

EVALUATION OF VISUAL ATTENTION IN DEVELOPMENTALLY DELAYED CHILDREN

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ABSTRACT

OBJECTIVE: To evaluate the visual attention in developmentally delayed children by comparing it with normal children.

METHOD: A comparative cross-sectional study was performed in different special education institutes to evaluate the visual attention in developmentally children by using different tests including attention paradigm test. Total 60 children including 30 normal and 30 developmentally delayed children were assessed by applying different tests for evaluation of visual attention.

RESULTS: Out of 30 normal children, 74.4% were having good response for attention paradigm test while out of 30 developmentally delayed children, 56.67% were having good response for the test. Same is the case with variation in gaze during the test. On the other hand, out of 30 normal children, 13.3% were having variation in gazes for attention paradigm test while out of 30 developmentally delayed children, 36.7% were having good response for the test which clearly shows that there is a significant difference in visual attention of developmentally delayed and normal children. The statistical test was performed by using Mann-Whitney test and Chi-square test (p value ≤ 0.05).

CONCLUSION: The process of visual attention like all other developmental processes is also delayed in developmentally delayed children as compared to normal children. However, Down's syndrome children have visual attention equally developed as that of normal children.

KEY WORDS: Visual Attention, Saccades, Attention paradigm test, Variation in gaze developmentally delayed children.

INTRODUCTION

There is an extraordinary potential in human beings to concentrate on the major areas of a scene that permits us to efficiently control huge amounts of visual information. This process in human visual system is called visual attention.¹ Things in our environment are always having a competition for visual selection. People make different eye movements or saccades to select required information from environment. The eye movements always evaluate a motor plan to perform a saccade on the basis of visual information provided.²

Visual attention is considered a selective process.³ It consists of perception, focus and eye-tracking or motility. It's not just about the movement of eyes, but everything matters.⁴ Suppressing of irrelevant is considered a prime part of attention control.⁵

Visual attention's maturation in first year of life can be overlooked as a sequence of key brain behavior transition.

The attention in an infant is predicted by the new born baby's potential to sustain the nervous system.⁶ There are five parameters that are used for further measurement of individual's visual attention profile: spatial bias of attention, visual processing speed, storage capacity, visual perception, threshold and efficiency of attention.⁴ Constant eye movement is required for the continuous visual tracking of performed activity.⁷

Eye tracking is used for detection and characterization of changes in voluntary visual patterns and is used for various types of persons especially children with special abilities irrespective of their level of motor and verbal needs.⁸ For many years, infrared eye tracking studies, that quantify unusual behaviors in visual attention to socially available details in school going children and autistic adults, have been explained by neurobiological theories suggesting decreased socially prominence in autism spectrum

disorder.⁹

To visualize a scene completely, both saccades and fixation is necessary, Saccades bring the eye to area of focus and through fixation the whole information is analyzed.¹⁰ Saccadic eye movements are usually followed by selective shifts of visual attention.¹¹ Gaze, a coherent movement of the eyes and head, has commonly been understood as a factor for attention in natural behavior. For example, a human or a robot has to communicate with other objects and control the gaze to carry out task while operating in the environment. According to it, gaze control utilizes vision, action, and attention at the same time to carryout sensorimotor coordination essential for the needed behavior.¹²

In Adult life years, persons who were born <32 weeks of gestation period are more prone to many health problems that can range from cognitive impairments to behavioral dysfunction.¹³ There are many conditions such as cerebral palsies, Autism, hypoglycemia at birth, ADHD, prenatal and cerebral infections, premature birth that can have drastic effect on visual systems and their functions resulting into cerebral visual impairment as well as complications in other systems.¹⁴

Vision impairment has effects on developmentally delayed children in a number of areas i.e. ideas, development, connections and communications, accessibility, social relationships, good health and inclusion in different activities.¹⁵ In different types of delayed development in children, there is impairment in visual attention e.g. Autism spectrum disorder. ASD children face difficulties to create and control eye contact as well as processing facial information of other individuals and intentions to maintain their social communication.¹⁶ Visual attention to faces and eye gaze sensitivity is most commonly recorded in new born babies and autistic children; still, the developmental pattern of alteration in sensitivity to eye gaze hint in ASD is mostly not clear.¹⁷ Autistic people also face difficulty in perspicacity of direct and indirect human gazes^{17,18} and there is a very reduced utilization of joint attention during communication with others.¹⁹

