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Research Article

Sensory Processing and Visual Motor Integration of Children with Autism Undergoing Occupational Therapy Intervention

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Abstract

Purpose: Limited studies have examined the relationship between occupational therapy, sensory processing, and visual motor integration abilities of preschool aged children with autism spectrum disorder. The relationship between Short Sensory Profile scores and pre Beery-Buktenica Developmental Test of Visual Motor Integration scores on post Beery-Buktenica Developmental Test of Visual Motor Integration scores of children with autism undergoing occupational therapy was unknown.

Methods: A secondary data analysis of 36 children (32 males and 4 females) who received occupational therapy services was included in the study. Four quantitative, exploratory research questions were analyzed using a multiple linear regression.

Results: Questions were assessed separately, and it was concluded that there was a statistically significant difference between pre and post beery test scores and that pre scores were most predictive of post scores. There was not a significant difference between pre and post Sensory Profile scores and these test scores were not predictive of post Beery test scores.

Conclusion: From this study, occupational therapy practitioners should be aware of the relationship between pre and post Beery scores, to assess their interventions by meeting expected changes. Future research should focus on the implications of sensory processing and visual motor integration but use a different sensory processing assessment.

Keywords: Beery-Buktenica developmental test of visual motor integration; Pediatrics; Rehabilitation; Sensory profile

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Introduction

Autism Spectrum Disorder (ASD) occurs in one out of 59 births in the United States and is approximately four times more common among boys than girls [1]. Additionally, the prevalence of ASD in American children has increased by almost 125% in 10 years, making it the fastest growing developmental disability [2]. ASD is a broad umbrella term for neurodevelopmental disorders that include stereotypical patterns of behavior and impairments in social interaction [3]. Although the cause of ASD is unknown, extensive research has concluded that there are likely many causes for the multiple types of ASD [4]. For instance, genetic factors (e.g., a family history of ASD) and environmental factors (e.g., exposure to air pollution, organophosphates, and heavy metals) have been linked to ASD [5-10]. Although these risk factors may be present before birth, symptoms of ASD typically do not present until early childhood [11].

Children with ASD may demonstrate both gross and fine motor impairments [12]. Impaired motor function is not included in the diagnosis of ASD, yet they are commonly noted by healthcare providers and caregivers. For instance, Visual Motor Integration (VMI) deficits are common [13-15]. VMI is the ability to perceive visual input, process the information, and coordinate a motor response [16]. The ability to control hand movements through vision is necessary for a multitude of academic and non-academic endeavors. Impairments in VMI skills can impact the ability to participate in academic and non-academic endeavors, which can be further affected by sensory processing difficulties. Significant VMI deficits have been described in children with ASD [13,14]. These deficits are theorized to be the result of lower activity in the right angular gyrus, precentral gyrus, and left middle cingulate [15]. Overall, VMI dysfunction is prevalent in children with ASD.

VMI may be positively impacted by occupational therapy intervention [17-20]. Occupational therapy practitioners utilize psychometrically sound assessment tools, such as the Beery-Buktenica Developmental Test of Visual Motor Integration (Beery VMI), to determine the severity of the impairment and realistic expectations for improvement. Other underlying causes for the delayed achievement of age-appropriate milestones must also be addressed during the evaluation. For instance, children with ASD often present with VMI deficits that can be related to their impaired sensory processing.

Sensory functions are described as visual functions, hearing functions, vestibular functions, taste functions, smell functions, proprioceptive functions, touch functions, pain, and sensitivity to temperature and pressure [21]. Children with ASD experience

difficulties modulating sensory stimuli. Behaviors associated with sensory modulation are conceptualized as bystander, seeker, sensor, or avoider and is captured through the Short Sensory Profile 2 (SSP; [22]). The role of sensory processing changes over the lifespan based on the individual's participation in meaningful and productive occupations. However, underlying each occupation is the ability to learn and adapt. Infants explore their environment, interact with their caregivers, and begin to learn and adapt. Children explore their environment, interact with their caregivers/teachers/friends, and begin to learn and adapt to academic occupations [23]. Therefore, sensory processing challenges can manifest in the performance of necessary tasks such as those encompassed by VMI.

