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The Influence of Multi-sensory Environment on Physiological Response in Children with

Autism Spectrum Disorders and Children with Special Health Care Needs

Rawan Atari

Mentor: Amy Vaughan Van Hecke, Ph.D., Associate Professor, Department of Psychology

Ronald E. McNair Scholars Program

Marquette University

Abstract

A research study based on the sensory integration theory was conducted to examine the effects of multi-sensory environment (MSE) on physiological arousal in children with autism spectrum disorder (ASD) and special health care needs. Adapted environments may serve as a mechanism to treat anxiety levels in a population of children who experience more severe generalized anxiety symptoms than typically developing children. The sample consisted of children with community-based diagnoses of ASD and children with special health care needs, primarily children diagnosed with cerebral palsy (CP) from the Milwaukee Center for Independence (MCFI). Treatment for the autism sample was carried out by a trained MCFI staff member and treatment for children with special health care needs was carried out by a trained physical therapist. Electrodermal response was used as a measure to detect the "fight or flight" response of the sympathetic nervous system. The measurement of electrodermal activity was recorded by a wireless bracelet device that recorded the skin conductance level of the participant prior to entering the sensory room, during treatment in the sensory room, and after exiting the sensory room. Results indicated increased arousal in children with CP, as sensory stimulation was the main goal of physical therapists. Results for the autism sample varied by participant and indicated that treatment needs to be individualized for optimal benefits. Findings support the use of MSE as an alternative technique to improve therapeutic opportunities for children with cerebral palsy by stimulating sensations that are otherwise generally dormant.

The Influence of Multi-sensory Environment on Physiological Response in Children with Autism Spectrum Disorders and Children with Special Health Care Needs

Introduction

Developmental disabilities are chronic and severe disabilities that are attributed to mental or physical impairment before the individual reaches adulthood. The following are categorized as developmental disabilities: intellectual disability, cerebral palsy, epilepsy and autism. Due to the sensory abnormalities present in developmental disabilities, the use of therapeutic techniques targeting sensory integration may prove to be beneficial for individuals with developmental disabilities. The use of sensory based intervention for individuals with cerebral palsy (CP) and autism spectrum disorders (ASD) is further discussed and highlighted. The necessity for alternate therapeutic techniques is prevalent as rates of CP and ASD increase in children in the United States (Yeargin-Allsopp et al., 2008; Baio, 2014).

Cerebral palsy was reported to be in 3.6 cases per 1,000 in 8 year old children (Yeargin-Allsopp et al., 2008), with estimated rates of 10,000 babies born in the United States affected by CP (Paneth, Hong & Korzeniewski, 2006). CP is defined as a group of permanent disorders in the development of movement and posture and is often accompanied by other developmental disorders, such as epilepsy. Individuals with CP often display disturbances in sensation, perception, communication, and cognition (Rosenbaum, Paneth, Leviton, Goldstein & Bax, 2006). Many children with CP have experienced sensory difficulties, in which the use of a sensory integration approach may be helpful in improving the child's ability to process and integrate sensory information. Some studies have reported on the benefits of sensory-based intervention as a useful treatment approach to children with CP, as well as other developmental disabilities like autism (Rosenbaum et al., 2006). Autism spectrum disorder (ASD) is characterized by the inability to meet social,

educational, and occupational demands starting from early development stages to later stages in life. The rate of ASD has grown largely throughout the decades. Beginning in the late 1960s and early 1970s, ASD was estimated at one in 10,000 children, and by the 2000's surveys estimated that ASD was prevalent in 1% to 2% of children. Most recent reports released in 2014 estimate that ASD has grown to be present in 1 in 68 children (Baio, 2014). The increase of ASD rates in children makes social, learning, and developmental programming imperative in order to help children become independent, functional adults.

