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VISUAL EVOKED RESPONSES TO PATTERN REVERSAL IN CHILDREN

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Abstract : Pattern reversal evoked potentials (PREPs) were studied in school going children 4-15 years of age (mean 9.9±2.6 yrs), using Ag/AgCl electrodes anchored on 01-A1 and 02-A2 scalp sites. Two sets of 256 pattern reversal stimuli with check sizes 32′ and alternation rate 1 Hz were applied to each eye and evoked responses thus obtained were averaged and analysed by the inbuilt computer of the evoked potential recorder. The latency of various components of visual evoked potentials along with P_1 amplitudes were recorded for the right and the left eye separately in boys and girls. The normative data are being reported and these do not show eye and gender differences in children.

Key words : visual evoked potentials pattern reversal P_1 latency P_1 amplitude

INTRODUCTION

Hubel and Wiesel (1) demonstrated that the stimulus configurations effective in eliciting electrical responses from neurons of mammalian visual cortex were rectangles of relative brightness and darkness, particularly the contrast borders between such areas. Movement of such contours was a specially effective stimulus. Analogously, Cobb et al (2) found that shifting black and white squares of a chess board pattern in the visual field of human subjects produced large and highly reproducible evoked potentials (EPs). The latency of the major occipital positive wave of the pattern reversal evoked potentials (PREPs) proved to be less variable. Hence these PREPs provide relevant and reliable information regarding the integrity of the visual system and have received wide acceptance as an important non-invasive tool for the assessment of visual dysfunction. Besides many technical factors like size of the checks, their alternation rate, luminance, contrast level, there are many physiological factors which influence PREPs. Some of these factors which need special mention are: recording montages, pupil size, visual acuity, level of light adaptation, age and sex (3). Therefore particular care must be taken in keeping these factors well controlled for rocording PREPs in normal subjects. No authentic report has appeared in the literature regarding normative data of PREPs in Indian children. It is in this connection, the present study was conducted to establish such data of PREPs in children and how it compares with data already reported for children in the western world. It was also aimed to see whether there were age and sex differences in the normative data in boys and girls.

METHODS

Eighty four children belonging to MCD Nandnagri School Shahdara, Delhi, with an average age of 9.9±2.6 yrs (range 4-15 yrs) were the subjects of this study. They were carefully examined to exclude any visual dysfunction and eyes were refracted to 6/6 acuity. PREPs were recorded from 01 and 02 (international 10-20 notation) referenced to A1 and A2 respectively. Fpz was kept as ground. The test stimulus of checkerboard pattern was produced on black and white TV monitor by the MEB 5200 (Nihon Kohden) evoked potential recorder having inbuilt visual pattern generator. The test stimulus was 14 x 14 pattern of black and white checks with

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sides 1.4 cm long, subtending an angle of 32′ of an arc at a distance of one metre. The pattern reversal rate was 1/sec. The signals recorded were filtered through band spread 1-100 Hz. Two sets of 256 responses were averaged for each eye and these were analysed by inline computer having automatic artifact rejection mechanism. The latencies of various negative and positive waves of evoked potential responses along with amplitude of P1 were calculated. The values so obtained were compared between right (OD) and left (OS) eyes and averaged values (OD+OS/2) of boys and girls. Student 't' test was used for statistical evaluation of the data.

RESULTS

The mean values of latencies of waves and P_1 amplitude is given in Table I separately for OS and

TABLE I : Showing latencies of various waves of PREPs in boys and girls.

				PREP—LATENCIES (msec)						
Sex	*Age (yrs)*	*No. of children*	*Eye*	N_1	P_1	N_2	P_2	N_3	P_3	P_1*Amp. (μv)*
BOYS	9.61 ± 2.8	49	OS	67.59 ± 5.6	99.2 ± 7.4	144.67 ± 24.9	183.4 ± 33.3	224.12 ± 39.6	257.97 ± 34.7	7.12 ± 4.0
			OD	70.24 ± 9.9	103.81 ± 14.6	146.32 ± 29.3	190.3 ± 35.3	235.2 ± 43.5	263.4 ± 31.2	6.3 ± 4.4
GIRLS	10.31 ± 2.3	35	OS	66.88 ± 6.73	98.9 ± 9.4	134.91 ± 23.5	167.9 ± 28.6	210.79 ± 36.0	251.64 ± 39.9	7.1 ± 3.9
			OD	70.85 ± 8.0	104.62 ± 15.0	135.5 ± 23.9	172.7 ± 26.8	209.6 ± 31.0	250.7 ± 38.6	6.0 ± 2.7
BOYS			OS+OD / 2	68.91 ± 6.2	101.5 ± 10.2	145.5 ± 24.7	186.8 ± 31.5	230.6 ± 38.4	260.7 ± 29.9	6.71 ± 3.8
GIRLS			—do—	68.89 ± 5.4	101.3 ± 9.0	135.5 ± 21.0	170.7 ± 24.0	209.9 ± 28.9	251.0 ± 36.2	6.6 ± 2.7

