronger responses to sensory diets. Participants showed variations in their responses to the withdrawal of sensory diets. None of the target behaviors for Participant 3 demonstrated a withdrawal response upon the removal of sensory diets. On the other hand, all target behaviors for Participant 1 showed withdrawal responses upon the removal of sensory diets. The variations in withdrawal responses suggest participants exhibited individualized responses to sensory diets.

All participants positively responded to sensory diets, even though they were recruited from three different classrooms, which suggests classroom environment related factor did not change target behaviors. The control intervention was used to determine the possible effect of interactions of the PI with participants. The results of the study suggest that these interactions did not have an effect on target behaviors in the areas of sensory processing skills, psychosocial skills, and classroom engagement. Variations in responses upon the withdrawal of sensory diets suggest that children's responses to sensory diets remain highly individualized. The findings of the study suggest that sensory diets brought positive changes in these children's measured outcomes for sensory processing skills, psychosocial skills, and classroom engagement.

The lack of response demonstrated by Participant 5 on sensory seeking behaviors suggests that sensory diets did not adequately meet the sensory needs of Participant 5. Sensory diets should be monitored and revised to ensure that they meet the individual's need in terms of duration, timing, and intensity of the stimuli (Wilbarger, 1995). The PI may have failed to develop effective sensory diets or revise sensory diets to meet the sensory needs of Participant 5; therefore, he may not have responded to sensory diets in this study. Participant 5 was the oldest participant in the study and may have needed a longer duration of each sensory diet session or external factors may have masked the effect of sensory diets.

Significance of the Results

The literature review showed that very few studies evaluated the effect of sensory diets or interventions similar to sensory diets (Watling & Hauer, 2015). Also, the results of these studies were mixed (Case-Smith et al., 2015; May-Benson & Koomar, 2010; Watling & Hauer, 2015). However, approximately 90% of school occupational therapists use sensory diets or similar interventions to manage manifestations of SPD (May-Benson & Koomar, 2010). The results of this study add evidence supporting the use of sensory diets to the evidence-base. The results are also significant as the current healthcare environment calls for evidence-based interventions (AOTA, 2018).

The results are consistent with the study conducted by Fazlioğlu and Baran (2008) that investigated the effect of a sensory intervention similar to sensory diets. Their study found statistically significant improvements in 5 out of 13 target behaviors in response to a sensory intervention. The target behaviors, aversion to touch, social communication, orientation to sound, stereotypical behaviors, and off-task behaviors, showed statistically significant improvements. Similarly, the findings of the study are consistent with the study by Lopez and Swinth (2008) that reported statistically significant improvements in 66% of participants, who exhibited aggressive behaviors.

They investigated the effect of a group proprioceptive program on aggressive behaviors exhibited by children with emotional disabilities and SPD. The results of this study are also similar to the finding of the study by Lin et al. (2012) that found significant improvements in the activity level and foot swinging behaviors exhibited by children with SPD in response to sensory activities. The findings of this study contradict the findings of the study by Devlin et al. (2011) that compared the effect of behavioral intervention with sensory diets in children with autism. Devlin et al.,'s study did not find improvements in aggressive behaviors exhibited by participants with sensory diets. However, behavioral intervention was provided for six hours and sensory diets for 15 minutes, six times per day.

The findings are consistent with the results of a pilot study by Pingale et al. (Submitted) that found improvements in target behaviors of participants with SPD in the areas of sensory processing skills, psychosocial skills, and classroom engagement. Unlike the findings of the pilot study, all participants showed a stronger response to target behaviors for psychosocial skills and classroom engagement. Unlike the pilot study, some participants in this study also showed a withdrawal effect, suggesting that the length of the sensory diet intervention required for bringing out lasting changes in sensory processing skills, psychosocial skills, and classroom engagement remains highly individualized.

Discrepancies seen in the results of the past studies and the findings of this study can be attributed to variations in the conceptualization of sensory diets or sensory strategies. Sensory diets or sensory strategies used in the past studies varied in the dosage. Frequencies of interventions used in the past studies ranged from six times per day (Devlin et al., 2011), one time per day (Lin, et al., 2012; Lopez & Swinth, 2008) to two times per week (Fazlioğlu & Baran, 2008). Durations of interventions ranged from five minutes (Lopez & Swinth, 2008), 15 minutes (Devlin et al., 2011), 45 minutes (Fazlioğlu & Baran, 2008) to two hours (Lin, et al., 2012). Activities selected as sensory diets or sensory strategies were not individualized to meet the needs of the participants. Sensory activities used in the past studies varied from a predetermined set of five activities (Devlin et al., 2011; Lopez & Swinth, 2008) that were administered each day to a predetermined set of 68 activities that were gradually introduced over the length of the study (Fazlioğlu & Baran, 2008).

Consistency in the conceptualization of intervention is necessary for determining the dosage (Hunt, Peterson, & White, 2017). The frequency and duration of the intervention are crucial for the effectiveness of the intervention. Sensory diets are conceptualized differently and misconstrued by occupational therapists, caregivers, and clients (Hunt et al., 2017). Since sensory diets in this study were developed based on the framework for sensory diets (Wilbarger, 1995), which can help to reduce misconceptions about sensory diets and help practitioners and researchers to develop effective sensory diets.

Mixed or inconclusive evidence observed in studies that investigated the effect of interventions similar to sensory diets has been attributed to not using sensitive outcome measures (Case-Smith et al., 2015; May-Benson & Koomar, 2010; Watling & Hauer, 2015). Sensitive outcome measures are essential to detect changes and determine the effect of the interventions (Schaaf et al., 2014). Outcome measures used in these studies were not individualized for participants, and therefore, may not have been sensitive to detect changes in response to interventions (May-Benson & Koomar, 2010). Devlin et al. (2011) and Lopez and Swinth (2008) used only one target behavior, while Fazlioğlu and Baran (2008) established a set of thirteen target behaviors as an outcome measure. Target behaviors used in this study were individualized for each participant by reviewing SP-2 Teacher Questionnaire items (Dunn, 2015), BASC-3 scale items (Reynolds et al., 2015), and information collected from classroom observations and teacher interviews. The target behaviors also took into account the effect of contextual factors on the manifestations of sensory processing issues. Therefore, the target behaviors used in this study were a cluster of behaviors for each target behavior rather than just one behavior. The fact that this study was able to document changes induced by sensory diets suggests that future studies should consider choosing outcome measures that take into account individual variations in representations of SPD, changing contextual factors, and the effect of contextual factors on the manifestations of SPD.