Sensory processing may be positively impacted by occupational therapy intervention. The sensory processing difficulties experienced by children with ASD, impact their ability to self-regulate, manage arousal level, and attend to tasks [24-26]. Children with ASD continually struggle to self-regulate, manage arousal level, and attend to tasks if sensory processing strategies are not applied [27]. Occupational therapists and assistants incorporate sensory integration approaches to create a comprehensive, individualized approach for each child. For the child that is unable to self-regulate to the changing conditions in a busy environment, the therapist may try a weighted vest or linear swinging [28]. For another child who is unable to manage his/her arousal level at the clinic, the therapist may try therapressure or heavy work [29]. For another child who is unable to attend to the board game, the therapist may try a therapy ball or a therapy cushion [30].

The understanding of sensory integration has evolved in the past 30 years due to technological advances and improved research techniques/methodologies [31,32]. A greater level of awareness regarding the intricacies of sensory integration has resulted. Researchers have continued to explore sensory integration with the use of more rigorous research methods [33,34], built on the work of [35,36] by proposing a model that delineated two major subtypes of sensory integrative dysfunction: dyspraxia and poor modulation. The model described the concepts of over-responsiveness and underresponsiveness to sensation on a continuum [32]. Researchers have also demonstrated increased attention to measurement of fidelity, greater usage of exploratory and factor analysis, and more routine practice of examining multivariate research problems with computer statistical programs [37]. Sensory integration has further advanced through the development of measurement tools that specifically evaluate sensory modulation, such as the SSP [38] and the Sensory Processing Measure [39].

The current research is at a consensus that ASD may negatively impact VMI and sensory processing [13,40-42]. Occupational therapy intervention may improve both VMI and sensory processing through evidenced-based practice [18,43-46]. Although the link between sensory processing and VMI performance in children with ASD has been suggested in research, there is very little currently available on the topic [14,47]. This study addressed the gap in knowledge by investigating SSP and Beery VMI scores of children with ASD undergoing occupational therapy intervention.

Methods

This study investigated the relationship between sensory processing and VMI performance of children with ASD undergoing occupational therapy. First, the study sought to establish a statistically significant difference between pre and post test scores. Then the influence of pre SSP, pre Beery VMI and post SSP scores on post Beery VMI scores was investigated. A multiple linear regression was used to answer the following research questions:

R_1: Is there a statistically significant difference between pre and post Beery VMI scores?

H_0: There is no significant difference between pre and post Beery VMI scores.

R_2: Is there a statistically significant difference between pre and post SSP scores?

H_0: There is no significant difference between pre and post SSP scores.

R_3: Are SSP scores significantly related to Beery VMI scores?

H_0: There is no significant difference between SSP and Beery VMI scores.

R_4: Are pre Sensory Profile, pre Beery VMI, and/or post SSP scores significantly predictive of post Beery VMI scores?

H_0: Pre SSP, pre Beery VMI, and/or post SSP are not significantly predictive of post Beery VMI scores.

G*Power was used to determine the number of subjects necessary to answer the research questions. The power was set at 0.8 due to the novel nature of the study. G*Power calculated the total sample size to be 34 [48].

Beery VMI raw scores were utilized for pre and post test scores. For the SSP, total score was calculated based on standard deviations from the norm. For instance, "much more" or "much less" received a score of 2 while "more" and "less" scored 1 and "the same as other children" received a 0. Therefore, higher Beery VMI scores indicated improved performance whereas lower SSP scores indicated lower severity of symptoms.

A non-probability purposive sampling strategy was employed for the study. Data were obtained from one pediatric outpatient clinic in South Florida. Patient charts of children aged two to five years of age with diagnoses of ASD were reviewed. The data reviewed spanned from June 1, 2017 to March 13, 2020. Patient charts with pre and six-month-post SSP and Beery VMI scores who attended at least one therapy treatment session were included in the study. Pre SSP, post SSP, pre Beery VMI scores, and post Beery VMI scores were recorded with relevant demographic information (e.g., age and gender).

Results

A sample of 36 children was included for data analyses. The actual sample exceeded the necessary sample size calculated through G*Power with an 80% confidence interval (N=34).