Previous research studies have examined the influences of traditional occupational therapy, auditory integration training, and sensory integration therapy on sensory and motor abnormalities in children with developmental disabilities. The effectiveness of these therapies has been demonstrated, not only by improving the sustained focus of the child, but also by improving the child's quality of life. Children with autism have shown less awareness in sensations, which could be due to the sensory overload they experience from the environment (Ben-Sasson et al., 2008). Sensory abnormalities include deficits in tactile sensitivity, auditory filtering, and taste/smell sensitivity (Rodgers, Hepburn & Wehner, 2003), whereas motor abnormalities include deficits in maintaining balance, rolling, sitting, crawling, and walking (Ozonoff et al., 2008). A limited amount of research has been conducted on the influence of the environment in helping children function adaptively. Also, adaptations of environments might serve as a mechanism to treat levels of anxiety children experience while in a naturally stressprovoking situation. As past research has indicated, children with autism and other developmental disorders have more severe generalized anxiety symptoms than typically developing children (Wiggins, Robins, Bakeman & Adamson, 2009). In order to provide optimal help to children with developmental disabilities, the effectiveness of adapted environments, or "sensory rooms," in easing feelings of anxiety needs to be evaluated. Further research which integrates a variety of previously mentioned therapies needs to be explored in order to provide children with optimal health care support and an environment which encourages the child to reach his or her full potential. If proven to be effective, parents and clinicians can implement sensory rooms to improve therapeutic and social opportunities for children.

Literature Review

Previous research studies have examined the influence of sensory integration in alternate therapies and the impact of these therapies on the development, learning, emotions, and behaviors of individuals undergoing sensory-based interventions. The following literature review provides an overview of autism spectrum disorders (ASD), including descriptions of sensory impairments and anxiety and mobilization in autism. Next, cerebral palsy (CP) and the sensory disturbances of the disorder are described due to the significant amount of participants diagnosed with CP in the special health care needs sample. Thirdly, the sensory integration theory is described and defined. Lastly, multi-sensory environments as a form of sensory interventions are described.

Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is characterized by communication deficits, impairments in social interaction, and the presence of repetitive and restrictive behaviors. People with ASD have a difficult time communicating with others and may respond inappropriately in a conversation, misread nonverbal interaction, and have difficulty forming friendships appropriate to their age (American Psychiatric Association, 2013). Psychiatrists and psychologists rely on the Diagnostic and Statistical Manual-5 (APA, 2013) to diagnose patients on the autism spectrum. According to the DSM-5, people with ASD may be overly dependent on others in daily routines, highly sensitive to changes in the environment, or intensely focused on inappropriate items. The symptoms of ASD fall on a continuum, with some people showing mild symptoms and other individuals showing much more severe symptoms. The spectrum in the DSM-5 allows clinicians to account for the differentiating behaviors and symptoms across individuals (APA, 2013). Starting in infancy through adulthood, social deficits such as lack of eye gaze, and an inability to demonstrate joint attention and share enjoyment or interests with others, as well as difficulty interpreting and communicating about others' emotions, have been observed (Cohen & Volkmar, 1997).

Sensory impairments in autism. Although sensory abnormalities are not specific to individuals with autism, literature suggests that the prevalence of these abnormalities is significantly high. Abnormal responses to sensory stimuli were prevalent in a significant subgroup of individuals diagnosed with autism, with an estimate ranging from 30% to 100% (Dawson & Watling, 2000). Sensory disturbances in processing were found more prevalent in earlier stages of childhood and therefore may be helpful in the early screening of autism (Dawson & Watling, 2000). In a study conducted by Wiggin, Robins, Bakeman and Adamson (2009), children with autism displayed more abnormal responses to sensory stimuli than children with other developmental delays, specifically in areas of tactile sensitivity, auditory filtering, and taste/smell sensitivity. Findings such as these indicate that severe sensory abnormalities should be considered distinguishing symptoms of autism.

Sensory dysfunctions stem from the brain's inability to process stimuli correctly from the sensory inputs of vision, hearing, touch, taste, smell, vestibular, proprioceptive and kinesthetic information (Kern et al., 2007). The synchronization of the brain is important in correctly

processing sensory information because sensory processing involves a cascade of events that involves the cortical regions of the brain as well as the cerebellum and subcortical regions. If any step of the processing is compromised, sensory information processing is abnormal and subsequent processing would be abnormal (Gomot et al., 2002; Kern et al., 2007). Although sensory dysfunction is mentioned in the DSM-5, it is not a criterion for diagnosis, but the prevalence of these sensory abnormalities in children with ASD has generated a vast amount of research in this area (APA, 2013; Kern et al., 2007).