Rationale for Sensory Diets

The results of the study are consistent with the assumption that sensory diets provide children sensorimotor experiences that meet their sensory needs and facilitate their participation in daily activities (Wilbarger & Wilbarger, 2002). Sensorimotor experiences that the sensory diets provided may have met the participants' sensory needs, and thereby, may have improved their target behaviors related to sensory processing skills (sensory seeking behaviors). These sensorimotor experiences may have helped participants produce appropriate adaptive responses and participate in daily occupations as evidenced by positive changes in target behaviors related to psychosocial skills (maladaptive behaviors) and classroom engagement (off-task behaviors).

Occupational Adaptation Theory

Understanding the desire for mastery and press from the environment is crucial for producing appropriate occupational responses for successful participation in occupations (Schkade & Schultz, 1992). Intact sensory processing mechanisms are necessary for forming an accurate representation of the self and the environment, which is a basis for generating appropriate occupational responses (Dunn, 2007). The results suggest that sensorimotor experiences provided by sensory diets may have helped participants to understand their desire for mastery as evidenced by increased participation in classroom group and the press from the environment. A decline in maladaptive behaviors for all participants suggests that participants may have produced occupational responses consisting of mature adaptive response behaviors when they faced occupational challenges during classroom group activities. Improvements in target behaviors related to sensory processing skills and psychosocial skills in response to sensory diets indicate that sensory diets may have decreased the overuse of psychosocial and sensorimotor components and increased the use of a cognitive component of the adaptive gestalt. Sensory diets may have led to improvements in the ability of participants to use balanced adaptive gestalt when producing occupational responses during classroom group activities. A decline in off-task behaviors suggests that participants may have used mixed or new adaptive response modes during classroom group activities. Withdrawal responses seen in some of the participants upon the removal of sensory diets suggest that some participants may not have experienced occupational adaptation and as a result, they may have reverted to using primitive adaptive behaviors, stable adaptive modes, and unbalanced adaptive gestalt (Schkade & Schultz, 1992; Schultz & Schkade, 1992).

The findings of the study suggest that sensory diets, as readiness activities, can improve children's interactions with the environment and help them overcome occupational challenges during classroom activities by facilitating the use of mature occupational behaviors, new adaptive response modes, and the balanced adaptive gestalt. As a result, sensory diets may provide children with increased opportunities for experiencing relative mastery and occupational adaptation. Consequently, sensory diets may facilitate increased participation in classroom activities and the acquisition of new skills.

Limitations

Attempts were made to minimize the effect of contextual factors. However, staff absences may have influenced the classroom dynamics and therefore, influenced the results of the study. Similarly, variations in activities may have influenced the results of the study. Activity components, such as the ease of activities, attentional and motor demands of activities, and participants' preferences for activities may have influenced the engagement of participants in classroom group activities each day. High variability in the data may have also influenced the results of this study.

Considering the participants were recruited from three different classrooms and all participants responded to sensory diets suggests that sensory diets caused changes in the target behaviors. Additionally, the study period was considered uneventful and lacked any major changes in the school calendar or the school environment. The control intervention was used to determine the possible effect of the PI and participant interactions. The results indicate that the PI and participant interactions did not have an effect on target behaviors in the areas of sensory processing skills, psychosocial skills, and classroom engagement.

Evidence from single-subject studies is lower on the evidence hierarchy (Law & MacDermid, 2008). However, a single-subject study with strong internal validity can be a source of good evidence. Systematic reviews and meta-analyses of single-subject studies can be used to synthesize evidence on interventions used in clinical conditions that show large variations in symptoms. Using a control intervention, second baseline, 5-7 data points per phase, and a statistical analysis to support the visual analysis increases the internal validity of single-subject studies (Johnston & Smith 2010). This study consisted of the control intervention, second baseline phase, and the recommended number of data points per phase. The binomial test was conducted to support the results of the visual analysis. The use of alternating treatment design, recommended phase length, second baseline phase, and statistical analysis used in this study boost the internal validity of the study. Clear intervention protocol and a process to identify target behaviors in this study also strengthen the external validity of this study. Moreover, participants were recruited from three different classrooms, and all participants in this study showed a positive response to sensory diets. This finding suggests that the methodology used for developing sensory diets and target behaviors in this study can be replicated to develop sensory diets in other settings.

Another limitation of the study was that the PI delivered sensory diets and also documented frequencies and durations of target behaviors, which may have led to bias. Attempts were made to reduce bias by watching video clips in a random order. Second observers reviewed at least 20% of video clips for each participant and continued to review additional videos until the ICC of > .90 was observed for six consecutive video clips. Second observers were occupational therapy graduate students. Their lack of clinical experience may have influenced the reliability of the data.

The final limitation of the study is that research team members reviewed only 39 video clips. Rigorous procedures were used to collect the data from the video clips. The

PI reviewed video clips in a random order. Video clips used for establishing interrater agreement were also selected randomly. Research team members continued to review video clips until excellent interrater agreement (≥ .90) was achieved for six consecutive video clips. These procedures boost the rigor of the collected data.

Clinical Implications

The study shows that sensory diets may have a role in managing SPD and facilitating the participation of children with SPD in classroom activities. Sensory diets can be used as readiness activities under Occupational Adaptation theory. As readiness activities, sensory diets can facilitate children to use mature adaptive behaviors, new adaptive modes, and balanced adaptive gestalt. Sensory diets can facilitate occupational adaptation by providing children with SPD opportunities for successful interactions with the environment and opportunities for experiencing relative mastery. Hence, sensory diets can facilitate increased participation in school activities and the acquisition of new skills.