Average age was 47.027 months old. 32 males and 4 females. The mean Beery VMI scores were 5.00 for pre and 7.03 for post. The mean SSP scores were 9.39 for pre and 7.78 for post.

The first research question asked if there was a statistically significant relationship between pre and post Beery VMI scores. There was a strong correlation between pre and post Beery VMI scores (p=.000). Therefore, the null hypothesis was rejected. The second research question asked if there was a statistically significant relationship between pre and post SSP scores. There was a weak correlation between pre and post SSP scores (p=.010). Therefore, the null hypothesis was not rejected. The third research question asked if there was a

statistically significant relationship between SSP and Beery VMI scores. At an 80% confidence interval, pre SSP scores were not significantly correlated with pre Beery VMI scores (p=.232). Pre SSP scores were not significantly correlated with post Beery VMI scores (p=.318). Post SSP scores were not significantly correlated with pre Beery VMI (p=.420) or post Beery VMI (p=.403). Therefore, the null hypothesis was not rejected. The fourth research question asked if there was pre SSP, pre Beery VMI, and/or post SSP were significantly predictive of post Beery VMI scores. The results of the regression indicated that there was a high degree of correlation (R=0.851). Additionally, the model explained 72.5% of the total variation in the dependent variable for the sample population and an estimated 69.9% of the represented population. The results indicated that the model was a significant predictor of post Beery VMI scores, F(3, 32)=28.091, p=.000.

Based on the correlations, pre Beery VMI scores contributed significantly to the model, but not pre or post Sensory Profile scores. Therefore, only the pre Beery VMI score was included in the final predictive model. The final predictive model was: post Beery VMI scores=.870+(1.057 pre Beery VMI score). The null hypothesis was rejected.

Discussion

The findings of the study illustrate the severity of VMI deficits in children with ASD. The mean Beery VMI scores were 5.00 for pre and 7.03 for post. The average pre Beery VMI score was 5.00, which has an age equivalent of 2.7 years. The average post Beery VMI score was 7.03 or 7, which has an age equivalent of 3.1 years. However, the average age of the subjects at the pre Beery VMI score was 47.027 months old or approximately 4 years of age, illustrating the severe deficits of VMI skills. In regard to this study's findings, it was unsurprising that pre Beery VMI scores were a strong predictor of post Beery VMI scores. Pre Beery VMI scores determined the amount of discrepancy between the child's current status and their expected age equivalent. While the mean SSP scores were 9.39 for pre and 7.78 for post. Despite the weak correlation between pre and post SSP scores, the mean SSP scores decreased by 1.61, indicating the severity of sensory processing difficulties diminished over the six months of occupational therapy intervention.

There was a statistically significant difference in Beery VMI scores after six months of occupational therapy intervention and pre Beery VMI scores were predictive of post Beery VMI scores. These findings are congruent with past literature that concluded occupational therapy's positive impact on VMI [17-20]. Occupational therapy practitioners can use the data to assess their interventions by meeting expected Beery VMI changes. Insurance companies can justify coverage of occupational therapy intervention. Caregivers can be motivated by understanding the potential and realistic expectations for improvement. Overall, the findings derived from this study are valuable to key stakeholders and benefit children with ASD.

Conclusion

The study investigated the relationship between SSP and Beery VMI scores of children with ASD undergoing occupational therapy. Four quantitative, exploratory research questions were analyzed using a multiple linear regression in SPSS. For the first research question, the null hypothesis was rejected because there was a statistically significant difference between pre and post Beery VMI scores. For the second research question, the null hypothesis was not rejected because there was not a significant relationship between pre and post SSP scores. For the third research question, the null hypothesis was not rejected because there was not a significant relationship between SSP and Beery VMI scores. For the fourth and final questions, the null hypothesis was rejected because pre Beery VMI scores were predictive of post Beery VMI scores. The final predictive model was: post Beery VMI scores=.870+ (1.057 pre Beery VMI score). Overall, occupational therapists can use the model established by this study to establish realistic goals for therapy and to assess their patients' progress. Future research should still investigate the relationship between sensory processing and VMI of children with ASD, but it is recommended that a different sensory processing assessment be utilized.

Declaration of Interest

The authors declare no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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