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Case report

Vision therapy for children with autism spectrum disorder – A review and case report

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ABSTRACT

A higher incidence of ocular morbidity including visual perceptual disorders has been noted in individuals with autism spectrum disorder (ASD). Individuals with ASD show a lack of eye contact, poorly developed eye-hand coordination, and decreased visual perceptual skills. The presence of such deficits may influence the development of cognitive, motor skills, perception, behaviour, social interactions, and communication of these children. A nine-year-old male child diagnosed with autism spectrum disorder presented with a lack of eye contact, challenges in gross and fine motor skills, and social interactions. A comprehensive eye examination was performed, followed by an assessment of visual-spatial abilities of the child. Developmental Test of Visual Perception - third edition, administered to understand visual-motor integration and motor-reduced visual perceptual skills, revealed perceptual deficits in all domains. The child completed 30 sessions of vision therapy resulting in significant improvement in visual-spatial skills, visual-motor integration, and motor-reduced visual perception. This case demonstrated that individuals with ASD can benefit from vision therapy. Significant changes in behaviour including improved attention span and increased understanding of instructions were evident from parental feedback. Visual perceptual skill training holds the promise of being an adjunct developmentally supportive intervention for some children with an autism spectrum disorder.

Keywords: Autism; perceptual training; vision therapy; visual information processing.

INTRODUCTION

Autism spectrum disorder is a complex neurological and developmental disorder characterised by difficulties in communication and interaction with other people, restricted interests, repetitive behaviour, and an inability to function at school, work and other areas of life (1). Although the exact cause of autism has not been understood by scientists to date, numerous risk factors have been put forth which vary from genetic conditions, environmental factors, very low birth weight, older parents and a sibling with autism (2), to less conclusive causes such as food intolerances (3).

Over the past decade, autism has emerged as a major public health concern affecting 1 in 44 children globally (4). More than 50% of children with autism spectrum disorder (ASD) are found to have some type of ocular morbidity. Several studies on ASD have reported visual disturbances such as significant refractive errors, strabismus and amblyopia (5). Impairments in visual perception have also been widely reported across scientific literature.

Oculomotor dysfunction

Pursuits and saccadic ability are two of the most common oculomotor assessments performed among children with ASD. While smooth pursuit eye movements allow the line of sight to track selected objects, saccadic eye movements aid to look in any chosen direction. Such assessments have yielded mixed results in children with ASD. Children with ASD were found to have normal pursuit latency but deficits have been noted in closed-loop pursuits (6). The presence of oculomotor disturbances is known to affect the reading and academic performance of children (7).

Visual perceptual deficits

Integration of every detail of an object is essential to gaining a holistic percept of an object or visual scene (8). The earliest descriptions of autism by Kanner in 1943 emerge from the atypical visual exploratory behaviour exhibited by children with ASD. Since then altered visual perception has been noted in individuals with ASD and documented in the literature. Weak central coherence has been reported among children with ASD, clinically evident from the performance of these children on block designs where they show superior facility for segmentation of the design (9); this has been reported as impaired visual integration skill (8). On the other hand, enhanced perceptual functioning (EPF) theory suggests that there is an enhanced perceptual flow of information in ASD that challenges the development and control of perceptual processes (10). Several reports on visual processing in autism propose superior visual discrimination (11), enhanced performance on visual search tasks (12), and not giving up on visual illusions (13). As a result of reduced bias from prior experience, children with ASD tend to perceive the world more naturally and realistically.

Case presentation

A nine-year-old male child diagnosed with autism was referred by a clinical psychologist for vision assessment. The child was found to have severe autism as indicated by a score of 39 on the Childhood Autism Rating Scale-II (14). His developmental quotient was 34, predictive of severe deficits in developmental functioning. Parents reported that the initial motor, speech and social milestones of the child were normal, but deteriorated by two-and-a-half years of age. The child was impulsive and reacted by walking constantly or being in motion. Toe walking was noted when the child presented for assessment. Activities of daily living were limited at the time of presentation. The child was non-verbal, and his parents indicated that he rarely made eye contact, and resisted interaction with extended family members and peers at school. The child seemed to be inconsistent in sports and seldom played games. His mother also reported that his reading, writing skills and comprehension were poor, though he had a good memory for directions.