Sensory abnormalities related to sensory sensitivity, sensory under-responsiveness, and sensory seeking behaviors have been frequently reported in children with autism. Such behaviors include covering ears during loud, unexpected noises, restricted food preferences, failure to react or orient to name, rocking, hand flapping and noise making (Lane, Young, Baker & Angley, 2010). Lane and researchers (2010) confirmed the existence of three distinct sets of sensory processing subtypes in children with autism. The three subtypes are as follows: sensory-based inattentive seeking (inattention, impulsivity, and distractibility), sensory modulation with movement sensitivity, and sensory modulation with taste/smell sensitivity. All of the subtypes are characterized by symptoms of both under- and over-responsiveness in their domains. Their findings support the use of sensory-based interventions to mediate communication and behavioral deficits in children with autism. Another study using the Sensory Profile to measure frequency thresholds of an individual's response to various sensory experiences found a strong correlation that suggests all of the modalities (auditory, visual, touch, and oral) are affected in autism. An interesting finding in the same study suggests that as age increases for individuals with autism, abnormal sensory processing decreases. Findings from a correlation analysis suggest that an adaptive or maturation process of sensory processing may occur over time (Kern

et al., 2007). In that case, implementing sensory-based interventions at an early age after diagnosis may be the most effective in aiding the development of sensory processing.

Anxiety and mobilization in autism. Symptoms of anxiety are reported more often in individuals diagnosed with ASD than in a typically developing population, and even in a population characterized by other developmental disabilities. A study conducted by Kushki and research team (2013) supported this report as the ASD group in the study displayed more severe generalized anxiety disorder symptoms than the typically developing group. The measure of electrodermal activity showed that the ASD group had a significantly higher number of electrodermal responses than the typically developing group during the baseline task after completing an anxiety-inducing task. Some of the core symptoms that characterize autism, such as the need for sameness, fixed behaviors, routines, and obsessions, are anxiety driven. Minor changes in the environment and the fear of possible change can induce feelings of anxiety and distress in children with autism (Kanner, 1943, as cited in Gillott, Furniss & Walter, 2001). In order to seek out the extent and nature of anxiety in children with high-functioning autism, Spence Children's Anxiety Scale (SCAS) and Spence Social Worries Questionnaires (SWQ) were used to compare a group of high-functioning children with autism and normally developing children between the ages of 8 to 12 years old. Results indicated that the children with autism had considerably higher levels of anxiety than normally developing children, with the highest scored obtained for obsessive-compulsive disorder (Gillot et al., 2001). These results support the feature of autism that insists on sameness, order and routine.

Due to the complexity of the limitations of children diagnosed with ASD and other developmental disabilities, measuring the emotions elicited by certain life events can be difficult. Due to the limitations, research needs to be focused on behavioral, nonverbal, or physiological aspects. The use of biopsychological measures, such as skin conductance level and electrodermal response, to understand a child's physiological response to stimuli is important in order to identify interventions most useful for a particular physiological reaction (Case-Smith, 2009).

Electrodermal response is a reliable measure of the sympathetic nervous system. When the sympathetic nervous system is excited, the individual begins to sweat, therefore lowering electrical resistance and increasing electrical conductance in the skin. Past researchers have hypothesized that children with autism use self-stimulatory behaviors such as rocking, wiggling their fingers, or obsessively lining up objects, as a mechanism to calm the responsive sympathetic nervous system activity (Hirstein, Iversen & Ramachandran, 2001). A study looking at the electrodermal response of autistic children during daily activities found a large reduction of sympathetic activity, therefore supporting the hypothesis previously mentioned. These results could explain why autistic children seek out self-stimulating behaviors in order to calm hyperresponsive activity of the sympathetic nervous system, "fight or flight" response (Hirstein et al, 2001). Using the same measure of skin conductance, Miller, Coll, and Schoen (2007) measured the level of sweat response in children with sensory modulation disorders after a trial of a sensory integration intervention. The research found that intervention can improve sympathetic nervous system response to sensory challenges because children showed an overall decrease in levels of sweat response (Miller et al., 2007). Overall, the results are encouraging and demonstrate the reliability of using skin conductance levels in order to measure physiological responses of stress in individuals with sensory disorders.

