Song listening does not affect pattern reversal visual evoked potentials

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BACKGROUND AND OBJECTIVE: The pattern reversal visual evoked response has been defined as a reproducible cortical response upon stimulation of the eyes. This response depends on the intensity of the light stimulus and its distance from the eyes and is not affected by simultaneous tactile or auditory stimulation. However, in some patients we observe different P100 latencies, at different intervals of testing, without lesions of the optic tracts. The purpose of this study was to evaluate whether a loud meaningful acoustic noise, simulated by song listening, during the testing of the visual evoked response, could alter the latency or amplitude of the cortical potentials.
DESIGN AND SETTING: The study was performed in the Clinical Neurophysiology Laboratory of the Medical Center by one technician trained to perform visual evoked potential analysis.
SUBJECTS AND METHODS: We performed pattern reversal visual evoked potentials on 40 eyes of normal individuals at rest and during auditory stimulation with loud meaningful acoustic noise in the form of songs familiar to the subject. We compared the latencies and amplitudes of the P100 wave during these two test conditions.
RESULTS: The latencies and amplitudes of the P100 waves evoked upon stimulation of the eyes of the subjects did not differ statistically during the test at rest and upon stimulation with songs simulating loud acoustic noise.
CONCLUSIONS: We conclude that loud song listening has no effect on the pattern reversal visual evoked potential latency or amplitude. Thus, it seems likely that the results are independent of environmental acoustic noise.

The question seldom arises whether an abnormal pattern reversal visual evoked response (PRVEP) could be secondary to an interfering auditory stimulus during recordings. This question becomes more valid when the abnormality in the wave is unexpected in an otherwise optimal recording. The published studies reports change in the PRVEP in different physiological states not related to the optic nerve and tract. We attempted to study the PRVEP of normal individuals at rest and when simultaneously hearing meaningful acoustic noise in the form of songs familiar to the listener, to see whether auditory stimulation has any effect on the latency or the amplitude of the PRVEP cortical response.

SUBJECTS AND METHODS

We studied 20 subjects, 15 males and 5 females, aged between 20 and 47 years. The subjects were completely healthy, not on any medications, not complaining of any ailments, nor wearing corrective eyeglasses if they had any refractive errors. They were students attending the medical school, and provided the required informed consent.

The subjects were placed in a dark silent room 1 meter in front of a computer screen displaying a checkerboard with a 60% check size to eye angle. Gold cup electrodes were pasted on their scalp at Oz (5 cm above the inion: active electrode), Fz (12 cm above the nasion: reference electrode), and the ground electrode on the forehead. Pattern reversal occurred at a rate of 1.9 reversals per second. The low frequency filter was 1 Hz and the high frequency filter was 100 Hz. The number of average sweeps was 100. Each eye was tested twice, with the other eye patched. The average latencies and amplitudes of the PRVEP were calculated for each eye separately. The same procedure was performed with high volume songs sung in the subject's native language, produced by earphones placed in the subjects' ears from a portable radio. The P100 latencies and amplitudes were recorded for each event, and the statistical analysis, *t* test, was per-

Table 1. P100 latencies in milliseconds and amplitudes in microvolts at rest and during stimulation with acoustic noise. Values are mean (standard deviation).

	P100 latency (ms)		P100 amplitude (µV)	
	Rest	Noise	Rest	Noise
Mean (SD)	109.3 (8.9)	109.9 (9.6)	8.1 (3.5)	7.9 (3.2)
Range (min-max)	82.0-127.0	80.0-127.0	3.8-18.0	3.0-17.0

P=.311 for latencies; *P* =.56 for amplitudes

formed to compare the effect of acoustic noise on these variables in comparison to the noise-free test.

RESULTS

The latencies and amplitudes of the P100 wave of the PRVEP of 40 eyes were recorded at rest and upon meaningful acoustic noise stimulation, in the form of songs sung through earphones. The results were compared for each eye separately. The latencies at rest ranged between 94 and 127 ms with a mean of 109.3 ms and an SD of 8.9 ms. The latencies of the P100 wave upon acoustic noise stimulation ranged between 80 and 127 ms with a mean of 109.9 ms and an SD of 9.6 ms.