Studies have found that decreased attention to social impulse or more attention to non-social impulse is related with behavioral considerations of autism.²⁰ In most aspects of visual attention, children with ADHD show notable differences from their typically developing peers.²¹

Visual attention to faces is important for social interactions considering the face is filled with hints pointing the desires, sentiments, and targets of others. Eyes in faces are

very exposing and the caliber to process details about eye gaze is infrastructural to human social relationships. adults with ASD show decreased visual attention to both the face and the gazed-at things.²²

MATERIAL AND METHODS

A comparative cross-sectional study was carried out in different institutes of special children. The size of obtained sample was 60 which included 30 developmentally delayed and 30 Normal Children. The demographic details were also noted which included gender, age and institute name. The proforma consists of several tests that includes Visual Acuity assessment of both eye, Motility tests for saccadic and smooth pursuit eye movements and the most important Attention paradigm test which includes time interval for diverting attention towards distracter and variation in gaze during the test. For data analysis we used statistical package for social sciences (SPSS version 25). Independent variables such as age, gender, level of intellectual disability and dependent variables which includes eye tracking and motility testing were kept in mind. Quantitative variables were presented as frequency and percentage. Graphs and Bar charts were made for descriptive analysis. The research protocol was approved by the Ethical Review Board of College of Ophthalmology and Allied Vision Sciences.

RESULTS

Attention paradigm test was performed on 60 children that were further divided into two categories i.e. Normal children and developmentally delayed children. Out of 30 normal children, 74.4% were having good response for attention paradigm test while 25.5% were having delayed response to the test. On the other hand, out of 30 developmentally delayed children, 56.67% were having good response for the test while 43.3% were having delayed response for the test (Table 1). The statistical test was performed by using Mann-Whitney test (p value ≤ 0.05).

Same is the case with variation in gaze during the test. Chi-square test was applied for evaluating variation in gazes during attention paradigm test. P value ≤ 0.05 was considered significant. 3 trials were conducted and same results were obtained in all of the 3 trials. Out of 30 normal children, 13.3% were having variation in gazes for attention paradigm test while 86.7% were not having any variation in gazes. On the hand, out of 30 developmentally delayed children, 36.7% were having good response for the test while 63.3% were not having any variation in their gazes which clearly shows that there is a significant

difference in visual attention of developmentally delayed and normal children (Table 2).

Additionally, Motility tests for saccades and smooth pursuit movements were also performed but there were no significant differences in normal and abnormal saccadic and smooth pursuit eye movements in children of both categories.

Table-1: Responses during Attention paradigm test

	Normal Children (30 children)				Developmentally delayed children (30 children)			
	Good response (0.10sec-2.00sec)		Delayed response (3.0 sec-22.00sec)		Good response (0.10sec-2.00sec)		Delayed response (3.0 sec-22.00sec)	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Trial 1	21	70%	9	30%	14	46.6%	16	53.3%
Trial 2	22	73.3%	8	26.6%	19	63.3%	11	36.6%
Trial 3	24	80%	6	20%	18	60%	12	40%
Total	22.3	74.4%	7.67	25.5%	17	56.67%	13	43.3%

Table-2: Variation in gaze during attention paradigm test

Category	Yes	No	Total
Developmentally delayed	11 (36.7%)	19(63.3%)	30(100.0%)
Normal	4(13.3%)	26(86.7%)	30(100.0%)
Total	15(25%)	45(75%)	60(100.0%)

DISCUSSION

The purpose of current study is to evaluate the visual attention in developmentally delayed children by comparing their level of attention with normal children. School-age children had been mostly concentrated in most of the literature related to developmental disorders.²³ For the evaluation of visual attention in developmentally delayed children, an attention control paradigm test was designed that included 4 pictures in the display at specific dimensions and a distracter that was introduced from different dimensions at the different time intervals.

