Multisensory Learning and its Effect on Students with Autism

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Abstract
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Abstract
The growing population of children diagnosed with autism has led to an increasing interest in the sensory processing difficulties experienced by this population. This study examined specific patterns of sensory processing deficits within seven sensory domains. The study involved five children with an autism diagnosis aged 10-12 years. Short Sensory Profiles were completed by each child’s special education teacher, two paraprofessionals, and one parent. Data was collected from four profiles per student for a total of 20 surveys. These surveys revealed probable to definite differences between children with autism and their atypical peers in every sensory domain except Movement Sensitivity. The sensory domain that has been more closely linked to academic performance is Auditory Filtering. Auditory Filtering was found to be the sensory domain with the second greatest deficit when compared to the group percentages and remained in the top three when comparing student’s individual sensory deficits. Throughout this study I sought to determine which sensory domains these children have difficulty with and the types of atypical behaviors that are associated with sensory sensitivity. This paper will discuss current brain-based research in children with ASD, sensory processing and the educational outcomes these deficits have, the use of multi-sensory learning strategies, specific sensory teaching, early intervention, and environmental modifications to provide an ideal learning environment for students with autism. This study indicates that while there is still so much we don’t know about this neurodevelopmental disorder, we can begin to try and understand how the world is perceived in the eyes of a child with autism. By examining the specific patterns of sensory processing and the atypical behaviors that students with autism exhibit in order to cope with the multisensory world around them, we can provide strategies to not only members of the educational field, but strategies to the students themselves so that they can make sense of the constant multisensory stimulation that surrounds them.
**Researcher Stance**

My role in this study was to collect, compute, and analyze the data from the Short Sensory Profiles. Once all 20 surveys had been collected I computed raw scores for each sensory domain for each individual participant. I then calculated group averages for each domain as well as individual averages to determine the domains that produced the largest deficiencies. I was able to determine patterns within the data as well as outlying data and determined reasons for those outliers. I graphed my data in a bar graph and line graph to visually see similarities and differences between different sensory domains. Through this research, I was able to determine that students with autism have difficulty with processing sensory information in almost all sensory domains. These sensory processing deficiencies lead to atypical behaviors that are frequently exhibited in students with autism. I found that auditory processing was a leading deficit in my research as well as the leading difficulty in the research presented in the literature review portion of this paper. I was also able to determine that auditory processing difficulties are closely related to academic performance and social communication difficulties. Based on my findings I provided multi-sensory teaching strategies and environmental modifications to try to minimize competing sensory input in students with autism.

I am currently certified in Childhood Education, grades 1-6. I am presently enrolled in a program working towards earning my Master’s Degree in Special Education. While I am working towards this certification, I am also employed as a fourth-grade teacher at the school where the study was conducted.
Introduction

In order to better equip educators to meet the needs of students with Autism Spectrum Disorder (ASD), we must examine those student’s sensory processing deficits. Our world contains an unsizeable amount of information that is coded in different sensory modalities (Murray, Lewkowicz, Amedi, & Wallace, 2016). The multitude of sensory input in our environment can be challenging for students with ASD and research suggests that there are early interventions and strategies that can be implemented to help students with ASD navigate a world that relies on multisensory processes.

In the following literature review, three distinct themes will be introduced. The first theme will begin to uncover current brain-based research in relation to brain function, patterns in brain development, and brain abnormalities in children with ASD (Murray al et., 2016). Looking at sensory systems and how they influence one another, even at early stages of a child’s development, can help researchers and educators gain an understanding of the inner workings of the autistic mind. The second theme will examine patterns of sensory processing and the emotional, behavioral, and educational outcomes that result from the dysfunction in sensory processing subtypes (Ashburner, Ziviani, & Rodger, 2008). Children with ASD respond differently to sensory stimuli and looking at these patterns in adaptive behavior can give us a better understanding of the perceptual experience of children with ASD. The third theme is the use of sensory specific techniques, environmental modifications, and early interventions that can support children with autism. This literature discussed in this review deals with using teaching models based on theoretical frameworks to promote optimal outcomes for students with ASD.

