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Event-related potentials in traffic policemen

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ABSTRACT

Objectives: Occupational exposure to environmental factors has various adverse effects on health. The traffic policemen are exposed to the higher health risk as they are constantly working in the noisy and polluted environment. Since the job of traffic policemen demands concentration and attention, we planned to study event-related potentials (ERPs) in them to assess this aspect of their cognitive ability.

Materials and Methods: The present study was conducted on 35 traffic police personnel from the area of East Delhi who were posted at busy traffic intersections for more than 3 years. ERPs were recorded using the oddball paradigm. They had to respond to target stimuli by pressing a button on the response pad with a thumb of their dominant hand.

Results: The latencies of N100, P200, N200, and P300 waves were not significantly different between controls and subjects. P300 latency was 266.41 ± 39.21 in controls and 254.20 ± 30.84 in subjects ($P = 0.15$). P300 amplitude was also not significantly different in both groups.

Conclusion: There are no changes in the latencies of different components of ERP's of traffic policemen, indicating preserved concentration and attention in our study.

Keywords: Traffic policemen, Noise, Event-related potential, Cognition, P300

INTRODUCTION

The occupational environment may present risks to the health and safety of people at work. An increase in air pollution has especially affected the health of traffic personnel who spend most of their duty hours on busy traffic intersection.[1,2] The traffic fumes have been reported to contain a variety of pollutants such as particulate matter, carbon monoxide and nitrogen dioxide which cause respiratory problems and other systemic diseases. In addition, vehicular fumes also contain potentially carcinogenic and genotoxic agents.[2] This health hazard becomes more severe with the duration of exposure. Many studies have reported a decrease in lung function and increased respiratory morbidity among traffic policemen.[1-3]

Apart from air pollutants, noise pollution is a major concern due to urban road traffic. Various physiological and psychological effects have been reported due to traffic noise exposure.[4] It can result in insomnia, annoyance, hearing impairment, and psychiatric disorders. It also affects heart rate, blood pressure and blood composition.[5,6] The traffic policemen performing their duties at busy traffic intersections are the most vulnerable group. The possible adverse effects of heavy noise and traffic congestion on the central nervous system are of growing concern. We have evaluated the possibility of deficits in auditory pathways in traffic policemen previously

by means of brainstem evoked response audiometry, mid-latency response (MLR) and slow vertex response.[7] Delayed conduction in the peripheral part of the auditory pathway was observed, while conduction was intact at the subcortical and cortical level.

Neural connectivity and functions of the brain can be studied using non-invasive techniques.[8] Event-related potentials (ERPs) are non-invasive methods of evaluating concentration and attention component of human cognitive information processing.[9] They are generated due to neural activity of specific sensory, motor, and cognitive processes and can be recorded from the scalp. Various aspects of cognitive processing can be depicted by the different waves of the auditory ERP. P300 wave is the most studied component of the ERP.[9] It reflects the attention and concentration component of cognitive processing. Its amplitude indicates the amount of difficulty encountered in differentiating target from non-target stimuli.[10,11]

Even though a number of health effects have been reported, the majority of the studies on traffic police have mainly focused on respiratory, cytogenetic and carcinogenic effects. Some researchers have focused on the long-term effects of stress and disease outcomes but various aspects of cognition are not evaluated much in this group. Since the job of traffic policemen demands concentration and attention, we planned to study ERP in them to assess this aspect of their cognitive ability.

MATERIALS AND METHODS

The present observational comparative study was carried out in the Electrophysiology Lab of the Department of Physiology, University College of Medical Sciences, Dilshad Garden, Delhi. Clearance from the Institute's Ethics Committee – Human Research was obtained. Informed written consent was obtained after the recording procedure had been explained to the subjects. Similar laboratory conditions were used for testing the subjects and controls. They were familiarised with the experimental and environmental (laboratory) conditions.

Subjects

Traffic policemen who were posted for monitoring and regulating the traffic at road junctions were selected from different areas of East Delhi. They carried out outdoor activities for most of their working time.

Sample size

The SD of P300 wave latency in controls and cases was 38.6 and 38.1, respectively.[12] To study a difference of 0.2 units, the required sample size for each group was calculated as 35. The calculated sample size is based on the assumption of type I error at 5% and power of study at 80%.

