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ASSESSING VISUAL PERCEPTION IN CHILDREN WITH DIFFERENT TYPES OF CEREBRAL PALSY

Original Research

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ABSTRACT

BACKGROUND: Cerebral palsy is a condition of neurodevelopmental disabilities that affects movement and often occurs with deficits in visual perception. This paper explores how children with several types of cerebral palsy—spastic, dyskinetic, and ataxic—were evaluated using the Barry Visual-Motor Integration Test and its three subtests regarding visual perception, motor coordination, and combined visuomotor integration.

OBJECTIVE: To determine assessing visual perception in children with several types of cerebral Palsy.

METHODOLOGY: The study was cross-sectional in design and conducted over a period of six months among 150 children aged 3 to 15 years at PSRD School and Children's Hospital, Lahore. Structured, purposive sampling ensured a representative cohort for all CP subtypes, including children with varying degrees of motor impairment.

RESULTS: The results indicate a variety of visual perception problems across all types of CP. Spastic CP manifested in the loss of depth perception and spatial orientation, seriously impairing the daily abilities. In the case of dyskinetic CP, visuomotor integration was impeded by involuntary movements, while object tracking and spatial awareness were diminished in the case of ataxic CP. The varying degrees of these deficits appear in various VMI indexes: spastic CP was measured at a mean value 80.03, ataxic at 77.23, and dyskinesia at 82.31. Cognitive performance also varied in the study, with individuals having dyskinetic CP showing slightly better results. Therefore, the variability of results indicates the complex interplay of motor, visual, and cognitive impairments in CP.

CONCLUSION: It is concluded that visual perception deficits have a significant impact on functional and social outcomes in children with CP. The study recommends the widespread use of individualized rehabilitation plans, improved diagnostic tools such as the Visual Function Classification System (VFCS), and virtual reality-based interventions. Future studies should aim to be more longitudinal, thus allowing them to monitor long-term consequences and address the least understood subtypes like ataxic and dyskinetic CP so that they may better direct treatment modalities for enhancing quality of life of a child with CP.

KEY TERMS: Visual Perception, Spastic, Dyskinetic and Ataxic Cerebral Palsy.

INTRODUCTION

Cerebral palsy (CP) is a group of neurodevelopmental disorders primarily characterized by abnormal movements, muscle tone, and posture as consequences of damage during brain development. In addition to impairing motor control, CP has an impact that goes beyond general movement disorders and extends into cognitive and sensory-perceptual functions, particularly visual perception. As research continues in this area, it is progressively more evident that visual perception plays a vital role in the developmental and functional capacities of children with CP vis-à-vis motor function, cognitive competence, and, most importantly, social behavior. Correspondingly, flaws in visual perception may significantly affect the actual progress of children in these plans of development. It therefore follows as a truism that there should be an appreciation for such a relationship[1].

Visual perception encompasses a wide range of cognitive processes comprising visual acuity, spatial relation, depth, and object recognition. All such processes play a necessary role in performing several activities ranging from reading and writing to socializing. Children with CP commonly suffer from visual perceptual deficits, but they vary in nature and extent based on the nature and degree of their motor impairment[2].

Thus, visual perception as a pathology is not only secondary but also has an association with a lack of movement and further complicates the life of a child with CP[3].

Visual perception relates to the brain's process of interpretation of visual stimuli that enables one to see the naming of shapes, objects, and their spatial relationship. In the typically developing child, this same sense is used in combination with motor skills, such as reaching and grasping and locomotion through space. Children with CP have some challenges here since there is invariably an impairment of motor and sensory processing. As shown by studies, a child suffering from CP has visual perception impairments that affect their interaction mechanisms and influence their connection with the environment; such elementary tasks as walking around, lifting, or avoiding obstacles become even complicated for these children[4].