The attention paradigm test was selected and designed based on preceding experiments to inspect primary indicators of administrative attention in different populations.²⁴ According to novel task design there are two situations in the paradigm, both of which have a distracter display and a prime. The distracter display, that consists of a target stimulus, is introduced in a moment after the prime display.²⁵ The distracter is presented in different dimensions after certain time intervals. The prime stimuli were a selection of animated characters while distracter is also a display of a more attracting animated character.²⁶

The child was asked to look at the pictures in the display and then the distracter was introduced. The time interval, in which child shifts its attention towards the distracter from prime targets, was calculated in seconds by using a stop watch. Three trials were taken for each child and the time interval was recorded. While recording the time, it was also taken into consideration that either child had variation in his/her gaze or his/her gaze remained fixed at the display. The variation in gaze for each trial was also noted.

Good and delayed responses for attention paradigm tests in developmentally delayed children and normal children are compared by taking average of the 3 trials by applying Mann-Whitney test. Time interval of 0.01-2.0 seconds was considered a good response while time interval greater than 2 seconds was considered a bad response. Out of 30 normal children, 74.4% were having good response for attention paradigm test while 25.6% were having delayed response to the test.

Variation in gazes was evaluated by applying Chi-square test in all 3 trials of attention paradigm test. On the hand, out of 30 developmentally delayed children, 56.67% were having good response for the test while 43.33% were having delayed response for the test. Same is the case with variation in gaze during the test. Out of 30 normal children, 13.3% were having variation in gazes for attention paradigm test while 86.7% were not having any variation in gazes. On the hand, out of 30 developmentally delayed children, 36.7% were having good response for the test while 63.3% were not having any variation in their gazes.²³

These results clearly show that the level of visual attention in developmentally delayed children evaluated by using attention paradigm test is lower than in normal children except some exceptions in children with down syndrome as they showed good responses for attention paradigm test.²⁷

In a research carried out by Bradshaw J., data showed that the change from reflexive to voluntary control of visual attention happening between 2 and 3 months of age may be obstructed. Supervising Month 3, conversely, it seemed that whichever this process is adaptive and gets fully functional, or performance is supported by the commencement of important process that maintain visual attention, proceeding in relevant performance in the 4th and 5th months.⁶

The other factors that can affect visual attention i.e. saccades, smooth pursuit eye movements, Visual acuity in both eyes were also evaluated. Motility tests for saccadic

and smooth pursuit eye movements in developmentally delayed children and normal children are compared. Out of 30 normal children, 86.7% have normal saccadic movements and 90% were having smooth pursuit eye movements while 13.3% were having abnormality in their saccadic eye movements and 10% were having abnormality in their smooth eye pursuit movements. On the other hand, out of 30 developmentally delayed children, 83.3% have normal saccadic movements and 90% were having smooth pursuit eye movements while 16.6% were having abnormality in their saccadic eye movements and 10% were having abnormality in their smooth eye pursuit movements. It is clearly evident from the above results that visual attention is not directly related to saccades or other eye movements as they don't have any significant difference in their levels among developmentally delayed and normal children.

According to a previous study carried out in year 2017, it was evident that there were no significant differences by using independent t-tests with Bonferroni correction in any of the saccadic main sequence parameters between children without and with delayed development ($p > 0.01$). In the same way, no significant differences were found in the number of saccades and their amplitude during the fixation task between the two groups ($p > 0.05$).²⁸

As eye movements have no significant effect on visual attention, special attention paradigm tests other than checking their eye movements should also be performed for every child to assess their visual attention along with other tests for eye examination.

CONCLUSION

The process of visual attention like all other developmental process is also delayed in developmentally delayed children as compared to visual attention in normal children. However, children with Down's syndrome that have visual attention equally developed as that of normal children. Visual attention is not totally dependent on visual acuity. Additionally, the attention paradigm test is the best method to evaluate the visual attention in children as it shows the minimum difference in time interval for focusing on distracters in normal Vs developmentally delayed children and also shows variation in gazes during the test which is equally important in evaluation of visual attention.

RECOMMENDATIONS

The study on the topic of "Evaluation of visual attention in developmentally delayed children" concluded that visual

attention is delayed in developmentally delayed children as compared to normal children. We recommend that there should be a proper visual attention evaluation and it should be considered an important part of eye examination like all other evaluation including (visual acuity assesment, motility testings etc) while examining a developmentally delayed children by the concerned eye health practitioner i.e. optometrist, orthoptist or ophthalmologist so that different vision therapies can be advised to improve visual attention.

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