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Case Report

# Management of bilateral amblyopia, abnormal eye movements and deficient visual perception in a child with autism spectrum disorder using vision therapy: A case report

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ABSTRACT

An 8-year-old boy, diagnosed with moderate autism spectrum disorder visited Divine Myndz with his mother with complaints of reduced vision, inability to maintain eye contact and less attention span in terms of visual tasks. Assessment done at Divine Myndz showed that he had bilateral amblyopia, difficulty with eye movements, visual attention span and visual perceptual skills. A multi modal approach in vision therapy was planned for a period of 2 months to work on amblyopia, visual attention span and visual perceptual skills. At the end of 40 sessions over a period of 2 months, the boy showed significant improvement in visual acuity and eye movements. However, the visual perception remained same. After the initial reassessment after 40 sessions, the parents were advised to continue with remote vision therapy using vision therapy softwares that can be administered with parental support at home. Both pts2 and AmbP inet (home based vision therapy softwares) were prescribed. After 1 year of using the remote vision therapy softwares, a reassessment was conducted. The reassessment results showed that the boy had shown significant improvement in both visual perceptual skills and visual efficiency skills along with improvement in visual acuity and stereopsis. His parents reported a significant improvement in his visual task and improved attention span and eye contact.



## 1. Introduction

Association between autism spectrum disorder (ASD) and visual deficits have been reported in past.[1] While, a recent study reported a 48.4% prevalence of refractive errors among ASD children,[2] amblyopia or lazy eye has been reported in a significant proportion of ASD children.[3] Furthermore, visual perception of children with ASD has also been reported to be altered or disrupted.[4]

Vision therapy is non-invasive treatment/therapy procedure involving various activities, for conditions like amblyopia, strabismus and visual perceptual anomalies. Vision therapy has been practiced efficiently by optometrist since last few decades to manage several visual anomalies in many of the above stated conditions along with in children with special population. However, there is significant lack of published data especially in special population like in ASD. Thereby, in this present report, authors report the outcome of vision therapy in a case of an 8 years old child having ASD who was also diagnosed as amblyopic with abnormal eye movements and deficient visual perception.

## 2. Case Report

An 8-year-old boy visited a vision therapy centre in Chennai, India with his mother in July 2022 with concerns

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of reduced vision even with spectacle, lack of eye contact and less attention span in terms of visual tasks. His previous assessment at the age of 4 and 5 years conducted by paediatric neurologist and developmental-behavioural paediatric specialist revealed a diagnosis of moderate ASD. He was prescribed spectacle at the age or 4. Later in 2018, he underwent another eye check-up and he was prescribed a new spectacle of -2.75 Dioptre spherical with -3.00 Dioptre cylinder at 5 degree and -2.00 Dioptre spherical with -3 Dioptre cylinders at 170 degrees in the right and left eye respectively. On examination at Divine Myndz, his visual acuity with present spectacle was recorded as 6/12 and 6/18 in right and left eye respectively using high Log MAR high contrast visual acuity chart. Both objective and subjective refraction was -2.75 Dioptre spherical with -3.50 Dioptre cylinder at 10-degree axis and -2.50 Dioptre spherical with -3.50 Dioptre cylindrical at 165-degree axis in right and left eye respectively with no further improvement. The boy was diagnosed as having bilateral amblyopia. Assessment on other visual functions is tabulated in Table 1. Furthermore, eye movements and visual perceptual skills of the child were evaluated using DEM (developmental eye movement test) and Motor free visual perception test (MVPT) respectively. After an initial assessment using DEM, the child was deemed to have both automaticity and oculomotor dysfunction. He was classified under type 4 ratio that indicates an abnormally increased horizontal time with a relatively normal performance in the vertical subtest and also higher than normal horizontal and vertical times with a normal ratio score. In age matched normative population the percentile score remains at 31 percentiles for vertical time and 32 percentiles for corrected horizontal time. Thereby he exhibited a low DEM score compared to his aged matched normal score. After the initial assessment using MVPT, the child's visual perceptual age as per the raw score obtained (18) was arrived at 4 years 10 months, revealing that his visual perceptual age lower than his chronological age (7 years - 8 month). Results of these tests are reported in the Tables 1 and 2 .