On examination, his distant visual acuity in both eyes was 0.1 log MAR assessed using Lea symbols. Objective refraction showed +0.50 DS in both eyes. The child's fixation was momentary (<2 seconds) and he showed little ability in moving his eyes towards the desired target. His extraocular motilities were full; however, his pursuit and saccadic movement assessed using the Northern State University College of Optometry (NSUCO) test showed a score below five years in both the domains, with significant head and body movements. The cover test was orthophoric for distance and near. His near point of convergence tested objectively was 7 cms. The monocular estimation method was used to test the accommodative response of the child, and it was +0.50 DS in both eyes.

Visual-spatial skills were assessed using standing angels and Piaget test of right-left concepts. Developmental Test of Visual Perceptual skills – third edition (DTVP-3) was administered to determine visual-motor integration and motor-reduced visual perceptual skills. A sample of the child's copying abilities prior to training is shown in Figure 1b. During the testing, the child was inattentive and needed to be constantly reminded to focus and respond to the assessments. However, with constant motivation, the child completed the assessment.

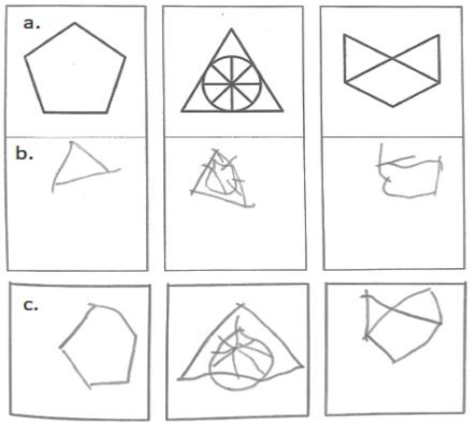

Fig. 1: Performance on copying task in the DTVP-3 tool. **a**. target stimuli **b**. pre-training performance **c**. post-training performance

Perceptual deficits were found in the following areas:
-*Oculomotor skills*: Inappropriate pursuit and saccadic eye movements, with large body movements;
-*Visual-spatial skills*: Poor body awareness, poor bilateral integration, and difficulty with laterality or right-left awareness;
-*Visual-motor integration skills*: Eye-hand coordination and copying skills not adequate;
-*Visual analysis skills*: Visual figure-ground, visual closure and form constancy skills were not age-appropriate.

Overall visual perceptual skills were highly scattered in the poor-to-average range and are presented in Table 1. A vision therapy program was recommended for the child. The child attended a one-hour in-office session twice a week, followed by home reinforcement over a period of 15 weeks. The therapy program was divided into three phases, each of five-week duration. Each phase comprised of a unique set of activities that supported the development of visual-spatial skills, visual analysis skills and visual-motor skills. This perceptual training program was designed in such a way that the child underwent a warm-up session for ten minutes followed by three to four therapies of ten minutes duration each, and the session ended with feedback on home reinforcement. Each set of exercises was provided over a period of five weeks comprising ten in-office sessions. At the end of five weeks, irrespective of the level of attainment on activities presented during that phase, the child progressed to the next phase. Overall improvement of the child at the end of the therapy program is as detailed in Table 1. Details of activities offered to the child are tabulated in Table 2.

Though co-management with an occupational therapist is advisable, visual-motor therapies, that help to stabilize the body in space, counteract gravity and sustain body balance, are often considered to support the development of the visual system (16).

Table 1: Clinical findings pre- and post- visual perceptual skills training

Diagnostic test	**Pre-vision therapy**		**Post-vision therapy**	
Fixation	< 2 seconds		>10 seconds	
NSUCO Pursuits	Ability: 2 Accuracy: 1 Head movement: 1 Body movement: 1	Age <5 years equivalent	Ability: 5 Accuracy: 3 Head movement: 3 Body movement: 3	Age 7-years equivalent
NSUCO Saccades	Ability: 1 Accuracy: 1 Head movement: 1 Body movement: 1	Age <5 years equivalent	Ability: 5 Accuracy: 3 Head movement: 3 Body movement: 3	Age 7-years equivalent
Piaget Left-right	Age < 5 equivalent		Age 10 equivalent	
Standing angels	Age 4 equivalent		Age 8 equivalent	
DTVP-3				
Eye-hand coordination	Raw score: 89 Age equivalent < 4 years		Raw score: 143 Age equivalent 5 years 4 months	
Copying Skills	Raw score: 3 Age equivalent < 4 years		Raw score: 17 Age equivalent 5 years 8 months	
Figure-ground	Raw score: 46 Age equivalent 6 years 11 months		Raw score: 49 Age equivalent 8 years 5 months	
Visual closure	Raw score: 10 Age equivalent 5 years 10 months		Raw score: 15 Age equivalent 8 years 5 months	
Form constancy	Raw score: 38 Age equivalent 10 years 3 months		Raw score: 42 Age equivalent 12 years 2 months	