TABLE II : Showing values of latencies of PREP responses and P_1 amplitude in left (OS) and right (OD) and average of both eyes (OS+OD/2) in school going children.

			PREP—Wave latencies (msec)						
Age Yrs±SD (Range)	*No. of children*		N_1	P_1	N_2	P_2	N_3	P_3	P_1*Amp. (μv)*
9.9±2.61 (4-15 Yrs)	84	OS	67.3 ± 6.1	99.11 ± 8.2	140.61 ± 24.7	177.0 ± 32.3	218.7 ± 38.5	255.3 ± 36.9	7.11 ± 3.9
		OD	70.5 ± 3.9	104.15 ± 14.7	141.9 ± 27.6	183.01 ± 33.0	225.2 ± 40.8	258.0 ± 34.9	6.20 ± 3.7
		OS+OD / 2	68.9 ± 5.9	*101.63 ± 9.7	141.4 ± 29.6	180.3 ± 29.7	222.2 ± 36.1	256.7 ± 32.8	6.6 ± 3.4

* 99% TL of P_1 130.7 msec.

TABLE III : Showing values of P_1 latency and amplitude reported by different authors in children.

Author	*Recording Montages*	*No. of Subjects*	*Age*	*P_1 latency (msec) (msec)*	*Remarks*
Wanger & Perssen (8)	OZ-FZ	10	4-6 yrs	OS 109.9 OD 110.2	
Kobayashi & Toyomura (9)	01, 02, A1, A2, C3, C4, A1, A2	74	3-13	About 100	
Moskowitz & Sokol (12)	OZ-A	439	1-5	108.4±5.3	
Fenwick & Hennesey (10)	OZ-FZ	73 (Boys=35, Girls=38)	6-11	102.5	No gender and age difference
Present Study	01, 02 A1, A2	84 (Boys = 49 Girls=35)	4-15	OS 99.1±8.2 OD 104.1±14.7 $\frac{OS+OD}{2}$ 101.6±9.7	No gender difference

OD in boys and girls. Though OD values are slightly higher as compared to OS values both in boys and girls, but the differences are not statistically significant. The averaged values (OS+OD/2) of latencies also do not show significant difference between boys and girls, though values are slightly lower in the latter. The average latency values of all the right (OD) eye did not also differ significantly from those of left (OS) eye Table II. Therefore, representative data of PREP responses for these children were calculated (OS+OD/2) as shown in Table II.

DISCUSSION

The school going children of the present study did not include those less than 4 yrs of age who could not cooperate in maintaining fixation of the eye at the central point of the checkerboard screen. This is an important prerequisite for recording PREPs, as improper fixation of the eye, even in adults, completely obliterates these responses (4). Moreover the transient pattern reversal method using O1,02 and A1, A2 recording montages with large check size i.e. 32′ of an arc was preferred to other methods (steady state or flash) as it produces undistorted, reproducible evoked responses having large P1 amp, with clear scope for component analysis (5,6). As defects in refraction affect visual evoked responses (5) visual acuity in these subjects was checked with Snellen's chart and refracted to 6/6. Fig. 1 shows normal PREPs record. There are many technical, physiological and eye factors which influence PREPs. The technical factors pertain to physical characteristics of stimuli i.e, check size, alternation rate, luminance, contrast and distance of fixation of the eye, besides recording montages. All these factors were monitored and kept constant for each subject as also done in our previous study reporting normative data of visual evoked potentials in young adults (7). The two main physiological factors known to affect visual evoked responses are age and sex. The latencies of various components particularly that of P1 latency and amplitude of the present study are comparable with age matched subjects of the western world (8-12) Table III. In fact the values are even comparable with those reported in the young adults (7). These observations suggest that there are no age differences in P1 latency and amplitude in children and adults. This might be due to the fact that post natal maturation of PREP components occurs to the adult values by 20 wks for large checks and 6 to 7 yrs of age for small checks (11-12). There are reports suggesting that P1 latency remains stable until 60 yrs of age and then increases justifying need for correction factor thereafter (13).