Cerebral Palsy

Cerebral palsy (CP) is a neurodevelopmental condition which affects the individual beginning in early childhood and continuing throughout his or her lifespan. The condition is

characterized by a group of disorders that involves the functions of the brain and nervous system, usually resulting from a brain injury that occurs before the completion of cerebral development. Movement, learning, hearing, seeing, and thinking are all affected as individuals with CP have a range of varying symptoms from very mild to very severe (Rosenbaum et al., 2006). Common symptoms include slow motor development, abnormal muscle tone, and unusual posture. Neurological impairment such as impairment of vision or hearing and abnormal touch and pain perceptions are common in individuals diagnosed with CP. The goal of treatments is to improve an individual's functionality and capability of moving towards independence. Due to the varying nature of symptoms, types of treatment for people with CP must depend on the individual's specific condition in order to provide optimal care (Krigger, 2006). A variety of therapeutic interventions have been used to assist children with CP. Traditional physiotherapy and occupational therapy is commonly used and has been shown to benefit children with CP. The approach of sensory integration is often used by occupational therapists in order to improve the child's ability to process and integrate sensory information. The sensory approach is meant to enhance the brain's specific skills to perceive, remember, and motor plan. Previous research studies have found this approach beneficial in aiding children with CP experiencing sensory impairments (Patel, 2005).

Sensory impairments in cerebral palsy. Cerebral palsy often affects sensation and perception through disturbances in vision, hearing, and other sensory modalities, ultimately putting limitations on the individual that restrict learning and the perceptual development of experiences. Individuals with CP often experience the inability to incorporate and interpret sensory information (Rosenbaum et al, 2006). The underlying sensory deficits in individuals with CP are often overlooked due to the vast amount of treatments focusing on the motor deficits associated with the disorder. A study conducted by Cooper, Magnemer, Rosenblatt and Bimbaum (1995) aimed to focus on determining the presence and extent of sensory deficits in children with CP using sensory assessment batteries. Results indicated significant bilateral sensory deficits in hemiplegic children compared to the healthy participants. Specifically, stereognosis and proprioception were the main modalities affected by the disorder (Cooper et al., 1995). Stereognosis is a composite of integrated primary sensory inputs and is the ability to perceive the depth and dimensionality through any of the senses, whereas proprioception is the ability to be aware of one's own body position. Both are complex sensations which are affected by the cortex involved with sensory processing. A similar study focused on tactile abnormalities in individuals with CP by analyzing performance of tactile tasks performed by participants with diplegia. Results revealed significantly more errors by individuals with CP on any task involving the nondominant limb and significant errors involving the dominant limb in participants with hemiplegia (Wingert, Burton, Sinclair, Brunstrom & Damiano, 2008). Lagunju and researchers (2010) concluded that the most frequent neurocognitive/sensory impairments in individuals with CP were hearing impairments, vision impairments, growth impairments, and speech disorders. The prevalence of sensory impairments associated with CP have been demonstrated by past research studies, and although sensory deficits are often overlooked, researchers recommend sensory evaluation as an integral part in assessing children with CP (Cooper et al., 1995). Due to the lack of attention on sensory impairments in CP, therapeutic techniques to target sensory deficits are scarce. The current study aims to explore the effects of sensory-based intervention in stimulating the senses of children with CP through the use of tactile, visual, and somatosensory stimuli.

Sensory Integration Theory

Ayres' theory of sensory integration is a neurological process that organizes sensation from an individual's body and the environment to make effective use of the body within the environment (Ayres, 1986, p.9, as cited in Thompson, 2011). The theory is based on the following assumptions: (1) Plasticity exists in the central nervous system; (2) the process occurs in a developmental sequence and is required for development of higher cognitive processes; (3) the brain is hierarchally organized, but the functions of the brain are an integrated whole; (4) adaptive interactions are critical; and (5) an inner drive to develop sensory integration through sensory-motor activities exists (Botts, 2006; Ayres, 1972, 1979, 2002; Bundy, Lane, Fischer, & Murray, 2002, as cited in Thompson, 2011). The sensory integration theory is supported by the assumptions that learning is contingent on the ability of the individual to receive, process, and integrate sensory information into an organized behavior. Providing opportunities for individuals to experience sensory adaptation increases the ability of the central nervous system to process and integrate sensory information (Botts, 2006, as cited in Thompson, 2011). Sensory integration theory provides clinicians and teachers with a framework to help individuals with autism, developmental delays, and other special health care needs in stress-provoking environments that may lead an individual to feel overwhelmed.