Brain Function Leads to Neural Markers in Children with Autism

In order to understand brain characteristics and function in the early stages of development, we must first focus on the postnatal period. According to Bebko, Weiss, Denmark,
and Gomez (2008), “multisensory processing and the brain circuits that support it mature over the course of postnatal life and that they depend critically on early experiences” (p. 571). This evidence tells us that a child’s ability to learn and develop cognitively, behaviorally, and socially relies heavily on their ability to process multisensory information. Bebko et al. (2008) point out the importance of the integration of multisensory modalities in infancy because it “assists infants in the discrimination of segments of the speech signal, which is a necessary step for language acquisition” (p. 89). For example, the early developmental stages of language acquisition begin with face and voice recognition, then connecting facial movement and speech sounds, which leads to imitating adult speech. On the other hand, during early development, if the environment is altered or if there are deficits or disruptions in multisensory processing like those thought to be characteristics of ASD this can lead to neural plasticity which could result with input being driven only by the visual sense (Shams & Seitz, 2008). In contrast, neural plasticity, which is the ability of the brain to change, supports the evidence derived from the following study that brain changes occur during the same period that autistic behaviors begin to emerge. Hazlett et al. (2017) completed a study in which brain enlargement, total brain volume, and hyper expansion of the surface area of the brain was evaluated in children during 6, 12, and 24 months of age. They hypothesized that the emergence of ASD was directly linked to brain overgrowth and total brain volume that occurred just before 24 months of age. Their data suggests that, “hyper expansion of the cortical surface area is an early event in a cascade leading to brain overgrowth and emerging autistic deficits” (Hazlett et al., 2017, p. 605). If we are able to identify children at the postnatal period, who are at risk for developing ASD, then according to Hazlett’s findings on neural plasticity, then we may be able to reverse or minimize the severity of their autistic deficits.
ASD is a neurodevelopmental condition that is typically diagnosed within the first three years of life which includes deficits in social skills, communication, repetitive behavior, and sensory processing. Researchers have been attempting to identify neural bases in attempts to diagnose and provide early interventions to children with ASD. A study conducted by Xiao et al. (2014) sought to investigate the brain structure and anatomy of children ages two-three in relation to volumes of gray and white matter using Diffusion Tensor Imaging (DT) as well as brain region alterations. Through the use of Magnetic Resonance Imaging (MRI) scans, researchers found children with ASD had larger volumes of gray and white matter found in the right superior temporal gyrus of the temporal lobe. According to Xiao et al. (2014), “These results provide powerful evidence to support that two to three-year-old old toddlers with ASD exhibit neuro-imaging abnormalities of certain brain regions and present a link between previous behavioral findings and neuroanatomical features” (p. 1639). On the contrary, while advances are being made in the medical field there is still so much we do not know about ASD and the flaws found in current studies include such small cohorts of children that are scattered along the spectrum as well as not providing long term evidence to surface. Lange (2012) states, “Until its solid biological basis is found, any attempts to use brain imaging to diagnose autism will be futile” (p. S17). While Lange believes that brain imaging does have a place in the study of autism, he does not believe that we can rely on these measure to get appropriate and accurate diagnosis. Although Lange et al. (2010), conducted a similar study then that of Xiao (2014), which sought to investigate:

white matter microstructure (WMM) in the superior temporal gyrus (STG) and temporal stem (TS), two brain regions in the temporal lobe containing circuitry central to language, emotion and social cognition, would identify a useful
combination of classification features and further understand autism neuropathology. (p. 2)

It has already been established that an increased volume of white matter was a characteristic of the anatomy of the brain in the previous study, therefore understanding the additional findings made by Lange could help the classification features of children with ASD. Lange presented six aspects of brain anatomy and development that differ between children with ASD and typically developing individuals. As stated by Lange (2010) in regards to his findings, “These six multivariate measurements possess very high ability to discriminate individuals with autism from individuals without autism with 94% sensitivity, 90% specificity and 92% accuracy” (p. 2).