A framework for developing sensory diets was used to construct sensory diets in this study (Wilbarger & Wilbarger, 2002). This intervention can be replicated in clinical settings. It should be noted that the effectiveness of sensory diets depends upon meeting the individual's sensory needs. Sensory diets should be constructed with attention to timing, intensity, duration, and type of sensory stimuli (Wilbarger & Wilbarger, 2002). Sensory diets should be monitored and revised to ensure sensorimotor experiences continue to meet the individual's ongoing sensory needs.

Future Directions

In school settings, teachers or classroom aides administer sensory diets. Sensory diets in this study were delivered by an occupational therapist. Future research should investigate the effect of sensory diets delivered by the other school staff. The researchers should also consider developing clear guidelines for implementing, monitoring, and revising sensory diets in school settings to ensure the rigor of the intervention.

Sensory diets caused a significant reduction in sensory seeking behaviors, maladaptive behaviors, and off-task behaviors. However, these behaviors were not extinguished. The acceptance of interventions is dependent on measurable and visible improvements. Future studies should also focus on determining the dosage of sensory diets needed to extinguish behaviors interfering with children's participation in occupations. Also, future studies should consider controlling classroom group activities and the delivery of these activities for consistency and revising the phase length of baseline and intervention phases to establish stability in the data.

Assessing and demonstrating the effectiveness of sensory diets and other SBIs in clinical settings is crucial (AOTA, 2018). Considering the variations in the manifestations of sensory processing issues, a criterion-referenced assessment is needed to document changes induced by SBIs. Therefore, future studies should consider developing criterion-referenced assessments to help clinicians document progress effectively.

REFERENCES

Achenbach, T., & Rescorla, L. (2013). Achenbach system of empirically based assessment. In *Encyclopedia of autism spectrum disorders* (pp. 31-39). New York, NY: Springer Publishing.

Ahn, R. R., Miller, L. J., Milberger, S., & McIntosh, D. N. (2004). Prevalence of parents' perceptions of sensory processing disorders among kindergarten children. *American Journal of Occupational Therapy, 58*(3), 287-293. doi: 10.5014/ajot.58.3.287

American Occupational Therapy Association. (2014). *Occupational therapy practice framework: Domain & process* (3rd Ed). Bethesda, MD: AOTA Press, Inc.

American Occupational Therapy Association. (2015). *Occupational therapy fact sheet.* Retrieved from: http://www.aota.org/-/media/corporate/files/advocacy/hill-day 12/hill-day-ot-fact-sheet.pdf

American Occupational Therapy Association. (2018). American Occupational Therapy Association Joins Choosing Wisely Campaign. *SIS Quarterly Practice Connections*, *3*(3), 4–5.

Amitay, S., Ahissar, M., & Nelken, I. (2002). Auditory processing deficits in reading disabled adults. *Journal of the Association for Research in Otolaryngology, 3*(3), 302-320. doi: 10.1007/s101620010093

Ashburner, J., Ziviani, J., & Rodger, S. (2008). Sensory processing and classroom emotional, behavioral, and educational outcomes in children with autism spectrum disorder. *American Journal of Occupational Therapy, 62*(5), 564-573. doi: 10.5014/ajot.62.5.564

Ayres, A. J. (1972). *Sensory integration and learning disorders*. Torrance, CA: Western Psychological Services.

Bar-Shalita, T., Vatine, J., & Parush, S. (2008). Sensory modulation disorder: A risk factor for participation in daily life activities. *Developmental Medicine & Child Neurology, 50*(12), 932-937. Doi: 10.1111/j.1469-8749.2008.03095.x

Baranek, G. T., Watson, L. R., Boyd, B. A., Poe, M. D., David, F. J., & McGuire, L. (2013). Hyporesponsiveness to social and nonsocial sensory stimuli in children with autism, children with developmental delays, and typically developing children. *Development and Psychopathology, 25*(2), 307-320. doi: 10.1017/S0954579412001071

Barton, E. E., Reichow, B., Schnitz, A., Smith, I. C., & Sherlock, D. (2015). A systematic review of sensory-based treatments for children with disabilities. *Research in Developmental Disabilities*, *37*, 64-80.

Ben-Sasson, A., Carter, A., & Briggs-Gowan, M. (2009). Sensory over-responsivity in elementary school: Prevalence and social-emotional correlates. *Journal of Abnormal Child Psychology, 37*(5), 705-716. doi: 10.1007/s10802-008-9295-8

Benson, J. D., Nicka, M. N., & Stern, P. (2006). How does a child with sensory processing problems play? *Internet Journal of Allied Health Sciences and Practice, 4*(4), 4.

Bodison, S. C. (2018). A comprehensive framework to embed sensory interventions within occupational therapy practice. *SIS Quarterly Practice Connections*, 3(2), 14–16.

Boets, B., Wouters, J., Van Wieringen, A., De Smedt, B., & Ghesquiere, P. (2008). Modelling relations between sensory processing, speech perception, orthographic and phonological ability, and literacy achievement. *Brain and Language, 106*(1), 29-40. doi: 10.1016/j.bandl.2007.12.004

Brandwein, A. B., Foxe, J. J., Butler, J. S., Russo, N. N., Altschuler, T. S., Gomes, H., & Molholm, S. (2012). The development of multisensory integration in high-functioning autism: high-density electrical mapping and psychophysical measures reveal impairments in the processing of audiovisual inputs. *Cerebral Cortex*, *23*(6), 1329-1341.

Brett-Green, B. A., Miller, L. J., Schoen, S. A., & Nielsen, D. M. (2010). An exploratory event-related potential study of multisensory integration in sensory over-responsive children. *Brain Research, 1321*, 67-77. Doi: 10.5014/ajot.2010.09077

Brown, N. B., & Dunn, W. (2010). Relationship between context and sensory processing in children with autism. *American Journal of Occupational Therapy, 64*(3), 474-483.

Byiers, B. J., Reichle, J., & Symons, F. J. (2012). Single-subject experimental design for evidence-based practice. *American Journal of Speech-Language Pathology, 21*(4), 397-414.

