Major Article

# Functional and cognitive vision assessment in children with autism spectrum disorder

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**PURPOSE** To assess functional vision in children with autism spectrum disorder (ASD) with a cognitive visual function battery in addition to standard ophthalmic examinations.

**METHODS** Subjects were recruited from a school for children with ASD. In addition to a comprehensive ophthalmic examination, all children underwent cognitive vision assessment at a tertiary ophthalmological care center in India.

**RESULTS** A total of 30 children were included. The distribution of the number of children with mild to moderate versus severe ASD was nearly equal based on CARS autism scores. The majority of subjects had normal color vision (16/18), contrast (24), shape discrimination (26), and perception of directionality (28). Most were not able to identify optical illusions or differentiate tests of emotions. Ocular pursuits, saccades, and recognition of size differences were often abnormal. Poor visual closure was noted in (11) subjects. The duration of fixation to Heidi face target was inversely proportional to the severity of ASD. The study further established that cognitive visual impairment was present in children with ASD irrespective of their severity of ASD.

**CONCLUSIONS** All subjects had some form of cognitive visual impairment independent of ASD severity. (J AAPOS 2018;■:1-5)

Autism spectrum disorders (ASD), a group of neurobiological disorders occurring in children, are generally identified by 30 months of age. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) of the American Psychiatric Association defines ASD as "persistent difficulties with social communication and social interaction" and "restricted and repetitive patterns of behaviors, activities or interests" present since early childhood, "limiting and impairing everyday functioning."[1] The Centers for Disease Control and Prevention (CDC) estimates the prevalence of ASD in children as 1:68 (1 in 42 boys; 1 in 189 girls).[2] There is no prevalence data for ASD in the South India. Approximately one-third of children with ASD have an intellectual disability.[3] Visual impairment, especially cognitive visual impairment in children with ASD, has yet to be studied in depth. The literature on vision-related problems in children with ASD is sparse,[4] and a comprehensive ophthalmological evaluation with appropriate interventions should be mandatory before the diagnosis is made. Traditional methods of ophthalmological examination may be challenging if the child is nonverbal or unable to understand typical communication. Cognitive vision assessments are not typically performed, despite the fact that these abnormalities can have a profound effect on communication, education, and social-emotional development of the child. This study aimed to investigate whether children with ASD also have cognitive visual dysfunction.

## Subjects and Methods

The Institutional Ethics Committee of Aravind Medical Research Foundation approved this study, which followed the tenets of the Declaration of Helsinki. The parents of the children provided written informed consent before their children were enrolled. The examinations were conducted at Aravind Eye Care System, Madurai, South India, during January 2017. All 30 students attending a school for children with ASD were included.

All children had been diagnosed with ASD by the same pediatric neurologist and clinical psychologist team using the validated Childhood Autism Rating Scale (CARS), a clinical rating scale for trained clinicians to score ASD by direct observation of the child. Scores range from 15 to 60, with 30 being the cutoff rate for a diagnosis of autism. A score of 30-37 indicates mild to moderate autism; of 38-60, severe autism.[5]

A detailed history was taken for all children, and all children received comprehensive ophthalmic evaluation performed by a pediatric ophthalmologist with experience in evaluations of

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children with autism (SB). A low-vision rehabilitation specialist experienced in assessments for persons with developmental disabilities and cognitive visual impairment (JF) and the same ophthalmologist (SB) performed the functional and cognitive visual assessments on a different day with the refractive correction in place.

## Ophthalmologic Evaluation

Depending on age and ability, visual acuity at near and distance was measured by Teller acuity cards adopting the standard procedure (Teller Acuity Cards, University of Washington Precision Vision, Woodstock, IL),[6] Lea Symbol 15 Line Pediatric Eye Chart (Good-Lite, Elgin, IL), by verbally identifying or matching, or Snellen eye test chart by copying or verbal response binocularly and, if able, monocularly.

All patients underwent fundus examination using indirect ophthalmoscopy. Accommodation was assessed by dynamic retinoscopy, using the method described by Hunter.[7] Ocular alignment was assessed using the Hirschberg test and alternate cover-uncover test. In the presence of strabismus, a complete orthoptic evaluation was performed. Visual fields were assessed using the confrontation method. Stereopsis was assessed using Lang Stereotest I (Lang-Stereo-test AG, Switzerland)[8]; because the stereoscopic clues were familiar no pretest was performed. Pupillary reaction was tested using a flashlight; anterior segment examination, using a handheld slit-lamp. Cycloplegia was achieved with 2 drops 10 minutes apart of cyclopentolate 1% and phenylephrine 2.5%; refraction was performed 45 minutes later. A refractive error of $\geq -1.00$ DS was categorized as myopia; $\geq +1.0$ DS, as hyperopia; and cylinder of $\geq 0.75$, as astigmatism. Glasses were prescribed with full cycloplegic correction if the above criteria were met.