Sensory Based Interventions

A variety of interventions utilize the sensory integration theory to create an intervention environment that involves the entire body, which promotes intrinsic motivation through play and activities that are their own reward (Thompson, 2011). A study conducted by Hall and Case-Smith (2007) investigated the use of sound-based intervention on children with sensory processing disorders and visual-motor delays. Parents of the children were interviewed at the end of the program and reported notable difference in the behavior of their child and they also stated that their child demonstrated improved attention, greater interaction with peers, decreased nightmares, improved transitions, better listening, greater self-awareness, better communication, improved sleep patterns, and more consistency in following directions.

Multi-sensory environments (i.e., Snoezelen rooms). A multi-sensory environment (MSE) is a room where many different forms of stimuli such as colored lights, music, and tactile boards, may be presented together. The rooms are typically implemented in order to increase relaxation and stimulation for individuals in the room (Martin, Gaffan, & Williams, 1998). MSEs are also referred to as Snoezelen rooms. *Snoezelen* is a Dutch word and concept meaning "to sniff and doze" which refers specifically to the activities that take place within the MSE (Hulsegge & Verheul, 1987). The stimuli present in MSEs allow the patient to experience various sensory experiences through the visual, olfactory, auditory, and tactile sensory systems. The use of a safely adapted environment is meant to promote feelings of relaxation for the individual taking part in an activity (Hulsegge & Verheul, 1987). The results of a meta-analysis exploring the effectives of intervention in MSEs concluded that the Snoezelen approach has a positive influence when used as an intervention tool and recommend that clinicians implement this method in order to achieve relaxation and positive sensorial experiences for individuals with intellectual and developmental disabilities (Lotan & Gold, 2009).

One of the main benefits of MSEs is the flexibility the environment allows for the individual to select and receive the type of sensory input and the amount of input the individual desires (Kaplan, Clopton, Kaplan, Messbauer & McPherson, 2006). A variety of equipment is used in MSEs, including items such as bubble tubes or columns, colors wheels for spotlights or projectors, bean bags, mattresses, and music (Carter & Stephenson, 2012). The rooms are

typically softly lit with the walls painted white and sounds (e.g. water, music, birds) playing through speakers (Martin et al., 1998). Schools that implemented MSEs into their weekly schedule indicated that the equipment used in the MSE were increasingly beneficial to their curriculum because they provided sensory stimulation, an opportunity to relax, and reduction in anxiety for the students with autism and special health care needs (Carter & Stephenson, 2012).

Previous research studies have examined the influences of MSEs by implementing visual, auditory, somatosensory and tactile stimuli in a classroom setting and medical settings. In order to study the influence of a multi-sensory center in a classroom setting, a pilot study used a sample of students with severe developmental disabilities representing four classes of students. Students were observed while in a regular classroom, in the multi-sensory center, and a regular classroom after being exposed to the multi-sensory center. Results indicated a significant increase in sustained focus when students returned to regular classroom activities after experiencing the MSE with a 13% increase in relaxation, a 16% increase in happiness, and a 13% increase in overall engagement (Thompson, 2011). Another research study took a similar approach in implementing a sensory adapted environment in a dental office in order to examine sympathetic nervous system response in children with developmental disabilities (Shapiro, Sgan-Cohen, Parush, & Melmed, 2009). The research study examined the influence of a sensory adapted environment on the behavior and arousal levels of children with developmental disabilities in comparison to typical children in a stress inducing medical setting. Results showed that children with developmental disabilities expressed a shorter duration of anxious behaviors in the sensory adapted environment compared to the regular environment and showed a greater difference on all measures when compared to typical children (Shapiro et al., 2009).

Summary

Individuals diagnosed with ASD and developmental disabilities display difficulties in sensory processing. Examples include sensitivity to loud noises, an aversion to or excessive seeking of sensory stimuli and feelings of anxiety with activities involving touch, sound, and movement (Huebner, 2001). Past research studies have highlighted the significantly high amount of sensory impairments and further suggest that these distinguishing symptoms should be considered during the diagnosis process of ASD, as well as CP. Additionally, anxiety and physiological mobilization limit the abilities of individuals with ASD, and make interacting with the world difficult or impossible. Literature encourages the use of sensory-based interventions, such as MSEs, to reduce feelings of anxiety and increase feelings of happiness and overall engagement. The results of previous research studies focusing on the use of sensory-based interventions as an additional form of therapy indicated the benefits of these interventions and encourage further study into the effects of a sensory approach.