The amplitudes of the P100 at rest ranged between 3.8 and 18 µV with a mean of 8.1 µV and an SD of 3.5 µV. The amplitudes upon acoustic noise stimulation ranged between 3 and 17 µV with a mean of 7.9 µV and an SD of 3.2 µV (**Table 1**). Comparing the P100 latencies for each eye between the state of rest and acoustic noise stimulation using the paired samples *t* test analysis did not reveal any statistically significant difference between the two groups with a *P*=.311. Comparing the P100 amplitudes for each eye between the state of rest and acoustic noise stimulation using the paired samples *t* test analyses did not reveal any statistically significant difference between the two groups with a *P*=.56.

DISCUSSION

The PRVEP is an electrophysiological test performed to study the optic tracts and nerves from the retina to the occipital cortex through the chiasm and lateral geniculate body. The technique of performing the study has been standardized in published studies and proved to be a reproducible and reliable test of the optic tracts.[1] Nevertheless, there occur instances were an unusual delay in the PRVEP latency or a decrease in the PRVEP amplitude appears unexpectedly in a patient. The physician may question whether this is an unexpected abnormality arising from an environmental interference affecting the technique or a confounding variable in the patient, or whether this abnormality is a genuine pathology in the patient's visual system.

Studies have shown that the PRVEP may be asymmetric in patients with migraine with aura during pain-free periods. The asymmetry was in the latency and amplitude of the PRVEP, suggesting an abnormality in visual information processing.[2] Other studies have found that the PRVEP latencies in patients with migraine differ whether they are on treatment or not. The treated patients have a similar P100 latency as controls, while the patients with migraine without treatment had a lower P100 latency also suggesting changes in visual processing.[3]

The color of the patterned screen does not seem to affect the cortical latency in normal individuals, but impairment of visual perception of red was observed in patients with migraine with aura compared with patients with migraine without aura or normal controls.[4] Changes in the PRVEP have also been noticed in conditions not directly affecting the visual system. Studies in woman have shown that fluctuations in the ovarian steroid hormones affect the latencies of the PRVEP, suggesting changes in the excitability of the visual system. A significant reduction in the PRVEP latency and an increase in the PRVEP amplitude was seen in the luteal phase of the menstrual cycle in comparison to the follicular phase.[5]

Cigarette smoking was also found to decrease the P100 latency and increase the P100 amplitude of the PRVEP in comparison to sham smoking, suggesting a stimulant effect of smoking on the pattern PRVEP.[6]

Physical activity in the form of acute or regular exercise affects PRVEP responses. This effect seems to be independent of body temperature and other physiological parameters. Lower PRVEP amplitudes and shorter latencies were seen in athletes in comparison to normal individuals at rest as well as after an episode of exercise.[7]

A few studies have attempted to evaluate the effect of auditory stimulation on the PRVEP. Musicians with extensive musical training in childhood seem to have a more symmetrical PRVEP latency and amplitude and a more effective interhemispheric transfer time in comparison to music naïve individuals.[8] The effect of music on long latency visual event related potentials (ERPs) has also been studied. Music with a fast tempo seems to shorten the visual ERP latency in comparison to music with a slow tempo or normal controls. However, there are no reports of music affecting the short latency PRVEP or amplitude.[9] Several studies have attempted to evaluate the effect of attention and consciousness on PRVEP. The results suggest that the short latency P100 PRVEP may not be affected by selective attention or consciousness, while the long latency visual ERP with a latency at 220 to 300 ms seems to be affected by attention.[10-13]

We conclude from this study that loud song listening does not affect the latencies or amplitudes of short latency PRVEP. Thus, the PRVEP characteristics are unlikely to be altered by an acoustically noisy environment. This study further gives credit to the PRVEP study as a reliable measure of the conductivity of the optic tracts and is independent of an acoustically noisy testing environment.

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