### 2.1. Therapy & treatment plan

Based on the above assessment results, vision therapy protocol was planned focussing on amblyopia treatment, eye movement training and visual perceptual skill training.

A multi modal approach of vision therapy was planned. Multimodal approach is an approach that uses various techniques and methods in order to work towards obtaining a desired result.[5] In recent years, Optometrist and vision therapist are employing multimodal approach to manage several conditions including anomalies of eye movements, vergence, accommodation, amblyopia and several other binocular vision anomalies.

In the present case, Sanet Vision Integrator (SVI) software and Vision Therapy System (VTS4) software and Computerized Perceptual Processing (CPT) along with manual techniques were employed for the therapy. Although, reported literatures are relatively less on these software's, these software's are used efficiently by optometry practitioners for the diagnosis and management of various visual conditions.[6–10] The therapy included the following phases. Figures 1 and 2 shows some glimpse of the vision therapy using this software.

### 2.2. Phase 1 – Treatment of amblyopia

#### 2.2.1. Using SVI software

Amblyopia treatment was planned with the concept of monocular fixation in binocular field (MFBF) method in SVI with the usage of red blue glasses. Monocular Fixation in Binocular Field (MFBF) vision therapy works as a link between monocular to binocular activities. The MFBF method insists on using one eye at a time while both eyes are open thus using binocular filed. The therapy is performed while patient wears anaglyphic glasses so each eye can see different objects presented. Modules in SVI namely Eye Hand, Rotator and Saccades were used with setting up the target colours to be red and blue against a black background. Activity performed and their expected functions of each module are tabulated in Table 1.

#### 2.2.2. Using VTS4 software

The VTS4 presents different 3D colour targets in a ViewSonic projector screen which is fixed at 5 feet from the screen and the distance between patient and screen is 2.5 feet (With support of Nvidia 3D GeForce GT 1030 Graphics, and screen resolution with 1920× 1080 with refresh rate of 60 Hz) which is synced with 3D glasses (liquid crystal shutter goggles (3D Active glasses). The software presents various child friendly pictures such as different fruits, as target. Activity performed and their expected functions of each module are tabulated in Table 1.

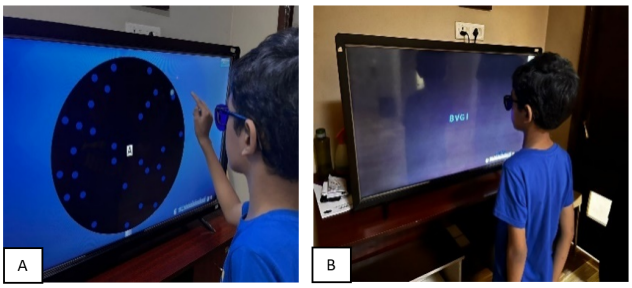


**Figure 1:** Phase 2 training to improve Eye Movements using manual activities. **A)**: training for pursuit and saccadic, finding the alphabets in the sequence and **B**): BVGI: training for saccadic eye movements and visual perceptual skills, child is asked the visualize the letters flashed on screen, and then he has to find the same sequence of the letters that would be fleshed next

