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VISUAL EVOKED POTENTIAL STUDY IN SLOW LEARNERS

FARAH KHALIQ*, YUMNAM ANJANA AND NEELAM VANEY

Department of Physiology,
University College of Medical Sciences & Guru Teg Bahadur Hospital,
Dilshad Garden, Delhi – 110 095

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Abstract : Slow learners are individuals with low achievement and comparably low IQ scores. It may be a symptom reflecting a larger underlying problem in them. Sensory neural processing of visual information can be one of the contributory factors for their underachievement. The present study was undertaken to examine the integrity and function of visual pathway by means of Visual Evoked Potential (VEP). Pattern reversal VEP was performed on seventeen slow learners. Fifteen age and sex matched children with good school performance and normal IQ were taken as controls. There was significant prolongation of N75 component of VEP in slow learners. The latencies of P100 and N145 were also increased but could not reach the level of significance. Our findings are suggestive of the presence of a weaker VEP response in slow learners indicative of a deficit early in the visual processing. There is some abnormality in the geniculate afferents to V1 which is consistent with a defect in the magnocellular pathway at the level of Visual Area 1 or earlier.

Key words : slow learners; visual evoked potential; visual information processing; magnocellular pathway

INTRODUCTION

Slow learners (borderline intelligence) is a term used for individuals with low achievement and comparably low IQ scores (70–85) (1). These individuals make up approximately 14% of the population, larger than the group of children with learning disability (LD), mental retardation and autism combined. They disproportionately account for nearly every major problem within education & society like school dropouts, illicit drug users, violent offenders, alcohol abusers, gang & hate group members etc (2, 3). For this large and vitally important population, research is scarce. There seems to be few large scale innovative educational or mental health programs for slow learners.

Various intrinsic or environmental factors may contribute to a child's failure to learn. It is well known that genetic factors play a primary role in intellectual deficits (4, 5). In addition it is known that other factors like prematurity, low birth weight, birth asphyxia, chronic malnutrition, low socio economic status play a contributory role in adversely affecting the intellectual ability of children (6, 7).

Hence it may be a symptom reflecting a larger underlying problem in children. It

*Corresponding Author : Phone No. : 0-9868350022, 011-22029877; E MAIL: farahphysio@yahoo.com

is essential that this symptom be scientifically analyzed to discover the underlying cause if any. Since sensory impairment can be one of the contributory factors of their performance, a thorough sensory examination is mandatory in these children. Visual evoked potential (VEP) is one of the non invasive tool which can assess the functional integrity of the visual pathway from the retina to the visual cortex. The VEP is primarily a reflection of central 3 degree to 6 degree of the visual field projecting onto surface of the occipital lobe. As VEP is mostly of foveal origin reflecting cone activity, any abnormality of fovea, cones or its projection to occipital lobe could be assessed by it (8). To the best of our knowledge the complete processing of visual pathway have not been studied earlier in slow learner group with unassociated specific learning disability or psychological problems. Hence the present study aims to investigate the possibility of deficits in central neural processing of visual pathway in slow learners.

MATERIALS AND METHODS

The study was conducted in the Electrophysiology Laboratory, Department of Physiology, University College of Medical Sciences, Delhi. The subjects were selected from a school for special children of Delhi. These subjects were referred for classroom behavioral or academic problems and they were tested by a psychological evaluation team. All those students not in the category of specific psychological disorders like learning disability (LD), attention deficit hyperactivity disorder (ADHD), mental retardation etc were selected for the study. Out of 31 children diagnosed as slow learners 5 could not participate in the study due to lack of consent from parents or prolonged absenteeism from school, one had visual field defect and 8 had ADHD, dyslexia or other psychological problems and were excluded from the study. Hence 17 slow learners, 10 males and 7 females with mean age of 10.59±1.87 yrs participated in the present study. Fifteen age and sex matched controls (9males and 6 females) with mean age of 10.87±2.94 yrs who had good school performance, were recruited from an elementary school in the vicinity of our institution. The clearance from the Ethical Committee of the institution was taken and an informed written consent was taken from the parents, after the recording procedure was explained to them. The recording was done in the presence of either one of the parents or teacher.

A thorough optometric examination was conducted to rule out any non correctable visual deficits. A detailed history of clinical, academic, physical, psychological and neurological examinations was noted. The parents were interviewed to get specific information about their child's birth history, developmental history and other relevant behavioral problems. The clinical psychologist conducted the standard IQ test MISIC (Malin's Intelligence Scale for Indian Children) an Indian adaptation of Wechsler intelligence scale for children (WISIC). The counselor interviewed the parent (s) to get specific information about any behavior problems in the child.

Recording of visual evoked potential

The recording was done in a sound proof room and the subjects were given a trial session a day before the recording to familiarize them with the recording procedure. The PRVEP (Pattern reversal visual evoked potentials) was recorded on Nihon Kohden Neuropack μ MEB –9100, Japan using silver- silver chloride disk electrode placed at standard scalp locations according to the 10–20 International System. Subjects were told about the procedure before the test. The electrodes were placed at O_1, O_2 (Active electrodes), A1 and A2 (reference electrode), Fpz (ground electrode) after cleaning the scalp or skin site with alcohol followed by Skinpure™ Skin preparation gel and EEG paste Elefix™. The skin electrode contact impedance was kept at less than 5 KΩ. The subject was seated comfortably in a quite darkened room, 1 meter away from the screen of a television and instructed to fixate on a small dot at its centre with one eye while the other eye was covered with a patch. The screen size measured 275 by 350 mm. The black and white checks (16x16 mm size) subtending an angle of 32 minutes of an arc were generated on the monitor by an electronic pattern generator. Luminance of dark checks was 6.31 ft-L and of the light checks was 31.6 ft-L giving contrast between black and white checks of 67%. The checks were made to reverse at a rate of 1 Hz and 200 responses were recorded and averaged by the computer of the evoked potential recorder with low and high frequency filters 1-200 Hz. Two trials of 200 responses were averaged for each eye. The absolute latencies of positive and negative waves were recorded.