## Cognitive Visual Assessment

Cognitive visual impairment in its broadest sense refers to a condition leading to misinterpretation of the visual world either with respect to where things are or concerning what things are.[9] Children who were nonverbal were assessed with the help of the caregiver or parent and a special educator. Each child was asked to perform all tests demonstrated by the observer or special educator for at least 2 to 3 trials. Even after the trials, if the child could not perform the test, the result was recorded as "absent." If the child did not attempt the test, it was categorized as "not testable."

The child's fixation to a 5" Heidi fixation target (Good-Lite, Elgin, IL) at 30 cm was observed and the duration of fixation recorded in seconds by the same observer, only once for each child, so that repeated testing did not affect fixation time from loss of interest or attention. Color vision was assessed by Ishihara color vision test (Kanehara Shuppan Co Ltd, Bexco, Haryana), with nonverbal children asked to trace the number or the pattern.

The Hiding Heidi low-contrast test was used to assess contrast sensitivity in nonverbal children. The test picture and control were moved in opposite directions at the same speed, 30 cm from the child: the result was considered positive if the child fixed on or pointed to the face picture. Children unable to respond verbally were tested using the Pelli-Robson Contrast Sensitivity Chart (Precision Vision, Woodstock, IL) at a distance of 3 m.[10] Contrast sensitivity of $\geq 5\%$ on Hiding Heidi and $\geq 2\%$ on Pelli-Robson was considered normal.

Saccadic and pursuit eye movements were assessed using the validated NSUCO (Nova Southeastern University College of Optometry) oculomotor test. The results were scored based on four factors: ability, accuracy, head movement, and body movement. The scoring was based on a 5-point scale, with 5 being highest; a score of $\leq 3$ was a failure, and a score $>3$ was considered normal.[11]

The Lea Mailbox Game was used to assess the visual recognition of line directions. The child was asked to drop the card into the mailbox slot oriented in horizontal, vertical, and oblique axes at a distance of 0.5 m.[12]

The Lea Puzzle (Good-Lite, Elgin, IL) was used to assess the concept of same/different. The child was asked to match the puzzle pieces in three dimensions using color cues and then on the flip side of the puzzle. If the child was successful, the 3D puzzle pieces were matched to the 2D symbols. As a modification in our study, a final step was included where the child was asked to match the black-and-white side of the puzzle with a crowded background, designed by introducing a collage from varied pictures in the 3D black-and-white puzzle background to assess the effect of crowding.

The Lea Rectangle Game (Good-Lite, Elgin, IL), a modification of Efron's rectangles, was used to assess the child's ability to appreciate differences in size by matching one set of 5 rectangles according to size and length to a similar set of a different color.[13] Figure–ground discrimination was assessed by displaying several familiar objects cluttered together in a tray and having the child pick out a specific object.[14] Visual closure was assessed by displaying a familiar picture partially hidden in view and the child was asked to name or match the complete object.[14] To assess the perception of optical illusions, a 2D illusion showing a rabbit and a duck were shown on a 22″ TV screen at a distance of 1 m. The child was given 10-15 minutes to find the hidden images. The ability to identify both the animals meant the child was able to perceive this illusion.[15] To assess the ability to perceive emotions, the child was presented with emojis 6.5″ in diameter, with four different emotions: happy, sad, angry, and fearful on a 22″ screen at one meter and asked to identify. The ability to identify 2 was considered a positive response.[16,17]

A questionnaire for characteristics of cerebral visual impairment (CVI) was adapted from the CVI inventory developed by Dutton.[18] Parents and special educators were asked 5 screening questions, individually or together. A score of 3 or more suggested the presence of CVI. The modified CVI inventory asked whether the child (1) has difficulty in walking down stairs (for visual reasons), (2) does not see things that move quickly (eg, small animals), (3) does not see something that is pointed out in the distance (despite requisite visual acuity), (4) has difficulty locating an item of clothing in a pile, or (5) has difficulty copying words or pictures.

## Statistical Analysis

The statistical analysis was performed with STATA version 14.0 (Stata Statistical Software, release 14 [2015]; Stata Corp, College