Visual-motor activities, such as writing and drawing, and other kinds of sports, now pose extra difficulties for kids with CP. These types of problems can significantly limit independence as well as social interaction. For example, children who lack clear depth perception are bound to make errors while estimating the distances separating objects; therefore, it becomes dangerous for them to move around their surroundings and interact freely with other people. Problems associated with visual tracking can also significantly affect their ability to track moving objects, thereby losing out in educational and play fields[5].

The type of CP brings an enormous impact upon the extent and seriousness of visual perception disabilities. There are three types of cerebral palsy, categorized as spastic, dyskinetic and ataxic. These have completely different challenges to motor and to visual functions. Spastic cerebral palsy is the most diagnosed, accounting for about 70 to 80 percent of all children diagnosed with cerebral palsy. It is characterized by increased muscle tone and stiffness, which in turn affects voluntary movement and coordination. In spastic cerebral palsy, the visual perception of children often includes poor depth perception, bad spatial orientation, leading to an inability to understand their surroundings (Berlowitz & Franzsen, 2021). For example, such children would find it difficult with activities that require accurate hand-eye coordination like writing, drawing, or even reaching out for objects[6]. Their improved muscle stiffness affects their control of eye movements, thereby exacerbating the problems of perceiving spatial field[7].

Dyskinetic cerebral palsy, characterized by spasm and involuntary movements that the patient cannot control, presents other challenges. Children with cerebral palsy have incessant movements that make them fail to focus and gauge the distances hence major difficulties in picking or dressing themselves. Problem. Visual motor integration is usually severely impaired in this group, which further prohibits them from being able to coordinate movement with what they see. As a result, quite simple everyday activities such as eating, playing, and even playing with friends can be severely impaired due to their inability to react to visual stimuli[8].

Ataxic cerebral palsy is the rarest form and causes major balance and coordination issues. Children with CP often struggle to track moving objects and understand spatial relationships, limiting participation in physical and group activities[9]. Because visual perception and motor control are closely linked, impaired motor functions make it harder for these children to process visual information, creating a cycle of difficulty in learning and adapting[10]. These challenges appear in daily activities like dressing, feeding, and bathing, where both movement and visual interpretation are required. Poor spatial skills affect independence and self-esteem, and difficulty interpreting visual cues can reduce social participation Dera more[11].

METHODS

A cross-sectional study was conducted over six months following synopsis approval. The research was conducted at Children Hospital Lahore, PSRD OT Department, and PSRD School using a stratified purposive sampling technique, with a sample size of 150 participants. Children aged 3–15 years diagnosed with cerebral palsy (spastic, dyskinetic, or ataxic) who had normal or corrected vision, varying motor impairments, and the ability to complete the Beery VMI test were included, while those with severe intellectual disabilities, other neurological conditions, uncorrected visual impairments, or behavioral issues preventing testing were excluded. Data was collected using the Beery Visual-Motor Integration (VMI) Test and its subtests—Visual-Motor Integration, Visual Perception, and Motor Coordination—with assessments conducted in a clinical setting after informed consent, and all information kept confidential. Data analysis involved descriptive statistics for demographics and VMI scores. Ethical approval was obtained from the Institutional. Review Board of Children's Hospital Lahore, with informed consent from parents or guardians, assurance of voluntary participation, confidentiality of information, and adherence to all ethical guidelines to ensure participant safety.

RESULTS

The study included 150 participants aged 5–14 years (mean = 8.43 ± 2.82), with the most common ages being 5 and 9. No missing data were found for gender, CP type, or severity. Males made up 59.3% of the sample. Ataxic CP was most common (40%), followed by spastic (38.7%) and dystonic (21.3%). Most participants had mild (39.3%) or moderate (40%) CP, while 20.7% had severe CP. VMI scores averaged 80.03 (SD = 11.68), ranging from 62 to 94, with 80 being the most frequent score. The score distribution was uneven and showed multiple peaks. Cognitive scores averaged 73.02 (SD = 9.33) with common scores at 70, 60, 78, and 85, also showing a non-normal spread. Further analysis of subsamples showed mean Beery VMI scores around 77–82 and cognitive scores around 70–75, with moderate variability and bimodal patterns in several distributions. Histograms across all groups showed clustered scoring patterns, indicating diverse performance levels in both visual-motor integration and cognitive abilities.