Case-Smith, J., & Holland, T. (2009). Making decisions about service delivery in early childhood programs. *Language, Speech, and Hearing Services in Schools, 40*(4), 416-423.

Case-Smith, J., Weaver, L. L., & Fristad, M. A. (2015). A systematic review of sensory processing interventions for children with autism spectrum disorders. *Autism: The International Journal of Research and Practice, 19*(2), 133-148. doi: 10.1177/1362361313517762

Chandler, B. E., & Clark, G. F. (2013). *Best practices for occupational therapy in schools.* Bethesda, MD: AOTA Press, Inc.

Conners, C. K. (2001). *Conners' rating scales--revised: CRS-R* Multi-Health Systems North Tonawanda, NJ.

Cosbey, J., Johnston, S., S., & Dunn, M., L. (2010). Sensory processing disorders and social participation. *American Journal of Occupational Therapy, 64*(3), 462-473. doi:10.5014/ajot.2010.09076

Cosbey, J., Johnston, S., S., Dunn, M., L., & Bauman, M. (2012). Playground behaviors of children with and without sensory processing disorders. *OTJR: Occupation, Participation & Health, 32*(2), 39-47. doi:10.3928/15394492-20110930-01

Coster, W., Deeney, T., Haltiwanger, J., & Haley, S. (1998). *School Function Assessment (SFA)*. San Antonio, Texas: Psychological Corporation.

Dar, R., Kahn, D. T., & Carmeli, R. (2012). The relationship between sensory processing, childhood rituals and obsessive–compulsive symptoms. *Journal of Behavior Therapy and Experimental Psychiatry, 43*(1), 679-684.

Davies, P. L., Chang, W., & Gavin, W. J. (2009). Maturation of sensory gating performance in children with and without sensory processing disorders. *International Journal of Psychophysiology, 72*(2), 187-197. doi: 10.1016/j.ijpsycho.2008.12.007

Davies, P. L., & Gavin, W. J. (2007). Validating the diagnosis of sensory processing disorders using EEG technology. *American Journal of Occupational Therapy, 61*(2), 176-189. doi: 10.5014/ajot.61.2.176

DeSantis, A., Harkins, D., Tronick, E., Kaplan, E., & Beeghly, M. (2011). Exploring an integrative model of infant behavior: What is the relationship among temperament, sensory processing, and neurobehavioral measures? *Infant Behavior and Development, 34*(2), 280-292. doi: 10.1016/j.infbeh.2011.01.003

Devlin, S., Healy, O., Leader, G., & Hughes, B. M. (2011). Comparison of behavioral intervention and sensory-integration therapy in the treatment of challenging behavior. *Journal of Autism and Developmental Disorders, 41*(10), 1303-1320. doi: 10.1007/s10803-010-1149-x

Dunn, W. (1999). *Sensory Profile: User's manual*. San Antonio, TX: Psychological Corporation.

Dunn, W. (2007). Supporting children to participate successfully in everyday life by using sensory processing knowledge. *Infants & Young Children, 20*(2), 84-101.

Dunn, W. (2008). Sensory processing: Identifying patterns and support strategies. *Learners on the Autism Spectrum: Preparing Highly Qualified Educators,* 138-159.

Dunn, W. (2015). *Sensory Profile 2*. Bloomington, MN: Psychological Corporation.

Fazlioğlu, Y., & Baran, G. (2008). A sensory integration therapy program on sensory problems for children with autism. *Perceptual and Motor Skills, 106*(2), 415-422. doi: 10.2466/pms.106.2.415-422

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59-109.

Gartin, B. C. M. & Murdick, N. L. (2005). IDEA 2004: The IEP. *Remedial & Special Education, 26*(6), 327-331.

Gouze, K. R., Hopkins, J., LeBailly, S. A., & Lavigne, J. V. (2009). Re-examining the epidemiology of sensory regulation dysfunction and comorbid psychopathology. *Journal of Abnormal Child Psychology, 37*(8), 1077-1087. doi: 10.1007/s10802-009-9333-1

Gresham, F., & Elliott, S. N. (2007). *Social Skills Improvement System (SSIS) rating scales* San Antonio, TX: Pearson Education Inc.

Heima, S., Friedman, J. T., Keilc, A., & Benasichb, A. A. (2011). Reduced sensory oscillatory activity during rapid auditory processing as a correlate of language-learning impairment. *Journal Neurolinguistics, 24*(5), 539-555. doi: 10.1016/j.jneuroling.2010.09.006

Hong, S. B. (2014). Inter-professional collaboration: Early childhood educators and medical therapist working within a collaboration. *Journal of Education and Training Studies, 3*(1), 135-145. doi: 10.11114/jets.v3i1.623

Hood, M., & Conlon, E. (2004). Visual and auditory temporal processing and early reading development. *Dyslexia, 10*(3), 234-252.

Hubert, B., Guimard, P., Florin, A., & Tracy, A. (2015). Indirect and direct relationships between self-regulation and academic achievement during the nursery/elementary school transition of French students. *Early Education and Development, 26*(5-6), 685-707. doi: 10.1080/10409289.2015.1037624

Hunt, A., Peterson, M., and White, E. (2017). *Exploration of the use of sensory diets in occupational therapy*. Poster session presented at the Student Research Posters at Dominican University of California. San Rafael, CA.

Johnston, M. V., & Smith, R. O. (2010). Single subject designs: current methodologies and future directions. *OTJR: Occupation, Participation and Health*, *30*(1), 4-10.

Junod, R. E. V., DuPaul, G. J., Jitendra, A. K., Volpe, R. J., & Cleary, K. S. (2006). Classroom observations of students with and without ADHD: Differences across types of engagement. *Journal of School Psychology, 44*(2), 87-104. doi: 10.1016/j.jsp.2005.12.004

Kern, J. K., Trivedi, M. H., Grannemann, B. D., Garver, C. R., Johnson, D. G., Andrews, A. A., . . . Schroeder, J. L. (2007). Sensory correlations in autism. *Autism, 11*(2), 123-134. doi: 10.1177/1362361307075702

Kratochwill, T. R., & Levin, J. R. (2014). *Single-case intervention research: Methodological and statistical advances*. Washington, DC: American Psychological Association.