**Table 1:** Name of the modules, activity performed and their expected functions of different programs using SVI and VTS4 software

| Name of the module | Activity performed | Expected function |
|---|---|---|
| **Eye-Hand-SVI software "Proactive" option was chosen in the module** | Pointing on to the red and blue targets against a black background that appeared both at the centre and at the periphery in a 55-inch touch screen. The next target appeared only after the child had pointed on to the first target. | Improves in his eye-hand coordination. Improve the child's central fixation, visual attention and thereby work on anti-suppression. |
| **Rotator (with Auditory feedback)- SVI software** | Pointing on to the rotating targets. The targets chosen were blue targets against a black background for one trial followed by red targets against a black background for the next trial | Helps the child to fixate on a moving target and pan an appropriate motor response. Auditory feedback helps to make the child pay more attention and to point perfectly on to the target. |
| **Tachistoscope-SVI software** | Pointing to the targets in the same organised sequence that was reflected in the screen for 3 seconds. | Works on anti-suppression when the child was wearing the red and blue glasses. Also works on visual sequential memory where the child has to remember and recall sequentially seen/heard targets. |
| **Amblyopia - VTS4 software** | Naming the targets that appeared on the screen using both eyes using 3 D shutter glasses | Works on anti-suppression |
| **Cheiroscope- VTS4 software** | Tracing lines that started from targets on the left side and led to targets on the right, using the computer mouse. | Works on anti-suppression. |
| **Pursuit and saccades- VTS4 software** | Tracking a moving target from left to right using the computer mouse. Then pressing the corresponding direction of arrows that appear randomly, one at a time, on the projector screen using the game controller connected to the computer. | Works on amblyopia and eye movements. |

### *2.3. Phase 2 – training to improve eye movements using manual activities*

Marsden Ball and saccadic chart activities were used for eye movement training. Both the above-mentioned activities were tried manually where the child is made to stand facing the ball and saccadic chart respectively. This activity was initially tried monocularly (patching one eye alternatively) and then binocularly (without eye patch).

### *2.4. Phase 3 – Visual perceptual skills*

CPT programme to work on visual perceptual skills was administered from the first session. The CPT program presents computerized perceptual processing. Different programmes comprising different components of visual perceptions are used in this phase to improve overall visual perceptual skills. The programmes used included visual closure, visual scan, visual span, visual concentration, visual search, visual coding, visual memory, directionality.

#### *2.4.1. Reassessment after 40 sessions of clinic based therapy*

After 40 sessions of multi modal method of vision therapy, visual acuity improved to 6/9 in both eyes. Initial reassessment with MVPT after 40 in office sessions revealed his visual perceptual age to be 5 years 1 month indicating a mild improvement. The different components of visual perception pre and post therapy are tabulated in Table 3. Initial reassessment using DEM still revealed the child was deemed to have both automaticity and oculomotor dysfunction. However, after the therapy, DEM overall score improved with percentile score of 18 and 12 for vertical and horizontal score respectively. Thus, visual acuity and eye movements improved noticeably after the therapy. Gross stereopsis was present after the therapy. Few parameters of visual perception including visual memory and figure ground showed mild improvement. Comparison of visual parameters pre and post clinic based therapy of 2 months

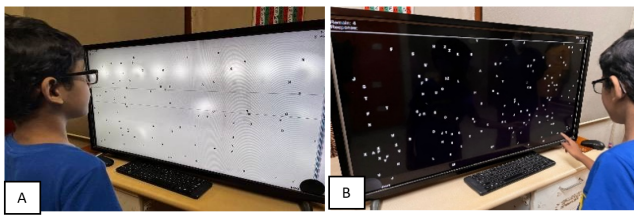


**Figure 2:** Visual scan program in CPT. **A**): Child is searching for the random numbers from the clusters of alphabets and **B)**: Child is searching alphabets from the cluster of the symbol

can be found in Table 3.

### 2.5. Phase 4 – Home based therapy

He was advised to continue vision therapy using Amb inet and PTS2 software's from HTS, USA. Both of these software's are home based, where the child can try the programs from his place without coming for in office sessions, with the parent guidance. Each program comes with 150 runs and the mode can be changed as per the practitioner's choice. The progress and development in the child can be tracked using the doctor's tool, remotely by the practitioner for further improvement. The purpose of home base therapy was to retain the improvement and to further address the remaining lacks visual efficiency and visual perception. The activities performed and the expected functions of the home based softwares are mentioned in Table 2.