Table 2: Vision therapy goals and activities planned

Goals	**Activity Description**
Visual spatial skills	
Bilateral Integration	Angels in snow, Body map, Randolf shuffle
Develop laterality	Ball bounce, Slap tap
Develop directionality	Kirschner arrows, Directional mazes, Letter find
Visual analysis skills	
Develop visual discrimination	Parquetry blocks, Geoboard
Develop visual figure-ground	Visual tracing, Michigan tracking, Spot the difference
Develop visual closure	Dot-to-dot figures, Parquetry blocks
Develop visual attention and processing speed	Visual scanning, Hart chart, Michigan tracking
Visual motor skills	
Develop eye-hand coordination skills	Flash light tag, Peg board techniques
Develop accurate and rapid visually guided fine motor control	Maze tracing technique, Haptic writing, Xs and Os
Develop patient's ability to plan visually guided motor actions to reproduce complex spatial patterns	Rosner Program

During the initial phase, the child was motivated and encouraged to perform with enthusiasm by patting on the back, clapping upon achievement, or providing positive feedback; however, these were withdrawn in due course as any form of external appraisal may prevent the child from acting independently (14).

Changes in performance were graded, based on the speed and accuracy with which the child completed the activities. This was noted for each session. Session by session progress in terms of accuracy and speed of performance on vision therapy activities are presented in Figure 2. A gradual improvement in performance was noted in activities that focussed on bilateral integration, laterality and directionality such as angels in snow, directional arrows, flashlight tag and parquetry blocks. The child completed three levels of mazes during five weeks. During each session, the child challenged his efficiency in completing the mazes and succeeded. The child could not perform only one activity namely, "spot the differences", during the treatment period.

DISCUSSION

Vision therapy supports the development of visual capabilities. Various aspects of vision that can be trained through vision therapy and its efficacy for children with special needs are reported through a few case reports in the literature (15). An improvement in oculomotor skills and visual perceptual skills would help a person stay grounded and foster learning of newer skills (16). The development of eye movements often perpetuates motor development of the body.

Gross motor coordination needs to be reinforced before establishing eye-hand coordination (17).

Visuo-spatial skills are reported to be underdeveloped in children with autism and these children compensate for the lacunae through toe walking, flicking fingers close to the eyes or hand flapping (18). Similar symptoms were reported in this case also and after improving visuospatial skills like body awareness and laterality, these symptoms disappeared and the child walked on flat foot with an improved gait.

A vision therapy regimen was administered by the author to a verbal child diagnosed to have mild symptoms of ASD (19). Improvement in visual capabilities achieved by that verbal child with mild symptoms of ASD and this non-verbal child with severe ASD was equivalent. This child showed significant improvement in oculomotor and visual perceptual skills. His visuospatial abilities almost paralleled age-equivalent scores at the end of therapy program. His visual analysis skills improved significantly. Ability to perceive abstract shapes changed drastically post-training as shown in Figure 2b. The pace at which the activities were performed during the training period is testimony to the development of effective response skills, evident from Figure 2b. The child faced challenges in "spot the difference" activities and this lacuna could be because he was non-verbal. As pointed out by his mother initially about his aptitude for routes and directions, he performed very well on mazes. He completed even the difficult mazes in a very short time.