The goal of the current study aims to explore the effects of multi-sensory environments to measure arousal response of children with developmental disabilities. The MSE aims to increase concentration, alertness, calmness, and general awareness. Children participating in the study will have their skin conductance levels measured before entering the MSE, while in the MSE, and after exiting the MSE. Due to the available population, children diagnosed with autism and children with cerebral palsy will be the main focus of the study. The study will focus on the following research questions: (1) Will sensory-based interventions, through the use of a MSE, lower levels of arousal, as measured by skin conductance levels, in children with ASD? (2) Will sensory-based interventions, through the use of the MSE, increase levels of arousal, as measured

by skin conductance levels, in children with special health care needs? The hypotheses of the current study is that (a) children with autism will demonstrate a reduction in levels of arousal when engaging in the MSE, and (b) children with cerebral palsy will demonstrate an increase in levels of arousal when engaging in the MSE.

Methodology

Selection procedures

Participants were selected from a group of children who were attending the summer day camp at the Milwaukee Center for Independence (MCFI). The center features a summer day camp which serves children with ASD, sensory disorders and special health care needs. Parent packets including a letter describing the study, a consent form, and a demographics form were sent to the homes of possible participants and if interested in taking part in the study, parents of the children were asked to complete the previous documents mentioned and bring the completed forms to the first day of camp. Parents who signed consent forms and indicated that their child was diagnosed with ASD or other special health care needs and used the MSE at MCFI during camp were selected as participants. Due to the electrical signal the q-sensor bracelet elicits, children with health conditions sensitive to electrical signals were excluded from the study.

Sample

The population was made up of children with ASD and children with other special health care needs (2 girls, 5 boys, M_{age} = 6.5 years, age range: 5-10 years). Children with special health care needs (2 girls, 2 boys, M_{age} = 5.5 years, age range: 5-7 years) had the following diagnoses (3 with cerebral palsy, 1 with cerebral palsy and epilepsy). Children with community-based diagnoses of ASD and sensory disorders (3 boys, M_{age} = 8 years, age range: 7-10 years) made up

the rest of the sample. The sample of participants in terms of ethnicity included 4 White, and 3 Black or African American.

Measures

Electrodermal Activity. The measurement of electrodermal activity (EDA) was recorded by the Q-Sensor, a wireless bracelet device that records skin conductance as a function of sympathetic nervous system activity. The most common measure of EDA is skin conductance, which serves as a reliable measure in capturing the intensity of an individual's experience. When the participant is aroused whether they are engaged, stressed, or excited, skin conductance increases and decreases when the participant is less aroused, whether they are disengaged, bored, or calm. The Q-Sensor device is worn as a bracelet around the wrist of the participant by the help of a Velcro strap. Electrodes are attached the inner side of the bracelet, placed directly on the skin of the participant, and are activated by sweat response.

Setting. All measurements and treatment sessions occurred in the MSE at the MCFI. The MSE is a room that includes the following Snoezelen-type equipment:

- a) Light effects produced by projectors and effect wheels that reflect light patterns throughout the room
- Bubble columns, spotlights, fiber optics, UV lights, mirrors, sound-activated string light and fan light.
- c) Sound effects, including pleasant music, sounds of nature, and selective rhythmic music with a variety of tone, pitch, rhythm, and spacing.
- Tactile experiences of changing textures on an interactive tactile wall panel and gentle vibrations.

- e) Soft items such as thick floor mats, vibrating chairs, and waterbeds.
- f) Motion stimulation, including ball pools which provide comfortable pressure.
- g) Central control that controls lighting and the colors of the lighting.(Fornes, 2009)

Appendix A, Multisensory Environment Equipment Descriptions, contains a sample of the equipment and descriptions.

Procedure

Baseline condition. The baseline phase was measured 3 minutes prior to entering the MSE. Each of the participants followed his or her regular schedule of daily camp activities prior to beginning the MSE portion of the camp. The Q-Sensor bracelet was placed and secured on the wrist of the participant 3 minutes prior to entering the MSE. After checking for any feelings of discomfort, the researcher pressed the timestamp button on the bracelet to indicate the start of the 3 minute pre-test condition. The researcher timed 3 minutes and pressed the timestamp button on the bracelet to indicate the end of the 3 minute pre-test condition before the participant entered the MSE with the MCFI staff member.