Lane, J. D., Ledford, J. R., & Gast, D. L. (2017). Single-case experimental design: Current standards and applications in occupational therapy. *American Journal of Occupational Therapy, 71(2), 7102300010p1-7102300010p9 doi:10.5014/ajot.2017.022210*

Lane, S. J., & Schaaf, R. C. (2010). Examining the neuroscience evidence for sensory-driven neuroplasticity: Implications for sensory-based occupational therapy for children and adolescents. *American Journal of Occupational Therapy, 64*(3), 375-390. doi: 10.5014/ajot.2010.09069

Lane, A. E., Young, R. L., Baker, A. E., & Angley, M. T. (2010). Sensory processing subtypes in autism: Association with adaptive behavior. *Journal of Autism and Developmental Disorders, 40*(1), 112-122. Doi: 10.1007/s10803-009-0840-2

Lang, R., O'Reilly, M., Healy, O., Rispoli, M., Lydon, H., Streusand, W., ... & Didden, R. (2012). Sensory integration therapy for autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders*, *6*(3), 1004-1018.

Law, M., & MacDermid, J. (2008). Evidence-based rehabilitation: A guide to practice Slack, Thorofare, NJ.

Lin, C.-L., Min, Y.-F., Chou, L.-W., & Lin, C.-K. (2012). Effectiveness of sensory processing strategies on activity level in inclusive preschool classrooms. *Neuropsychiatric Disease and Treatment, 8*, 475. doi: 10.2147/NDT.S37146

Lonigan, C. J., Allan, D. M., & Phillips, B. M. (2017). Examining the predictive relations between two aspects of self-regulation and growth in preschool children's early literacy skills. *Developmental Psychology, 53*(1), 63. doi: 10.1037/dev0000247

Lopez, M., & Swinth, Y. (2008). A group proprioceptive program's effect on physical aggression in children. *Journal of Occupational Therapy, Schools & Early Intervention, 1*(2), 147-166. doi: 10.1080/19411240802313044

Marco, E. J., Khatibi, K., Hill, S. S., Siegel, B., Arroyo, M. S., Dowling, A. F., . . . Nagarajan, S. S. (2012). Children with autism show reduced somatosensory response: A MEG study. *Autism Research, 5*(5), 340-351. doi: 10.1002/aur.1247

Maruyama, E., Coster, W., & Thomson, L. K. (1997). *Occupational therapy services for children and youth under the individuals with disabilities education act*. Bethesda, MD: AOTA Press, Inc.

May-Benson, T. A., & Koomar, J. A. (2010). Systematic review of the research evidence examining the effectiveness of interventions using a sensory integrative approach for children. *American Journal of Occupational Therapy, 64*(3), 403-414. doi: 10.5014/ajot.2010.09071

McClelland, M. M., & Wanless, S. B. (2012). Growing up with assets and risks: The importance of self-regulation for academic achievement. *Research in Human Development, 9*(4), 278-297. doi: 10.1080/15427609.2012.729907

Miller, L. J., Anzalone, M. E., Lane, S. J., Cermak, S. A., & Osten, E. T. (2007). Concept evolution in sensory integration: A proposed nosology for diagnosis. *American Journal of Occupational Therapy*, *61*(2), 135. doi: 10.5014/ajot.61.2.135

Lawson, L., & Dunn, W. (2008). Children's sensory processing patterns and play preferences. *Annual in Therapeutic Recreation, 16*, 1-14.

National Center for Educational Statistics. (2017). The condition of education. Retrieved June 27, 2017, Retrieved from https://nces.ed.gov/programs/coe/indicator_cgg.asp

Nochajski, S. M. (2002). Collaboration between team members in inclusive educational settings. *Occupational Therapy in Health Care, 15*(3-4), 101-112.

Olive, M. L., & Smith, B. W. (2005). Effect size calculations and single-subject designs. *Educational Psychology, 25*(2-3), 313-324.

Parham, D. L., & Mailloux, Z. (2013). Sensory Integration. In *Occupational Therapy for Children* (6th Ed.). Maryland Heights, MO: Mosby Elsevier.

Pfeiffer, B., May-Benson, T. A., & Bodison, S. C. (2018). Guest Editorial-State of the science of sensory integration research with children and youth. *American Journal of Occupational Therapy*, 72 (1), 7201170010. https://doi. org/10.5014/ajot.2018.721003

Pingale, V. K., Fletcher, T.S. & Candler, C. (Submitted). *Effectiveness of sensory diets on classroom behaviors.* Manuscript submitted for publication.

Portney, L. G., & Watkins, M. P. (2000). *Foundations of clinical research: Applications to practice* (2nd Ed.). Upper Saddle River, NJ: Prentice Hall Health.

Rahkonen, P., Nevalainen, P., Lauronen, L., Pihko, E., Lano, A., Vanhatalo, S., . . . Valanne, L. (2013). Cortical somatosensory processing measured by magnetoencephalography predicts neurodevelopment in extremely low-gestational-age infants. *Pediatric Research, 73*(6), 763-771. doi: 10.1038/pr.2013.46

Reynolds, C., & Kamphaus, R. (2004). *Behavior Assessment System for Children*. Circle Pines, MN: AGS Publishing.

Reynolds, C. R., Kamphaus, R. W., & Vannest, K. J. (2015). *BASC-3: Behavior Assessment System for Children*. Bloomington, MN: Psych Corp.

Robles, R. P., Ballabriga, M. C. J., Diéguez, E. D., & da Silva, P. C. (2012). Validating regulatory sensory processing disorders using the Sensory Profile and Child Behavior Checklist (CBCL 1½–5). *Journal of Child and Family Studies, 21*(6), 906-916.

Rothbart, M. K., & Rueda, M. R. (2005). The development of effortful ontrol. *Developing individuality in the human brain: A tribute to Michael I. Posner*, 167-188.