The studies above indicate abnormalities in both brain anatomy as well as brain function of children with ASD. While we have merely scratched the surface on identifying a biological basis for autism diagnosis, Lange et al. (2010), Xiao et al. (2014), and Hazlett et al. (2012) have begun to correlate brain overgrowth, white and gray brain matter volume, and brain region abnormalities in people with ASD. Researchers have presented us with possible neural markers that may indicate children who are at risk for ASD and early intervention may be possible.

**Processing Patterns Suggest Atypical Patterns in Children with ASD**

Perceptual learning studies have focused primarily on stimuli coming from a single sensory modality. However, further research suggests that through our experiences and performed tasks, we are constantly using multisensory modalities and our optimal learning environment includes multisensory learning mechanisms (Shams & Seitz, 2008). Learning through the integration of multisensory input has been proved to be effective through brain-based research. In relation to the brain function, sensory signals are relayed to cortical structures in the
brain and are processed along modality specific pathways, however several brain areas specialize in the integration of multiple sensory modalities (Iarocci & Mcdonald, 2006). This type of multisensory integration is atypical in children with ASD and the perceptual consequences result in difficulty in processing more than one sensory modality. According to Howe and Stagg, (2016) “Sensory processing issues in ASC (Autism Spectrum Condition) cover a broad spectrum from unisensory issues such as hyper/hypo sensitivity to specific stimuli through to multisensory issues that involve integrating information from different senses” (p. 1656). A common theme among clinical symptomology is the evidence of three atypical patterns of sensory responsiveness. Lane, Young, Baker and Angley (2009) define these three atypical patterns as hyporesponsiveness (reduced or absent behavioral responses to stimuli), hyperresponsiveness (exaggerated responses to stimuli), and (craving fascination with sensory stimuli) sensory seeking. The causes of these atypical behaviors derive from a child with ASD’s reaction to sensory input and help the child cope with their sensory environments by either generating sensory stimuli in which they can control or avoiding that input.

A study by Lane et al. (2009) used The Short Sensory Profile to provide cluster analysis to determine impairments in sensory processing. Scores on The Short Sensory Profile were taken from seven sensory domains including tactile, taste/smell, movement, and visual/auditory sensitivity, underresponsive/seeks sensation, low energy/weak, and audio filtering. Social processing dysfunction was evident in 87% of participants with the most extreme impairments in auditory filtering and underresponsiveness/seeks sensation domains. High deficits in social processing and auditory filtering tell us children with ASD have behavior deficits in the perception of complex stimuli such as the identification of visual and the ability to filter out auditory input such as a noisy room or deciphering speech when integrated through multiple
sensory modalities. In comparison, a study was completed by Feldman et al. (2018) to determine whether the perception and integration of speech stimuli directly correlated with atypical sensory responsiveness in children with ASD. Using the McGurk illusion to assess multisensory speech perception and integration, researchers sought to evaluate the effects of temporal synchrony. Temporal synchrony is whether subjects could correctly identify speech sounds with auditory only stimulus, visual only stimulus, congruent audio-visual stimulus and incongruent audio-visual stimulus. Temporal synchrony deals with a fourth concept in which incongruent audio-visual stimuli are presented and the participant has to fuse those two modalities together. Temporal synchrony is also known as binding and can be identified as the process in which auditory and visual stimuli are bound together into a single perceptual entity. Evident in children with ASD is the wider window of time that it takes to bind together auditory and visual stimuli, this is known as the Temporal Binding Window. The wider the temporal binding window is in children with ASD the weaker their audio-visual temporal acuity. A wider temporal binding window results in more atypical patterns of sensory responsiveness and is when children with ASD begin to exhibit hyperresponsive and sensory seeking behaviors (Feldman et al. 2018). Hyperresponsiveness and sensory seeking behaviors are exhibited by children with ASD as ways to cope with sensory overload. In contrast to the auditory and complex visual stimuli deficiencies, Baum (2015) noted that people with ASD display behavioral enhancements in regards to vision and hearing when perceiving simple stimuli. Enhanced performance on static visuospatial tasks were also found with tasks like block design, reproduction of impossible figures, and visual search tasks (Shah & Frith, 1993). While we often examine the deficits and impairments associated with ASD, there are commonalities of enhanced performance and strengths within this population.
Due to atypical sensory processing, children exhibit behavioral and emotional problems which directly affects their achievement academically. Ashburner, et al. (2008) used the Short Sensory profile as well as two caregiver questionnaires to determine how sensory processing and behavioral atypical responses affect the outcome of student achievement. Their results also yielded the most atypical sensory processing factor to be auditory filtering. Ashburner et al. (2008) explained the results of the study, “A pattern of auditory filtering difficulties, sensory underresponsiveness, and sensory seeking was associated with academic underachievement” (p. 564). Children who have difficulty with auditory filtering will struggle to process verbal instructions especially in environments that are loud, and will often exhibit sensory seeking behaviors that affect them academically. Ashburner (2008) and Howe and Stagg (2016) wanted to determine what implications these sensory responsiveness deficits and atypical behavior had in the classroom and their effects on academic achievement. Rather than use the Short Sensory Profile which is typically completed by caregivers, Howe and Stagg wanted a first-hand account of, “how adolescents with autistic spectrum conditions perceive sensory differences to be affecting their learning experiences in the classroom” (p. 1657). A questionnaire was completed in which the participant rated how much each sense affected them in the classroom. Consistent with the findings of Ashburner et al. (2008) and Lane et al. (2009), the data showed that the majority of participants were affected by issues related to hearing and auditory filtering, followed by touch, vision, and smell. Is evident that impairments in sensory processing and the atypical behaviors exhibited by children with ASD directly impacts their emotional, behavioral, and education well-being in the classroom.