There is a controversy regarding gender differences in visual evoked potentials. Some authors re-

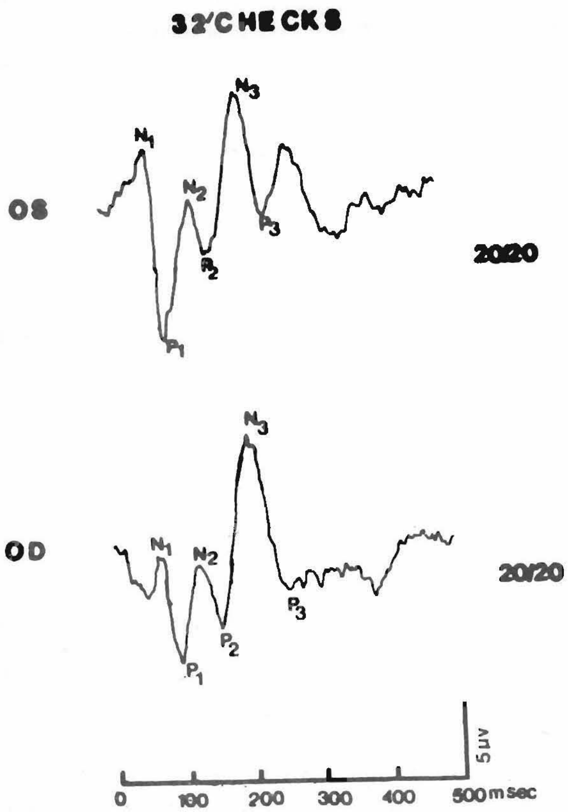

Fig. 1 : A representative PREP response obtained from a child, to a full field stimulation (32' checks; 14×14 field, alternation rate 1/sec) with luminance of dark checks 6.3 ft-L and of light checks 31.6. ft-L giving contrast of 67%. Three positive (P1-P3) and three negative waves (N1-N3) are indicated for left (OS) and right (OD) eye refracted to 6/6 or 20/20 visual acuity.

port that females have shorter P1 latency (3,14), whereas Shearer and Dustman (15) found no gender difference in age matched normal subjects of 6-59 yrs. The present study also does not show any PREP changes in boys and girls (Table I). Similar observations have been made by others in their studies on children (9,16). Reports regarding brainstem auditory evoked potentials in infants and children from this laboratory also showed no gender differences (17). So it can be inferred that whatever be the gender differences in PREPs, they must be developing after puberty.

The other factors which influence PREPs are the eye factors, of which refraction, adaptation and pupil size are important. The large check size of 32′ of arc, alternation rate of 1 Hz, refracted 6/6 eye and the distance of one metre from the TV monitor further minimised the eye factors' influence on PREPs. However the latencies of PREPs in OS and OD were slightly different (Table I and II). The OD values of latencies were slightly on the higher side and P1 amplitude lower as compared to those of OS. However the differences were not significant. This trend of increased P1 latency in rt. eye (OD) was seen both in boys and girls. It has been observed that P1 latency is shorter and amplitude greater in the dominant eye (18). In the present study, no such correlation was seen. Similar observations showing no rt. and lt. eye differences in evoked potentials have been reported by others (16,19).

Thus the latency values of various waves of PREPs reported in the present study in the school going children should serve as normal baseline data. However these are quite comparable with the adult normative data with the exception that 99% tolerance limit of P1 latency i.e. mean+3 SD extends beyond that reported in adults. As per data of the present report 99% tolerance limit of P1 in children is 130.7 msec which is higher as compared to adults where sex differences are also seen (7). This is not surprising because it is well documented that P1 latency norms in children are higher (as much as one SD or more of adult mean) than in the adults (12). As regards the clinical significance of the other PREPs waves i.e. N2 to P3 nothing is definitely known. However, future studies would throw light on the neural substrates acting as generators for these components of PREPs and criteria of their abnormalities based on latency delays or amplitude changes.

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