Statistical analysis

The data obtained was analyzed using SPSS software (Version 13.0). The average of left and right eye was taken and analyzed. Unpaired ‘t’ test was used to compare between the controls and the subjects. Results were expressed as mean±SD.

RESULTS

The mean IQ of slow learners was 81.26±4.23 which was significantly lower as compared to that of controls having mean IQ of 99.73±8.63. The age, gender and anthropometric measurements are given in Table I. There was no significant difference in these parameters between the two groups. It was observed that 76.5% of the subjects have delayed milestone/development history, 29.4% did not cry immediately after birth, 29.4% had history of convulsions, 23.5% had premature birth 17.6% had delayed speech, 17.6% of the subjects were kept in incubator after birth, 11.8% had history of post term delivery, 5.9% had history of nocturnal bedwetting, 5.9% had history of caesarean delivery, 5.9% had history of forceps delivery (Table II).

TABLE I : Age, gender and anthropometric parameters of controls and slow learners.

		Control (n=15)	*Slow learners (n=17)*
Age		10.87±2.94	10.59±1.87
Gender :	Males	9	10
	Females	6	7
Height (cms)		148±9.86	145±12.30
Weight (kg)		45±10.23	42±12.56
BMI (kg/m^2)		20.5±2.74	19.86±2.98

TABLE II : Clinical History and findings of Slow Learners (n=17).

Clinical history	*Number of Subjects (%)*
Delayed developmental history	13 (76.5%)
Hospital delivery	7 (41.2%)
Home delivery	6 (35.3%)
History of convulsions	5 (29.4%)
Did not cry after birth	5 (29.4%)
Born prematurely	4 (23.5%)
Delayed speech	3 (17.6%)
Kept in incubator after birth	3 (17.6%)
Post term delivery	2 (11.8%)
Nocturnal enuresis	1 (5.9%)
Caesarean delivery	1 (5.9%)
Forceps delivery	1 (5.9%)
Delayed walking	1 (5.9%)
Hydrocephalus	1 (5.9%)

comparable to the values obtained earlier in our laboratory (10).

Theories relating visual dysfunction and visual processing problems to poor school performance have been discussed in the literature earlier (11). Four general classes of visual abnormality have been proposed to account for learning problems.

1. Blurred or double vision associated with uncorrected refractive error, abnormal binocular vision or abnormal accommodation.
2. Poor eye movement or fixation control during reading.
3. Abnormal central neural processing, recent theories of which suggest deficiencies in magnocellular pathway (12–14).
4. Problems in mechanisms of perceptual or visual information processing.

Prior to recording the VEP our subjects had undergone a complete optometric examination hence the first two visual defects were absent in them. Deficiencies in central neural processing of visual information can be one of the contributing factors in the performance of our subjects which has never been reported earlier in slow learner group. Studies with transient stimuli have found reduced sensitivity attributable to magnocellular deficits in individuals with learning disability (12–14). Differences have been reported between individuals with and without dyslexia in contrast sensitivity (15), flicker thresholds (16), VEP (12, 17) and anatomy in magnocellular layers of cadaver brains (16). These results have given support to the theory that weak saccadic suppression leading to problematic visual persistence during reading might be a causal element in learning or reading disorders.

It was observed that the response of magnocellular visual pathway is slowed in reading disabled children, who do not have a general slowing visual response (18). An abnormality of magnocellular pathway was confirmed anatomically by the demonstration that cells in magnocellular layers of the dorsal lateral geniculate nucleus of the brains of reading disabled persons were smaller than those in normal readers (19).

Our findings of a significantly prolonged latency of N75 component of VEP is consistent with delay in visual performance at very early stage of processing, such as that accomplished by M cells. VEP's to pattern reversal stimulation as used in the present study are evoked predominantly from the central 10 degree of the visual field and therefore reflect the function of the macular area and related pathways (4, 20, 21). The visual system processes information along multiple parallel channels (22). The separation of visual information starts at the neuronal circuitry of retina. The magnocellular system is involved primarily with motion analysis. The parvocellular system is associated with colour selectivity and shows a preference for high spatial frequency stimuli (22). The findings in the present study is suggestive of some abnormality in the geniculate afferents to V1 which is consistent with a defect in the magnocellular pathway at the level of Visual Area 1 or earlier indicating a loss of visual performance at a very early stages of visual processing in the slow learners which may be one of the contributing factors of the child's failure to perform. Electrophysiological methods may reveal underlying immaturity or abnormal brainstem timing and may serve as reliable tool in individuals with learning difficulties.

Other areas of information processing like auditory and central processing needs to be explored in this group to identify them at the earliest so that proper adjustment can be made for them.

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