Schaaf, R. C., Benevides, T., Blanche, E. I., Brett-Green, B. A., Burke, J. P., Cohn, E. S., . . . Schoen, S. A. (2010). Parasympathetic functions in children with sensory processing disorder. *Frontiers in Integrative Neuroscience, 4*, 4. doi:10.3389/fnint.2010.00004

Schaaf, R. C., Burke, J. P., Cohn, E., May-Benson, T. A., Schoen, S. A., Roley, S. S., ... & Mailloux, Z. (2014). State of measurement in occupational therapy using sensory integration. *American Journal of Occupational Therapy*, 68(5), e149-e153. doi: 10.5014/ajot.2014.012526

Schkade, J. K., & Schultz, S. (1992). Occupational adaptation: Toward a holistic approach for contemporary practice, part 1. *American Journal of Occupational Therapy, 46*(9), 829-837.

Schultz, S., & Schkade, J. K. (1992). Occupational adaptation: Toward a holistic approach for contemporary practice, part 2. *American Journal of Occupational Therapy, 46*(10), 917-925.

Searle, A. K., Miller-Lewis, L. R., Sawyer, M. G., & Baghurst, P. A. (2013). Predictors of children's kindergarten classroom engagement: Preschool adult–child relationships, self-concept, and hyperactivity/inattention. *Early Education & Development*, *24*(8), 1112-1136. doi: 10.1080/10409289.2013.764223

Shields, A. M., Cicchetti, D., & Ryan, R. M. (1994). The development of emotional and behavioral self-regulation and social competence among maltreated school-age children. *Development and Psychopathology, 6*(01), 57-75.

Simonds, J., Kieras, J. E., Rueda, M. R., & Rothbart, M. K. (2007). Effortful control, executive attention, and emotional regulation in 7–10-year-old children. *Cognitive Development, 22*(4), 474-488. doi: 10.1016/j.cogdev.2007.08.009

Sinclair, D., Oranje, B., Razak, K. A., Siegel, S. J., & Schmid, S. (2017). Sensory processing in autism spectrum disorders and Fragile X syndrome—From the clinic to animal models. *Neuroscience & Biobehavioral Reviews*, *76*, 235-253.

Stein, B. E. (1998). Neural mechanisms for synthesizing sensory information and producing adaptive behaviors. *Experimental Brain Research, 123*(1-2), 124-135. doi:10.1007/s002210050553

Stein, B. E., & Rowland, B. A. (2011). Organization and plasticity in multisensory integration. early and late experience affects its governing principles. *Progress in Brain Research, 191*, 145-163. doi:10.1016/B978-0-444-53752-2.00007-2

Stevenson, R. A., Siemann, J. K., Schneider, B. C., Eberly, H. E., Woynaroski, T. G., Camarata, S. M., & Wallace, M. T. (2014). Multisensory temporal integration in autism spectrum disorders. *Journal of Neuroscience, 34*(3), 691-697. doi:10.1523/JNEUROSCI.3615-13.2014

Suldo, S. M., Gormley, M. J., DuPaul, G. J., & Anderson-Butcher, D. (2014). The impact of school mental health on student and school-level academic outcomes: Current status of the research and future directions. *School Mental Health, 6*(2), 84-98. doi: 10.1007/s12310-013-9116-2

Talsma, D., Senkowski, D., Soto-Faraco, S., & Woldorff, M. G. (2010). The multifaceted interplay between attention and multisensory integration. *Trends in Cognitive Sciences, 14*(9), 400-410. doi: 10.1016/j.tics.2010.06.008

Valiente, C., Swanson, J., & Lemery-Chalfant, K. (2012). Kindergartners' temperament, classroom engagement, and student–teacher relationship: Moderation by effortful control. *Social Development, 21*(3), 558-576. doi: 10.1111/j.1467-9507.2011.00640.x

Van Rie, G. L., & Heflin, L. J. (2009). The effect of sensory activities on correct responding for children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 3*(3), 783-796. doi: 10.1016/j.rasd.2009.03.001

Villeneuve, M., & Hutchinson, N. L. (2012). Enabling outcomes for students with developmental disabilities through collaborative consultation. *The Qualitative Report, 17*(49), 1.

Wallace, M. T., & Stein, B. E. (2007). Early experience determines how the senses will interact. *Journal of Neurophysiology, 97*(1), 921-926. doi: 10.1152/jn.00497.2006

Watling, R., & Hauer, S. (2015). Effectiveness of Ayres sensory integration® and sensory-based interventions for people with autism spectrum disorder: A systematic review. *American Journal of Occupational Therapy, 69*(5), 6905180030p1-6905180030p12

Watling, R., Koenig, K., Schaaf, R., & Davies, P. (2011). *Occupational therapy practice guidelines for children and adolescents with challenges in sensory processing and sensory integration*. Bethesda, MD: AOTA Press.

Watling, R., Kuhanek, H., Parham, D., & Schaaf, R. (2018). *Occupational therapy practice guidelines for children and youth with challenges in sensory processing and sensory integration.* Bethesda, MD: AOTA Press, Inc.

Watson, L. R., Patten, E., Baranek, G. T., Poe, M., Boyd, B. A., Freuler, A., & Lorenzi, J. (2011). Differential associations between sensory response patterns and language, social, and communication measures in children with autism or other developmental disabilities. *Journal of Speech, Language, and Hearing Research, 54*(6), 1562-1576. doi: 10.1044/1092-4388(2011/10-0029

Wilbarger, P. (1995). The sensory diet: Activity programs based on sensory processing theory. *Sensory integration special interest section newsletter*, *18*(2), 1-4.

Wilbarger, J., & Wilbarger, P. (2002). Clinical application of the sensory diet. In A. C. Bundy, S. J. Lane, & E. A. Murray (2nd Ed.). *Sensory integration: Theory and practice.* Philadelphia, PA: FA Davis.

Woo, C. C., & Leon, M. (2013). Environmental enrichment as an effective treatment for autism: A randomized controlled trial. *Behavioral Neuroscience, 127*(4), 487. doi: 10.1037/a0033010

Yeung, H. H., & Werker, J. F. (2013). Lip movements affect infants' audiovisual speech perception. *Psychological Science, 24*(5), 603-612.