Inclusion criteria

Traffic policemen in the age group between 25 and 40 years and working for more than 3 years were included in the study. All the subjects were healthy at the time of the visit and were having no signs or symptoms of ear disease. They had no history of ear surgery or exposure to an accidental explosion. None of them were suffering from any chronic illness or were on medication. Policemen having field postings of <3 years were excluded as the group included chronic exposure to noise for a long duration. Control group (age and sex-matched) comprised 35 people working in GTB hospital. These were either technicians or sweepers mostly working indoors and having no exposure to noise. The controls were selected through the same exclusion/inclusion criteria used for the traffic policemen.

All the subjects were explained about the procedure for recording of ERPs. The recording was done using EMG/NCS/EP – 4 Channel system – Octopus 4 machine by Biostar Healthcare, India, in a soundproof room. Standard scalp locations of the 10–20 international systems were used to place silver-silver chloride disk electrodes. Active electrodes were applied on ear lobes (A1 and A2), reference electrode on the vertex of the skull at Cz position, and ground electrode on the forehead (FPz). The scalp and skin site was cleaned with alcohol followed by Skinpure™ skin preparation gel and EEG paste Elefix™. The skin electrode contact impedance was kept at <5 KΩ.

Recording of P_{300}/ERPs

ERPs were recorded using the oddball paradigm. Two types of the stimulus were given at an intensity of 90 dB and an average count of 100. A type 1 stimulus was a click frequency of 1000 Hz and 80% occurrence. A type 2 stimulus was a beep frequency of 3000 Hz with its occurrence 20% of the time. Subjects had to distinguish a target (rare) from a non-target (frequent) stimulus. They had to respond to target stimuli by pressing a button on the response pad with a thumb of their dominant hand. The stimulus was delivered by headphones. The responses were filtered with a band pass of 0.1–50 Hz. The eyes of the subjects were fixed on a particular spot on the wall in front to avoid electro-oculographic artefacts due to eye movement. Peak latencies of the ERP waves (N100, P200, N200, and P300) and peak-to-peak amplitude of N200-P300 were recorded. Data for two trials were obtained, stored, and averaged by a computer.

Statistical analysis

Statistical Package for the Social Sciences 20.0 statistical package was used for analysis. The two groups were compared

using an unpaired *t*-test. Data were presented, as mean ± SD. $P < 0.05$ was considered as statistically significant.

RESULTS

Latencies of ERPs

The latencies of N100, P200, N200, and P300 waves and amplitude N200-P300 of ERP's in the control and subject groups are shown in [Table 1]. No statistically significant changes were observed. [Figure 1] shows representative ERP waves in subjects and controls.

DISCUSSION

The present study was conducted on traffic police personnel from the area of East Delhi. Only those subjects working at traffic junctions for at least 3 years were selected as we planned to study chronic exposure to noise for a long duration. There were no significant changes in ERP waves between controls and subjects, which show that attention and concentration are not affected in traffic policemen.

Table 1: The mean latencies of ERP waves and P300 amplitude in controls and subjects.

ERP	Controls	Subject	*P*-value
N100 (ms)	79.41±15.02	75.65±16.33	0.32
P200 (ms)	137.22±23.67	135.66±20.10	0.77
N200 (ms)	192.17±33.70	191.15±25.37	0.89
P300 (ms)	266.41±39.21	254.20±30.84	0.15
N200-P300 amplitude (μv)	4.24±1.80	4.05±2.05	0.68

ERP: Event-related potential

The purpose of ERP research is to evaluate information processing in the central nervous system. There is a change in the content of thought and the attentional resources during the performance of a given task. The different aspects of selective attention are reflected by the different waves of the auditory ERP.[11] N100 and P200 components of ERP's depict the activity in neural areas activated by sensory stimuli. These are independent of the subject's attention. N200 indicates the degree of the unexpectedness of the stimulus.

The most important component of the ERP is P300, which indicates psychological processing. It originates from various sites of the brain such as the auditory cortex, hippocampus, amygdala, brainstem, and thalamus. It measures various components of information processing such as attention, concentration, expectancy, decision-making and memorisation.[10,11] P300 latency is the time required to categorise and evaluate stimuli. P300 amplitude signifies the amount of difficulty encountered in differentiating target from non-target stimuli in the 'oddball' paradigm.