Students with autism process information differently than peers without autism. It has been found that although they show enhancements in unisensory input, they have deficits when
trying to perceive sensory information from multiple modalities. Based on the findings of the studies discussed, auditory filtering showed the most significant correlation to atypical behavior and processing. The processing difficulties of ASD children lead to the atypical behaviors which can result in poor academic achievement.

**Effects of Early Intervention and Sensory Specific Techniques on Children with Autism**

Educators have the responsibility to teach the curriculum in many different modalities so that all students are capable of learning. The multi-sensory approach reaches a diverse group of learners including those with disabilities by engaging them through auditory, visual, and tactile senses. Obaid (2012) reinforced the concept of multi-sensory learning by stating, “The idea that learning experienced through all the senses is helpful in reinforcing memory has a long history in pedagogy” (p. 75). Using multi-sensory techniques engage and motivate learners and provide a richer learning environment. Obaid conducted a study of whether or not using a multi-sensory teaching approach to mathematics through the use of manipulatives would significantly increase participants scores on a post test. The study concluded showing significant mean score differential on behalf of the multisensory teaching approach. Correspondingly, a study conducted by Flores, Hinton, Strozier, and Terry (2014) also found that using a multisensory approach to teach math would aid in memory and conceptual understanding of mathematical concepts. The method involved is known as the Strategic Instruction Model (CRA-SIM) and it involves:

- an instructional sequence in which the operation is taught using manipulative objects;
- once master is demonstrated using objects, instruction involves the use of drawings and pictures. Once students demonstrate mastery at the representational level, they learn the strategy for solving operations that involve numbers only. (p. 548)
This teaching model encompasses all sensory modalities and was shown to be effective with students with ASD who may prefer to learn visually. The multisensory approach to learning includes the tactile/kinesthetic sensory input which promotes memory and understanding in students with ASD. The idea of “hands-on” learning is aimed to enhance sensory-perceptual input. Latham and Stockman (2013) conducted a study in which students with ASD were presented with a juice making task and half of the children participated with a hands-on manipulation of the juice maker while the other group simply observed the task. The analysis showed significantly higher mean scores for the hands-on participants in their ability to perform the task themselves as well as the ability to verbalize the vocabulary presented in the guided lesson.

As we look for ways to improve cognitive, behavioral, and emotional outcomes for students with ASD, early intervention may prove to significantly improve IQ, language, adaptive behavior, and even autism diagnosis. A trial known as the Early Start Denver Model (EDSM) conducted by Dawson, Rogers, Munsun, Smith, and Winters et al. (2009) proved the efficacy of early behavioral intervention for toddlers with ASD. The Early Denver Start Model is described as an early intervention strategy that:

- uses teaching strategies that involve interpersonal exchange and positive affect, shared engagement with real-life materials and activities, adult responsivity and sensitivity to child cues, and focus on verbal and nonverbal communication, based on a developmentally informed curriculum that addresses all developmental domains.