Table 1: Descriptive Statistics of Age of Participants

Mean	8.43
Standard deviation	2.822
Maximum age	5
Minimum age	14

Table 2: Gender distribution of participants:

Gender	Frequency	Percent
Male	89	59.3%
Female	61	40.7%
Total	150	100%

Table 3: Distribution of Cerebral Palsy Types:

Types of CP	Frequency	Percent
Spastic	58	38.7%
Ataxic	60	40.0%
Dyskinetic	32	21.3%
Total	150	100%

Table 4: Visual Motor Integration Score Across Different types of CP:

Beery VMI Component	Spastic CP (mean ± SD)	Dyskinetic CP (mean ± SD)	Ataxic CP (mean ± SD)	p-value
Visual-Motor Integration (VMI)	78.5 ± 9.8	68.2 ± 10.5 (lowest)	72.0 ± 9.1	<0.001
Visual Perception	81.4 ± 8.6	78.1 ± 9.0	70.6 ± 10.3 (lowest)	<0.001

Motor Coordination	70.2 ± 11.4	66.5 ± 12.7	62.3 ± 13.8 (lowest)	0.002
Overall Composite Score	76.7 ± 8.2	69.7 ± 9.4	68.9 ± 9.9	<0.001

DISCUSSION

Children suffering from CP display variability in performance when being assessed on VMI and cognitive function, revealing the complex nature of neurological abnormalities in this population. The findings from the studies thus provide a clearer understanding of the effects of cerebral palsy on those areas, consistent with an increasing body of research exploring the different difficulties faced by children with CP. The Berry VMI scores noticed in the present research displayed high performance diversity, ranging from 62 to 94, with a mean of 80.03 (SD= 11.68). This variance is in accordance with the other earlier studies[12]. It was found that children with cerebral palsy (CP) show marked defects in visual perceptual processing, including problem areas of area, length, orientation, and position. These deficiencies in visual perception explain the difficulties demonstrated on VMI tasks, given that these basic perceptual skills form the foundation over which integration of visual input with motor outputs is achieved. The effect of this variance is found in the group scores that all fall between 80 and 94, which suggest, in terms of performance, that while few children are performing well enough, others are seriously challenged given their location, severity, and type of CP injury.

The average performance of children with ataxic CP was a bit lower (mean=77.23, SD=8.216), which made visible the impact of postural instability and poor coordination on their visuomotor activities. According to Michaela Sjödin's (nod) research on postural stability in children with cerebral palsy, ataxic CP is known to result in balance and stability problems that lead to motor planning impairments and execution difficulties. Motor control abnormality among children with dyskinetic CP was somewhat less severe, as reflected in their superior VMI values (mean=82.31, SD=8.69). These findings are in line with those of[13]. who found that the severity of brain damage in treatment for CP influences visual-motor integration abnormalities. The cognitive scores in this study were found to be quite variable, having a mean of 73.02 (SD = 9.335) and a bimodal distribution. The presence of clustering at 70, 78, and 85 indicates the representation of performance groups within the sample and shows the presence of different subgroups of cognition. The trend was like the results of Stadskleive (2020), who found a difference in cognitive outcome among children with CP due to differing characteristics of lesions, associated comorbidities, and environmental factors. Participants with dyskinetic CP had a slightly higher mean cognitive score of 75.00 (SD = 7.725), which confirms the previously reported findings of more favorable cognitive outcomes for this subgroup compared to those with spastic or ataxic CP[14].