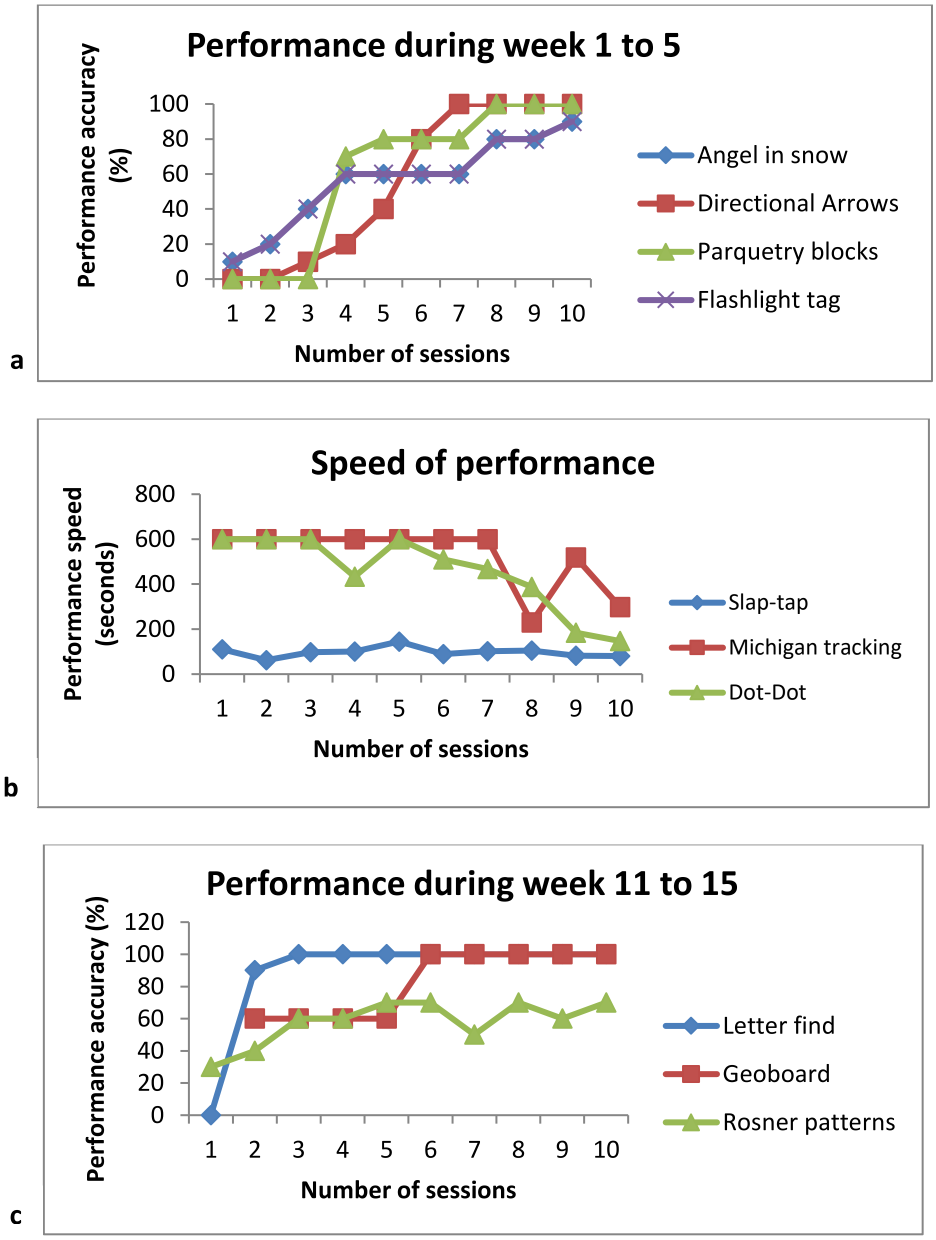

Fig. 2: Session-by-session change in accuracy of performance on different activities. **a**. performance accuracy on activities during week 1 to 5; **b**. performance speed on activities; **c**. performance accuracy on activities during week 11 to 15.

Though south Indian children were found to have superior visual-motor skills compared to their age-matched peers as assessed by DTVP-3 (19), this child was found to have greatly underdeveloped visual motor skills at the beginning of the vision therapy session. Though visual-motor skills improved post-training as shown in Table 1, significant delays were still noted, requiring further training.

Home reinforcement of the activities helped understand the activity, and attain speed of action and automaticity over the tasks in a shorter duration of time. This has been found to support long-term retention of their performance on tasks (17). Occasional dip noted in performances was likely due to the health of the child on that particular day which is common among children with autism.

Parental feedback was also elicited at the end of the training session. The mother indicated that the child had started to bathe and dress up on his own. The child had become independent in toileting activities. The child showed interest in going out in the evenings and showed interest in joining other children playing in the park. The mother also reported that the child was showing an increased interest in reading-writing activities and had started to respond verbally with one or two words.

CONCLUSION

The case report reveals that structured vision therapy activities targeting visual-spatial, visual-analysis and visual-motor skills over 15 weeks resulted in significant improvement in oculomotor and visual perceptual skills, with concurrent parental reports of significant improvement in activities of daily living. The case report presented preliminary evidence that vision therapy holds promise as an adjunct therapy for children with autism. Evaluation by a behavioural and developmental optometrist is needed to plan intervention.

Children with ASD have an increased need for vision therapy to support adequate development of vision; however, this is often overlooked by eye care professionals. Though all individuals with autism may not develop at the same pace due to variations in physical and cognitive abilities, they need to be clinically evaluated by a behavioural and developmental optometrist as even small improvements in abilities can greatly enhance their living.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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