(Dawson et. al 2009, p. 20)

The EDSM consists of a team of related service providers and intense parent involvement, which may not always be feasible, however the effectiveness of the model has
evidence of showing drastic positive change in children with ASD. Sullivan, Stone, and Dawson (2014) support the EDSM as means to bridge the deficits exhibited by children with ASD by providing multisensory curriculum and interactions through their social environment in order to help establish and maintain complex neural networks in the brain. Ultimately, the EDSM can influence brain function due to the remarkable plasticity of the brain and lead to significant gains in children with ASD. Teaching strategies presented by this model encourage teaching multiple objectives through multiple modalities in a given task or episode. Sullivan (2014) explains that during each episode children should be exposed to multiple modalities including auditory, visual, tactile, and kinesthetic as well as multiple brain functions such as face and emotion processing, linguistic processing, and affective responses.

The use of intensive early intervention has shown tremendous impact on a social, cognitive, and behavioral scale in children with autism. While early intervention is not always possible providing students with a rich learning environment that aims to use multiple sensory modalities to meet the needs of diverse learners as well as facilitate social interactions and communication is essential. The use of hands-on learning and incorporating tactile and kinesthetic sensory modalities has been proven to aid in conceptual learning and memory. By incorporating the different teaching models described above we can address the core deficits associated with ASD.

**Conclusion**

Brain-based research has given us possible neural markers for the early detection of children with ASD. Through the use of MRI scans and neuroimaging we can use these neural markers such as brain overgrowth, brain surface area expansion, gray and white matter volume, as well as detection of abnormalities in particular regions of the brain. With these identifying
characteristics, we can begin early intervention for those children at risk for ASD. Due to the plasticity of the brain early intervention could normalize certain neural connections and reduce the severity of ASD symptoms or eliminate its diagnosis completely.

In order to determine the best interventions for children with autism we must gain an understanding of the way in which the autistic mind processes sensory information and what implications this has for the classroom. The modality with the most significant deficit is that of auditory filtering followed by touch. The way in which children with ASD process different sensory input lead to atypical behaviors in order to cope with the multisensory environment around them. By determining the modalities that affect children with ASD and the reasoning behind atypical behaviors we can begin to provide interventions and teaching strategies that best fit their needs.

**Methodology**

**Context**

The aim of this study was to determine the patterns of sensory processing difficulties in students with autism and examine the relationship between sensory processing patterns and adaptive behavior. My study took place in an elementary school in upstate New York where I work. I had the opportunity to survey a special education teacher, paraprofessionals, and parents in a 5th and 6th grade Autism Spectrum Disorder Classroom.

**Participants**

Five students with Autism Spectrum Disorder were involved in the study. Four Short Sensory Profiles were completed for each student: one by the special education teacher, two paraprofessionals, and one parent. Participants were between the ages of 10 and 12 years old. Written consent was received by each parent in the form of a formal letter and permission slip as
well as their participation in completing the survey. Permission was also granted by my school administration to conduct the study. The rights of the participants were protected by keeping all surveys and data derived from those surveys completely anonymous. Surveys and specific student data will be kept locked in a secure location for two years. After two years, it will be destroyed.

**Instrumentation**

The Short Sensory Profile (SSP) is a 38-item questionnaire designed to measure behaviors associated with abnormal sensory processing. The SSP that was used to determine how well the participants process sensory information and to profile the sensory system’s effect on functional performance was developed in 1999 by Dr. Winnie Dunn of The Psychological Corporation. The scores are derived from seven sensory domains which include Tactile, Taste/Smell, Movement, Underresponsiveness/Seeks Sensation, Auditory Filtering, Low Energy/Weak, and Visual/Auditory Sensitivity. Teachers, paraprofessionals and caregivers rate the frequency with which the child demonstrates behaviors on a 5-point scale that ranges from “always” to “never.” Higher raw scores relate to typical performance whereas lower scores indicate a probable or definite difference in sensory processing.