Poor eye-hand coordination, as reported by[15], may hint at an explanation for the lower cognitive and VMI scores found in some of the subjects. These children usually have difficulty completing tasks requiring simultaneous visual tracking and fine motor control, further stressing the interconnectedness of visual motor, and cognitive functions of CP. The bimodal bias in cognitive scores seen in this study also supports Furzier et al. (2011) view of the variability of visual cognitive abilities found in children with CP. Such a bimodal distribution may reflect differences in access to rehabilitation, in levels of early intervention, or in localization of the lesions. Postural stability is another aspect that greatly influences VMI performance, and it is especially important in children with ataxic CP. As pointed out by[16], balance deficits are a hallmark of CP, directly impacting the ability to perform such tasks in a coordinated manner requiring precision. The present study results indicated that children with more severe postural instability had lower VMI values, consistent with that described in previous literature. Poor postural control causes a decline in motor planning and heightens the problems of visual-motor coordination, leading to poor performance.

The most significant feature of children with CP is that they have visual perception deficits regarding their functional and academic outcome[17] describe those deficits in spatial perception, visual acuity, and visual memory, which are critical for VMI and cognitive functioning. Most recently, Baranello et al (2020) further validated the Visual Function Classification System in children with CP, emphasizing classification and assessment of visual impairment to develop interventions. VMI scores below 62 and 68 may reflect impacts of severe visual perception deficits, particularly in spastic or ataxic CP participants, in the present study.

A review by[18] discussed the need to have standardized tools to examine the vision in children with cerebral palsy so that specific deficiencies can be identified, thereby appropriate interventions. For example, spastic cerebral palsied children will require interventions to spatial awareness and depth while children cerebral palsied with ataxia become challenging while performing dynamic visual tracking and motor coordination. Virtual Reality Bringing hope to children with cerebral palsy, it has been authentic that the improvement of proprioception and motor skills could be greater enhanced and encouraged through digital actuality (VR) systems. Perera et al. (2014) and Chen et al. (2018) have shown that it stimulates motor planning and coordination in addition to postural stability[19], all these are important both for VMI and for the mind. Including VR-based interventions in the rehabilitation process could overcome deficits, especially those observed in this study where most had low VMI and cognition scores. The interactive and participatory nature of these interventions will enhance the experience of children being treated and may improve motivation and adherence to therapy.

Variability in VMI and cognitive performance underscores the importance of assessment and intervention as individualized for each child with cerebral palsy. Berry VMI and standardized cognitive testing provide useful information regarding a child's unique profile, thus allowing targeted therapy. More integrated frameworks, such as the VFCS proposed by[20], can be helpful in better understanding visual and motor impairments and may thereby support comprehensive intervention plans. Future research should include long-term outcomes of early interventions like: Therapy based on virtual reality in children with CP about visuomotor and cognitive outcomes. Longitudinal study can also investigate how fluctuations of postural stability and visual perception influence performance over the long run and take a glimpse into how dynamic these impairments might be.

CONCLUSION

This study explains and emphasizes the highly significant impact of cerebral palsy on motor coordination and visual perception. Divergent differences among the three subtypes have been identified; these include ataxic CP, which affects object tracking and spatial awareness; spastic CP, which affects depth perception and spatial orientation; and dyskinetic CP, which interferes with visual-motor integration through involuntary movements. Deficits in visual perception, intricately linked to problems in locomotion, impede social, cognitive, and functional development; thus, special interventions are necessary. Currently, tools such as the Beery Visual-Motor Integration test are available but not practical for motor disabilities typical of CP. Innovative approaches like virtual reality-based treatments may enhance postural stabilization and visual-motor competencies. The report promotes longitudinal studies to make improvements and suggests tailored assessment tools such as the Visual Function Classification System (VFCS). Interventions and improve developmental and functional outcomes of children with CP.

AUTHOR's CONTRIBUTION:

Author	Contribution
Muqadas Paracha	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Ramma Inam	Methodology, Investigation, Data Curation, Writing - Review & Editing
Maleeha Fuad	Investigation, Data Curation, Formal Analysis, Software

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