Yunus, F. W., Liu, K. P., Bissett, M., & Penkala, S. (2015). Sensory-based intervention for children with behavioral problems: a systematic review. *Journal of Autism and Developmental Disorders*, *45*(11), 3565-3579.

Zane, T., Davis, C., & Rosswurm, M. (2008). The cost of fad treatments in autism. *Journal of Early and Intensive Behavior Intervention, 5*(2), 44. doi: 10.1037/h0100418

Zimmer, M., Desch, L., Rosen, L. D., Bailey, M. L., Becker, D., Culbert, T. P., ... & Adams, R. C. (2012). Sensory integration therapies for children with developmental and behavioral disorders. *Pediatrics*, *129*(6), 1186-1189.

APPENDIX A

Intake Form

Intake Form

Participant:

Age: Grade:

Teacher’s Initials:

School routines:

Arrival routine:

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School lunch/ snack time routine:

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School dismissal routine:

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Child’s favorite activities or preferences:

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Dislikes:

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Behaviors at school:

During transition

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____

During class activities

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____

Overall compliance and conduct:

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____

____

Interaction with peers, teachers, and other staff:

____

____

____

Characteristics of participation in structured and unstructured play:

____

____

Sensory history (present and past):

Responses to various sensations, types of sensory systems involved and if variations are present in different environmental contexts, Sensory arousal, sustaining and shifting attention, following directions,

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APPENDIX B

Intervention Fidelity Form

Intervention Fidelity Form

Participant #

Date	Time and duration	Activities	Child's response

APPENDIX C

Recruitment Letter

TEXAS WOMAN'S UNIVERSITY

Dallas, TX

Date: ________

Name of the child's parent

Re: The Effect of Sensory Diet on Sensory Processing, Psychosocial Skills, and Engagement in Classroom Activities by Ms. Vidya Pingale

Dear___________________,

I am Ms. Vidya Pingale, an occupational therapist at the designated school and a Ph.D. student at Texas Woman's University. Your contact information was obtained from the school office. You are receiving this information because your child receives occupational therapy services and attends pre-kindergarten and fourth grade class at the designated school. I am contacting you to let you know about an opportunity to participate in a research study on investigating the effect of sensory diets on sensory processing, behavior, and engagement in classroom activities. A sensory diet is one of the occupational therapy treatment programs that involves participation in physical activities to improve the child's sensory processing skills, behavior, and participation in the classroom. As a part of this study, your child will participate in fine motor or visual motor activities with the occupational therapist for 5-7 minutes three times a day for seven days. For next seven days, your child will receive sensory diets three times for 5-7 minutes three times a day.

If you would like to participate in the study or need more information about the study, please contact Ms. Vidya Pingale at the email address or phone number provided below. You can also contact Ms. Pingale by informing your child's classroom teacher. If you show interest to participate in the study, Ms. Pingale will send you a consent form to sign. Upon signing the consent form, Ms. Pingale will send you a questionnaire to gather information about your child and screen your child in the school for the eligibility to participate in the study. The first six children who qualify for the study will be enrolled in the study.

Regards,

Ms. Vidya Pingale MS, OTR

Vpingale@twu.edu

Appendix D

Consent Form

TEXAS WOMAN'S UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

Title: The Effect of Sensory Diets on Sensory Processing, Psychosocial Skills, and Engagement in Classroom Activities

Researcher: Vidya Pingale ....vpingale@twu.edu

Advisor: Dr. Tina Fletcher, Ed.D.. tfletcher1@twu.edu

Explanation and Purpose of the Research

You are invited to participate in a research study conducted by Ms. Vidya Pingale MS OTR who is an occupational therapist. This study will be conducted at designated school. The purpose of this study is to understand the effect of *sensory diets* on children's learning and classroom behaviors. Sensory diets do not relate to a child's food diet. They are a set of exercises or activities. These activities provide a child helpful sensory experience. These experiences are expected to improve child's classroom behaviors. Many occupational therapists use sensory diets in schools. As a parent or guardian, you are invited to let your child take part in this study.

Description of Procedures

As a parent or guardian, you are requested to consent Ms. Pingale to get information about your child's classroom participation. Ms. Pingale will gather this information from

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Initials

the child's classroom teacher. The *Sensory Profile-2 (Teacher questionnaire)* form will be used to understand how your child processes sensations and how different sensations affect their classroom behaviors. This information will be used to decide if your child can take part in the study. If the child qualifies to take part in the study, Ms. Pingale will watch your child in their classroom to learn more about classroom behaviors.

Your child will spend three and half hour hours to four and half hours over 28 school days in this study. During this study, your child will receive two different sets of activities, *sensory diets* and fine motor or visual motor activities.

As a part of the study, your child will be video recorded during a group classroom activity for fifteen minutes each day. Your child will continue to take part in classroom activities during this time. The total time of video recording will be seven hours over twenty-eight days.

This study will occur in four phases. The details of each phase are explained below:

- During the first phase, Ms. Pingale or a research team member will only video record your child for fifteen minutes during a classroom group activity. This phase will last for seven days. Your child will be recorded for one hour and forty-five minutes during this phase.

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Initials

- During the second phase, you child will take part in fine motor and visual motor activities with Ms. Pingale for five to seven minutes three times a day. This phase
-

will last for seven days. Your child will spend one hour forty-five minutes to two and half hours with Ms. Pingale during this phase. Your child will be video recorded for fifteen minutes during a classroom group activity for seven days. Your child will be recorded for one hour and forty-five minutes during this phase.

- During the third stage, your child will receive a *sensory diet* for seven days. Sensory diets do not relate to a child's food diet. They are a set of exercises or activities that provide a child helpful sensory experience. These experiences are expected to improve child's classroom behaviors. Ms. Pingale will offer sensory diet activities three times a day. All activities will last only for five to seven minutes. Your child will spend one hour forty-five minutes to two and half hours with Ms. Pingale during this phase. Your child will also be video recorded for fifteen minutes during a classroom group for seven days. Your child will be recorded for one hour and forty-five minutes during this phase.
- During the fourth phase, Ms. Pingale or a research team member will only video record your child for fifteen minutes during a classroom group activity. This phase will last for seven days. Your child will be recorded for one hour and forty-five

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Initials

minutes during this phase.