#### 2.5.1. Reassessment of the visual functions after 1 year of home based vision therapy

The parents continued with home-based vision therapy for 1 year at a frequency of 30 minutes for 2 to 3 days a week, depending on the boy's cooperation. A second reassessment was done at the end of 1 year. The DEM overall score improved drastically with percentile score of 61 and 50 for vertical and horizontal score respectively. Therefore, the results revealed that the boy had progressed from type 4 ratio to type 1 ratio under the DEM classification. Reassessment with MVPT after home vision therapy sessions revealed his visual perceptual age to be 7years 5 months indicating significant improvement. All the components of visual perception improved from baseline score. The results of the reassessment after clinic based and home based therapy are tabulated in the Table 3. His parents reported a noticeably better visual performance at home after the vision therapy. Similarly, they further reported improvement in visual attention span, eye contact and reading skills after the therapy. He was advised to continue his therapy for another 20 sessions and visit clinic after 6 months.

## 3. Discussion

Literatures reporting the effectiveness of vision therapy in children with ASD are limited. Only a few reported literatures that suggested vision therapy to be effective in managing visual and motor deficits in children with ASD, did not follow a uniform protocol that can be adopted in vision therapy practice.[11–14] Similarly, not all the studies explained the evaluation and the therapy well. Thereby, the present case outlined step-wise evaluation, therapy planning and the results in an 8 years old child with ASD who was further diagnosed with bilateral amblyopia, oculomotor dysfunction and reduced visual perceptual skills.

In children with ASD, refractive error could be frequently associated with observable behavioural issues like head tilt, head turn, short attention span, difficulty with motor integration skills during child development and cognitive difficulties.[2] In addition to this amblyopia may contribute to the visual deficits of these children.[3] Amblyopia is a difficulty with visual efficiency skills which has a direct impact in a child's visual information processing, thereby impacting the perceptual, cognitive and integration abilities.[15] In the present case, the child with ASD, diagnosed to refractive amblyopia showed significantly improved visual functions in a span of 2 months. Although the child was using spectacle for past 4 years, there were no management provided to address his amblyopia. Thereby, his vision did not improve beyond 6/12 and 6/18 in the right and left eye respectively at the initial vision. After only 2 months of vision therapy, his vision improved by two and three lines in the right and left eye respectively and reached to near normal after 1 year of home based therapy. This result is supported by the previous research that has reported vision therapy to require fewer hours to gain 0.2 logMAR improvements.[16] Similarly his stereopsis that was absent in the initial assessment improved to 200 sec of arc after the 2 months of vision therapy and to 80 sec of arc after 1 year. Thus the amblyopia was managed well in the present case. This is in correspondence to the previous studies that reported vision therapy to improve amblyopia well in many clinical cases.[17]

On the other hand, children with ASD are known to have difficulties like visual seeking behaviours, lack of maintaining eye contact and poor attention to visual tasks. These signs indicate an underlying difficulty with either visual efficiency or visual information processing or both. Evaluating eye movements can provide a fair idea about the visual information processing in children.[18] Similarly, impairment of visual perception in children with ASD may lead to problems like "visual avoidance", "visual searching", and orientation of the objects.[19] Thereby, it is important to investigate the oculomotor functions and visual perceptions among these children. However, these important components are often overlooked at regular ophthalmic and optometric clinics. In the present case, the child who visited with the concern of lack of eye contact and less visual attention also revealed both automaticity and oculomotor dysfunction using DEM test. DEM is a validated method that can evaluate and quantify the eye movements.[20]

Similarly, MVPT revealed a reduced visual perception. MVPT used in the present case is a tool that is valid and reliable to assess visual perception.