**Procedures**

The SSP was completed by the special education teacher, two paraprofessionals that work in that specific classroom, and one parent of all participants. Sensory processing was the independent variable of interest that was measured using the SSP. Four surveys were completed for each of the five participants for a total of 20 Short Sensory Profiles in which to derive sensory processing data.
Data Analysis

Raw scores were computed for each of the seven sensory domains as well as an overall raw score total. Then, I took the participants individual section raw score totals and calculated the groups average raw score for each section and the average percentage for each domain. After computing the group’s average section raw score totals this shows that in the domains of Tactile, Taste/Smell, Movement, Underresponsiveness/Seeks Sensation, and Auditory Filtering there were probable differences in sensory processing. A definite difference was shown in the domain of Low Energy/Weak, whereas in the domain of Visual/Auditory Sensitivity their showed typical performance. Participant’s total raw score shows that 65% have definite differences in sensory processing.

Further analysis focused on the whole group percentages. This data was derived by taking each participants individual score for each sensory domain and calculating the group average.
Figure 1 shows the group percentages for each sensory domain. The lower the percentage the greater the sensory deficit. Based on this data point, Taste/Smell Sensitivity had the greatest sensory deficit at 67.25% followed by Auditory Filtering at 68%, Low Energy/Weak, 69.2%, and Underresponsiveness/Seeks Sensation at 72.4%. On the other hand, the least amount of sensory processing deficits were found in Movement Sensitivity, Tactile Sensitivity, and Visual/Auditory Sensitivity. After identifying atypical sensory processing as a group in each sensory domain further examination into the individual statistics would help us gain an understanding of the sensory processing deficits for the individual participant.

![Student Individual Profile Percentages](image)

Figure 2 shows the mean percentages in each sensory domain for each of the five individual students. Each line on the line graph shows where each individual student’s mean percentage falls in relation to their peers in each domain. Student 1 shows the greatest sensory processing difficulties in the domains of Movement at 60%, Underresponsiveness/Seeks Sensation at 61%, and Auditory Processing at 71%. Student 2 shows the largest deficits in the
domains of Taste/Smell Sensitivity at 45%, Movement Sensitivity at 62%, and Auditory Filtering at 68%. Student 3 deficits are dominant in the domains of Auditory Filtering at 45%, Visual/Auditory Sensitivity at 64% and Tactile Sensitivity at 70%. Student 4 records deficits in the domains of Taste/Smell at 70%, Movement at 74%, and Low Energy/Weak at 77.5%. Student 5 displays sensory processing difficulties in the domains of Underresponsiveness/Seeks Sensation at 63%, Movement at 63% and Tactile Sensitivity at 64%. The three domains that participants showed the greatest sensory difficulties were Movement Sensitivity, Auditory Filtering, and Taste/Smell Sensitivity. Data also suggests that 60% of participants had atypical performance in the domain of Auditory Processing. Besides the Movement domain, Auditory Processing was the second largest domain deficit. The group percentages are consistent with the findings of deficits in auditory processing and taste/smell, however were inconsistent with the data for movement which as a group showed probable to typical performance, but individually scored as one of the top three deficits. This inconsistency in data could be explained by the number of questions in that part of the survey. Only three questions pertain to the domain of Movement Sensitivity therefore the averages may be slightly skewed due to lack of data points for that domain.

**Findings**

This study supports the predominant views found within literature and case studies that students with ASD experience significant differences in their ability to process sensory input. The Short Sensory Profile has revealed specific characteristics and patterns of sensory processing within a small cohort of children with autism. As a cohort there were definite differences in the domains of Taste/Smell, Auditory Filtering, and Low/Energy Weak. The deficiency presented in the Auditory Filtering domain is consistent with the findings of Ashburner et al. (2008) and Lane
et al. (2009), which both studies found Auditory Filtering to be the domain with the most atypical sensory processing score. Ashburner et al. (2008) found 75% of participants to have definite differences and 21% having probably differences for a total of 96% of students showing either probable or definite differences in Auditory Filtering. In comparison, Lane et al. (2009), cited having 92% of participants showing sensory processing differences in the same domain. Within the Auditory Filtering domain most items relate to overresponsive behaviors such as being distracted or has trouble functioning if there is a lot of noise, or can’t work with background noise. However, there are also items in this section that deal with underresponsive behaviors such as not responding when name is called. These tend to be the more atypical behaviors associated with ASD.