P300 peak latency is proportional to stimulus evaluation timing, is sensitive to task processing demands and varies with individual differences in cognitive capability. P300 component latency changes across the scalp and is shorter over frontal areas but longer over parietal areas. Two

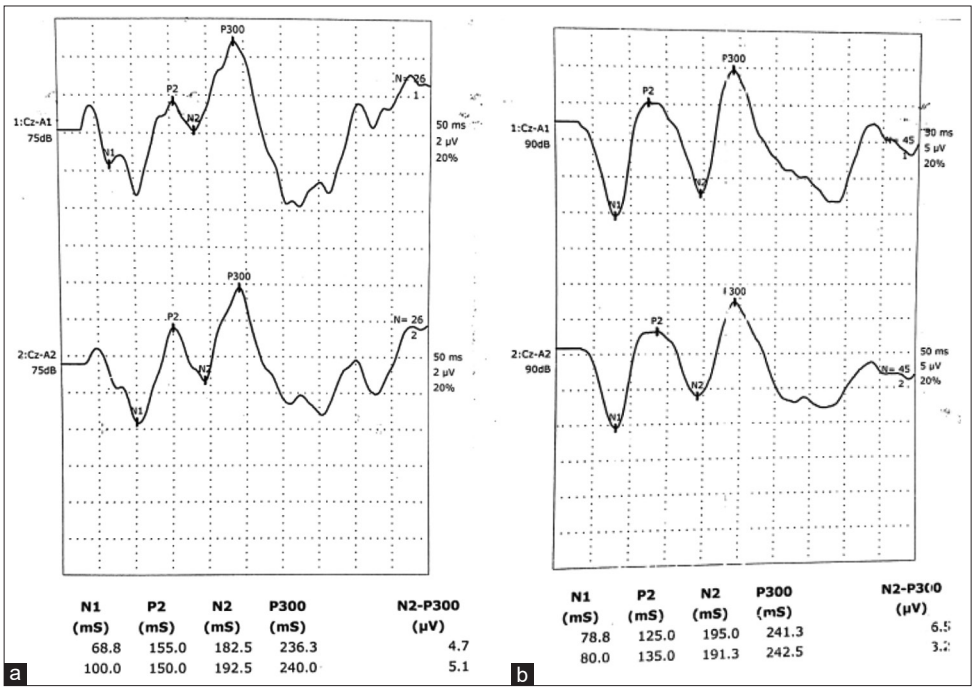

Figure 1: Representative event-related potential waves in subjects (a) and controls (b).

components of P3 have been identified – P3a and P3b.[12] The P3a comprises an early attention process stemming from a frontal working memory. The attention-driven stimulus signal is then transmitted to temporal and parietal structures related to P3b. These resulting potentials can be dissociated with paradigmatic manipulations and are generated when perceptual stimulus discrimination occurs.

Our results are consistent with earlier studies where no effect on cognition and emotional profile was observed in traffic police officers using P300 and Stroop task.[13] An increase of the P300 amplitude was observed by them under the baseline condition (without background noise and before the Stroop task). They interpreted the results as improved efficiency of traffic police officers in using their discrimination and selection abilities in the oddball task, as a consequence of their continuous need for diverting themselves from the environmental noise. However, this possible finer ability regressed as soon as the traffic police officers were experimentally exposed to exactly the same environmental noise as in the oddball task.

On qualitative analysis, Massa *et al*. (2012) observed altered P300 test results in workers exposed to occupational noise.[14] In their study, different results were obtained on quantitative and qualitative analyses. It was concluded that auditory nervous system plasticity due to prolonged exposure to occupational noise could have contributed to the increased latencies. The type of occupation and the level of noise they were exposed to is not known. In the present study, as there was no change in ERP latencies of traffic policemen, it appears that attentiveness and level of arousal are well preserved in our subjects. Further studies with a greater duration of exposure are needed to confirm these results.

Earlier, we observed a conduction delay in the peripheral part of the auditory pathway in traffic policemen.[7] In addition to traffic noise, various other factors such as lack of awareness of protective measures and duration of exposure for more than the allotted hours may have contributed to the development of hearing impairment in them. Similarly, alteration in brainstem auditory evoked response indicating altered auditory conduction up to the level of the brainstem with no significant change in MLR and P300 response was observed in subjects exposed to noise at Mumbai Airport.[14] Other adverse effects of environmental noise such as psychological symptoms, physical and mental health are also reported.[6,15,16] We did not assess the psychological status of our subjects as our study was primarily focused on assessing the attention and concentration aspect of cognitive function.

Limitations

The present study evaluates just concentration and attention. Measures of stress, memory, and other psychological parameters could have given a better cognitive evaluation. As the sample size is small, further prospective research with more number of subjects is suggested.

CONCLUSION

There are no changes in the latencies of different components of ERP's of traffic policemen, indicating preserved concentration and attention in our study. Further research with an increased duration of exposure is needed to confirm our results.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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