After the combination of clinic and home home-based vision therapy for 1 year 2 months in the present case, both the oculomotor and automaticity have improved along with significant improvement visual perceptual skills. The parent's observation of improved visual span and eye

**Table 2:** Name of the Modules, activities performed at home using home therapy software and expected functions of different programs using Inet Amblyopia and PTS software

| Name of the software | Modules used | Expected function |
|---|---|---|
| AmbP inet program | Follow the letter, letter jump, find the target, capture the target, penguin peek and traffic jam | Improves visual acuity, eliminates suppression, train occulomotor function |
| **Hts-PTS** (perceptual therapy software | Visual closure, visual concentration, visual search, visual scan, visual sequencing, visual span, tachistoscope and visual motor integration. | Improves visual perception and visual efficiency Decreases reading/comprehensive difficulties, spelling problem, memory difficulties, non-verbal learning difficulties, laterality and directionality difficulties. |

**Table 3:** Shows visual functions, eye movements and visual perceptual skills after a multimodal approach pre and post vision therapy

| Optometric/Visual Perceptual Skill Evaluation | | Pre Vision-Therapy Values | | Post Vision Therapy Values (2 months) | | After One Year of Remote VT (1 year and 4 months) | |
|---|---|---|---|---|---|---|---|
| Visual acuity | Distance | 6/12 | 6/18 | 6/9 | 6/9 | 6/6p | 6/6p |
| | Near | N6 | N6 | N6 | N6 | N6 | N6 |
| Retinoscope | RE | -2.75/-3.50*10 | | -2.75/-3.50*10 | | -2.75/-3.50*10 | |
| | LE | -2.50/-3.50*165 | | -2.50/-3.50*165 | | -2.50/-3.50*165 | |
| EOM | | Full Range Ocular Movement (FROM) | | Full Range Ocular Movement (FROM) | | Full Range Ocular Movement (FROM) | |
| Colour Vision | | Normal | | Normal | | Normal | |
| Stereo acuity | | Nil | | 200 sec of arc | | 80 sec of arc | |
| Cover test | DIST | Ortho | | Ortho | | Ortho | |
| | NEAR | Ortho | | Ortho | | Ortho | |
| Fixation (Visuoscopy) | | CSM | | CSM | | CSM | |
| Slit lamp examination | RE | NAD | | NAD | | NAD | |
| | LE | NAD | | NAD | | NAD | |
| Fundus examination | RE | Normal | | Normal | | Normal | |
| | LE | Normal | | Normal | | Normal | |
| DEM | | Vertical percentile: 31<br>Horizontal percentile: 32<br>Error percentile: 7<br>Ratio: 46% | | Vertical percentile: 18<br>Horizontal percentile: 12<br>Error percentile: 22<br>Ratio:25% | | Vertical percentile:61<br>Horizontal percentile: 50<br>Error percentile: 42<br>Ratio:38% | |
| MVPT | | Age equivalent: 4 years 9 month | | Age equivalent: 5years 1 month | | Age equivalent: 7 years 5 months | |
| Spatial relationships | | 3/9 | | 3/9 | | 4/9 | |
| Visual discrimination | | 5/9 | | 5/9 | | 6/9 | |
| Figure ground | | 3/9 | | 4/9 | | 5/9 | |
| Visual closure | | 4/9 | | 4/9 | | 5/9 | |
| Visual memory | | 3/9 | | 4/9 | | 5/9 | |

contact and visual performance of the child could be well explained with the post therapy improvement in the DEM score and MVPT score along with the improvement of visual acuity and stereopsis.

## 4. Conclusion

Present case reemphasised the need of a regular, comprehensive eye examination in children with ASD along with the need of assessing components like oculomotor functions and visual perception. It also indicated a positive outcome of vision therapy in managing the visual constrains of these children including amblyopia, oculomotor disfunction and reduced visual perception. Two months of a multi modal approach of in-office vision therapy vision therapy consisting 40 sessions, followed by home based vision therapy program for a span of 1 year showed noticeable change in the child visual span, eye contact and visual performance. Further research including randomized control trials are recommended to adopt this into the evidence based practise.

## 5. Consent

Written consent was obtained from the parent to disclose the details of the child's treatment.

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The author(s) receive no financial compensation for this present work.

## 7. Conflict of Interest

None.

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