Potential Risks

There is a small chance of minor physical injuries such as a fall. However, the activities will be carried out by Ms. Pingale who is an experienced therapist. Also, activities will be carried out in a clutter free area. Hence, the risk of injuries will be reduced. Ms. Pingale will stop activities if the child shows or expresses discomfort. A chance of boredom is another risk. Different activities will be used to avoid boredom. Ms. Pingale will make efforts to use activities that appeal to your child. The loss of confidentiality is another risk.

Confidentiality will be protected to the extent that is allowed by law. The children's identifiable information will be concealed. Codes will be used to mark each child's videos, forms, and data collection forms. All documents will be shredded five years after the completion of the study. Forms will be stored in a locked cabinet at Ms. Pingale's office. Media and software data will be Ms. Pingale's computer and on a cloud service account. This data will be password protected. Only Ms. Pingale's will know your child's identity. Only the research team can view media files. The result of the study will be published in a professional (scholarly peer-reviewed) magazine. Children's identifiable information will be concealed.

The final risk of the study is distractibility and loss of instructional time in the

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Initials

classroom. Your child knows Ms. Pingale and the research team member as they have been school staff for several years. They will take care to remain passive and inconspicuous in the classroom. They will try to keep the camera inconspicuous. Hence, the risk of distractibility will be reduced.

The researchers will try to avoid problems due to this research. You should let the researchers know at once if there is a problem. They will try to help you. However, TWU does not provide medical services or financial assistance for injuries that might occur because of your participation in this research.

Participation and Benefits

Your involvement in this study is completely voluntary. You may withdraw from the study at any time. If you would like, we will mail you the results of this study. The results of this study will help occupational therapists to develop effective activity plans.

Questions Regarding the Study

You will be given a copy of this signed and dated consent form to keep. If you have any questions about the research study, you should ask the researchers. Their phone numbers are at the top of this form.

You may contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or via e-mail at IRB@twu.edu if you have questions about your rights as a participant in this research. You may contact this office if you have questions about the way this study has been conducted.

____ __________________

Signature of Parent/Guardian Date

*If you would like to know the results of this study, tell us where you want them to be sent:

Email: ____________________________

or

Address:

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Record of Assent

☐ The child provided verbal assent to participate in the study

Appendix E

Behavior Assessment Systems for Children-3 Results

BASC-3 scores with 95% CI

BASC-3 Scales and Subscales	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Adaptive Skills	43 (39-47)	45 (42-48)	30 (26-34)	35 (32-28)	39 (36-42)
Functional Communication	41 (35-47)	28 (22-34)	28 (22-24)	21 (15-27)	17 (11-23)
Study Skills	NA	40 (35-45)	NA	42 (27-47)	43 (38-48)
Leadership	NA	43 (38-48)	NA	37 (32-42)	42 (36-48)
Social Skills	39 (34-44)	60 (56-64)	30 (25-35)	45 (41-49)	57 (53-61)
Adaptability	52 (47-57)	57(52-62)	39 (34-44)	41 (36-46)	44 (39-49)
Behavioral Symptoms Index	71 (68-74)	67 (64-70)	66 (63-69)	72 (69-75)	69 (66-72)
Withdrawal	88 (81-95)	46 (39-53)	76 (69-83)	77 (70-84)	48 (43-53)
Atypicality	102 (97-107)	99 (93-105)	65 (60-70)	90 (84-96)	90 (84-96)
School Problems	NA	81 (78-84)	NA	62 (59-65)	73 (69-77)
Learning Problems	NA	81 (76-86)	NA	60 (55-65)	66 (61-71)
Attention Problems	66 (62-70)	75 (71-79)	68 (64-72)	61 (57-65)	76 (72-80)

Continued

Internalizing Problems	48 (43-53)	45 (41-49)	48 (43-53)	44 (40-48)	41 (36-46)
Somatization	48 (42-54)	48 (42-54)	42 (36-48)	44 (38-50)	46 (40-52)
Depression	54 (48-60)	45 (38-52)	51 (45-57)	50 (43-57)	45 (39-51)
Anxiety	44 (37-51)	44 (38-50)	52 (45-59)	41 (35-47)	39 (33-45)
Externalizing Problems	42 (38-46)	54 (51-57)	57 (53-61)	61(58-64)	61 (58-64)
Conduct Problems	NA	49 (44-54)	NA	57 (52-62)	48 (43-53)
Aggression	42 (37-47)	46 (41-51)	56 (51-61)	61 (56-66)	56 (51-61)
Hyperactivity	44 (39-49)	66 (62-70)	57 (52-62)	63 (59-67)	76 (72-80)
Anger Control	50 (45-55)	49 (43-55)	58 (53-63)	74 (68-80)	57 (52-62)
Bullying	46 (38-54)	47 (42-52)	56 (48-64)	47 (42-52)	44 (39-49)
Developmental Social Disorders	90 (85-95)	65 (59-71)	78 (73-83)	80 (74-86)	59 (54-64)
Emotional Self-Control	49 (44-54)	56 (50-62)	59 (54-64)	68 (62-74)	56 (51-61)
Executive Functioning	63 (58-68)	64 (60-68)	69 (64-74)	73 (69-77)	75 (71-79)

Continued

Negative Emotionality	54 (48-60)	50 (44-56)	54 (48-60)	67 (61-73)	52 (48-56)
Resiliency	44 (38-50)	44 (39-49)	32 (26-38)	40 (35-45)	42 (37-47)

Note. CI represents confidence interval

APPENDIX F

Links for the BASC-3 Sample Reports

Sample Reports

- A sample report and the questions similar to the BASC-3 Teacher Rating Scale can be found at https://images.pearsonclinical.com/images/Assets/BASC-3/BASC-3-Rating-Scales-Report-Sample.pdf (PsychCorp, 2015a)
- A sample report and behaviors included on the Student Observation System can be found at https://images.pearsonclinical.com/images/Assets/BASC-3/BASC-3_SOS_Report_Sample.pdf (PsychCorp, 2015b)