Treatment condition for children with autism. During the treatment condition, the researcher pressed the timestamp button on the Q-sensor bracelet indicating the beginning of the 15 to 20 minute treatment condition after the 3 minute pre-test condition. The participant then entered the MSE with a trained MCFI staff member and other children in the summer day camp. The staff member prepared the sensory room by turning on all of the equipment and following the child's lead in terms of which equipment would be used. When the treatment condition was completed, the timestamp button was pressed to signal the end of time in the MSE and the beginning of the

post-test condition. The researcher timed 3 minutes while outside of the MSE and pressed the time stamp button to signal the end of the post-test condition.

Treatment condition for children with special health care needs. The same procedure used for children with autism was followed for children with special health care needs. However, the participants received one-on-one treatment from a trained physical therapist who determined the equipment used during treatment.

Results

The results of the study are presented contingent to the two major research questions. Data for individual participants were analyzed and will be reported independently through comparisons of means. Means represent the level of response for each individual during the pretest condition, multi-sensory condition, and post-test condition of the study. The multi-sensory condition was divided into three time intervals: 0 to 5, 5 to 10, and 10 to 15 minutes.

Research Question One

Will sensory-based interventions, through the use of a MSE, lower levels of arousal, as measured by skin conductance levels, in children with ASD?

Participant #2 generally experienced an increase in arousal from pre-test to post-test conditions and during treatment in the MSE. Participant #1 did not show significant change in EDA across conditions. Participant #3 experienced a decrease in arousal upon entering the MSE, an increase in arousal while inside the MSE at the 10 minutes peak, followed by a decrease in arousal after exiting the MSE. The mean EDA changes over time for all participants are displayed in Figure 1.



Figure 1. *Mean EDA changes over time for children with autism.*

Research Question Two

Will sensory-based interventions, through the use of MSE, increase levels of arousal, as measured by skin conductance levels, in children with special health care needs? Treatment implemented inside the MSE was determined by the physical therapist. See Table 1 for equipment used during treatment.

Participants # 4 through #7 generally experienced an increase in arousal from pre-test to post-test conditions and during treatment in the MSE. The mean EDA changes over time for all participants are displayed in Figure 2.



Figure 2. Mean EDA changes over time for children with special health care needs.

Discussion

Developmental disabilities, such as cerebral palsy and autism, have been characterized by sensory impairments including abnormalities in tactile sensitivity, auditory filtering, and taste/smell sensitivity (Rogers et al, 2003). The need for therapeutic interventions to target sensory deficits is necessary in order to increase stimulation in populations who do not receive enough sensory input or aid individuals who experience an overwhelming amount of sensations (Rosenbaum et al., 2006). The results in our study are inconsistent with past findings about the use of sensory based interventions in children with autism in order to promote relaxation, and rather demonstrate that sensory interventions can be used to create stimulation for children with CP who experience limitations in sensory modalities.

Each participant diagnosed with CP in the special health care needs population demonstrated an increase in electrodermal activity (EDA) from the pre-test to post-test conditions, as well as a steady increase in EDA during the three intervals in the MSE. Past research have studied the use of MSEs in promoting feelings of relaxation and easing feelings of anxiety; however, the current study demonstrates the benefits of incorporating MSEs during physical therapy in children with dormant sensations. As the goal of physical therapy is to improve balance, posture control, gait and joint mobility, active physical participation from the child with CP receiving care is necessary for development (Patel, 2005). Traditional physiotherapy and occupational therapy are the primary therapeutic interventions used for treatment of cerebral palsy. The integration of sensory based interventions should be considered in order to improve the individual's ability to process and integrate visual, perceptual, proprioceptive, and auditory sensory information (Patel, 2005). The significant increase in EDA witnessed among participants with CP in the current study captured the participant's experience and showed an increase in arousal likely due to engagement with the stimulating equipment in the MSE.