When we think of these domains in the school environment we can conclude that the processing deficits in the domain of Auditory Processing can directly effect a student’s academic performance. Auditory filtering difficulties are directly associated with learning and attention which is why they are the focus of our study and findings. Auditory filtering directly correlates to academic success and being able to function in a classroom setting. Consistent with the findings of Lane et al. (2009), she stated in her conclusion that,

A pattern of difficulty in sensory modulation without movement was predictive of communication impairment, and general sensory modulation difficulties predictive of maladaptive behavior. These findings support the continued use of sensory-based interventions in the remediation of communication and behavioral difficulties in autism.

(page 121)

We know students with autism process information differently than their typical peers, therefore through sensory-based interventions that include instruction within all sensory modalities, we
can not only try to close those gaps in sensory processing, but also use the student’s strengths to help them be successful in the classroom.

**Discussion**

There is an overwhelming amount of research that supports that the use of multi-sensory learning and sensory-based interventions can greatly impact the academic success of students with autism. Children with ASD process different sensory input and this leads to atypical behaviors in order to cope with the multisensory environment around them. If we are able to eliminate or manage that sensory input and create a less overwhelming sensory environment this could benefit our students with ASD. For example, if we can simplify our classroom setting, reduce any background noise, give students choice seating not in close range to other students, provide visuals when giving instructions, establish routines and predictability, allowing wait time, and minimizing competing input can all help students with autism in providing an environment conducive to learning.

In addition to establishing the classroom environment, we also need to incorporate a multi-sensory approach to teaching the content. A multi-sensory approach includes teaching using multiple sensory modalities that aid in memory and retaining information. We can address the core deficits associated with ASD by providing “hands on” learning that incorporates tactile and kinesthetic modalities. The data derived from this study coincides with similar findings of Lane et al. (2009) and Ashburner et al. (2008), which concluded that auditory processing was found to be the sensory domain with the largest deficit that has the greatest effect on a student’s academic performance. Based on these findings auditory processing needs to be at the forefront of our interventions strategies. Processing auditory information is a critical component not only of achieving academic success, but also social communication which deficits are evident in
students with autism. Therefore, as educators we need to provide interventions to students in multiple modalities to bridge the auditory processing gap. Providing visuals in conjunction with auditory instructions can assist student’s retention of steps as well as predictability of a task. In addition to visuals, incorporating tactile and kinesthetic components that tap into other sensory domains have been associated with recall and memory of those tasks. If we look at education as a whole for students with autism and concentrate on sensory issues we can reduce the levels of anxiety in the school environment that tend to lead to atypical behaviors. As educators we need to have a in depth understanding of the students in our room. The autism spectrum and the students that encompass that spectrum are so diverse in their needs and abilities that collecting as much data as possible and identifying strengths and deficits not only in their processing difficulties, but also their social communication needs can help us provide interventions that are unique and cater to the individual student. Through sensory profiles, IQ tests, cognitive tests, and sensory interventions we can get to know our students and their needs on a more in depth personal level. Building relationships and trust with students with autism needs to be the main focus of educators. Only when these things are established can we begin to address their social and academic needs in a world that involves constant multisensory stimulation. We are there to help students make sense of this multisensory world and ways to cope with constant sensory input.

Further research in neuropsychology and neuroscience can lead to discoveries in neural markers as well as abnormalities in specific brain regions that can lead to early diagnosis of autism. Early diagnosis and findings on neural plasticity, the ability of the brain to change, could lead to early interventions that minimize or reverse sensory processing difficulties or diagnosis. While studies are inconclusive and there is still so much we don’t know about this
neurodevelopmental disorder, brain-based research, and sensory processing studies are beginning to scratch the surface to uncover the causes as well at characteristic patterns of behavior and social communication. Studies with a larger cohort of children as well as children more closely identified on the autism spectrum can lead to more conclusive and reliable research.
References