There was no clear pattern in EDA levels of children with autism to support the hypothesis that treatment in a MSE would lower levels of arousal. Each participant displayed different experiences in the test conditions. One of the three participants showed an increase in feelings of relaxation and the remaining participants displayed increased levels of arousal or no significant changes in arousal. The need to individualize treatment in the MSE may be an important factor in promoting feelings of relaxation and easing anxiety. Research conducted by Stedele and Malaney (2001) supports specifying treatment to each individual in order to improve MSE intervention. During the current study in the autism sample studied, approximately 3 to 4 children were present in the MSE during treatment and all of the equipment was turned on before the children entered. Perhaps creating a slower progression of sensory stimulation would prove more effective because one of the main benefits of MSEs is the opportunity to control, manipulate, intensify, and reduce stimulation based on the preference of the individual receiving treatment (Kaplan et al., 2006). In order to individualize treatment and control stimulation, the MSE may be more effective with only the presence of the therapist and the individual receiving treatment.

Another implication to consider is that children with sensory modulation disorders, such as autism, need to have their senses awakened through an increase in sensory stimulation (Pagliano, 1999, as cited in Stedele & Malaney, 2001). This theory could potentially explain the increase in arousal experienced by one participant in the ASD sample. As electrodermal activity measures arousal based on engagement, stress, or excitement, the increase in arousal could potentially be representative of the overall engagement the participant experienced. Previous studies indicated an increase in engagement during MSE intervention, and positive sensorial experiences leading to increased electrodermal responses (Thompson, 2011; Lotan & Gold, 2009). Previous studies conducted on MSEs reported the use of such an intervention to help regulate the nervous system response by giving the individual an opportunity to engage in self-stimulating activities (Stedele & Malaney, 2001). The participant who demonstrated a decrease in arousal experienced the relaxing effect of the MSE. Due to the varying results reported, benefits of MSE use seem to differ across individuals, and therefore, use of multi-sensory environments need to be tailored to each individual for the most beneficial results. The inconsistent results of this current study do not support the use of MSEs as an intervention to decrease arousal in children with ASD, but do however support the use of MSEs to increase arousal in children with CP.

A limitation of the current study was the small sample size that was made up of 7 participants total. Due to the limited amount of children participating in the summer day camp at the Milwaukee Center for Independence; we were only able to analyze results on an individual basis. The results do not ensure a representative distribution of the population studied. Further studies to enhance findings in this field of research are required in order to gain a more complete understanding of the effects of sensory based interventions on children with developmental disabilities. Replication of this study should increase the sample size significantly or take an alternate approach by studying the same participants over multiple sessions in a MSE in order to determine the consistency of potential effects. The use of sensory rooms as a stimulator rather than a relaxer should also be further investigated because children with diagnoses other than ASD could potentially benefit from the alternative therapeutic technique, as demonstrated by the children with CP in the current study.

Conclusion

This research supports the use of implementing MSEs as an alternative therapeutic technique for children with developmental disabilities, and specifically encourages the use of MSEs to promote stimulation in children with cerebral palsy. Results of the different populations studied showed that MSEs are beneficial for increasing arousal in children with CP who often experience extreme deficits in sensation. Initially, sensory rooms were used primarily with children who experienced sensory overload because equipment in the sensory room allowed the clinician to choose the intensity of a certain stimulus. The current study exhibits the possibility of implementing sensory rooms in treatment for individuals who do not receive enough sensory stimulation. The benefits of sensory rooms illustrated for the various individuals in the current study suggests that MSEs are far more beneficial than initial claims and can be used for treatment on a wider array of individuals with special health care needs.

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Appendix A

Multisensory Environment Equipment Descriptions



Fiber Optic Waterfall The cascade of fiber optics hanging from the ceiling provides visual and tactile stimulation.



Interactive tactile wall panel Tactile experience of changing textures on an interactive wall panel and gentle vibrations.



Interactive Bubble Columns

Interactive columns with a color controller to enable the user to choose between 8 color options. Bubble column also vibrates for tactile stimulation.



Fiber Optics and Vibrating bed Vibrating bed and fiber optics connected above the bed provide gentle vibrations and tactile stimulation.

Appendix B

Table 1.Equipment used during treatment with special health care needs participants.

Participant	Treatment Equipment
# 4	Color lighting control, interactive bubble columns, and fiber optics
# 5	Relaxation setting: music, disco ball, fiber optics, mat with gentle vibrations, projector wheel displays colors along the wall
# 6	Music, interactive bubble columns, projector wheel displaying colors along the wall, and disco ball
#7	Mat with gentle vibrations, projector wheel displays colors on the wall, and music