

P300- Long Latency Auditory Evoked Potential (LLAEP) in Normal Hearing Individuals with and Without Contralateral Noise Stimulation

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Abstract: *Objective:* To analyze P300 in normal hearing individuals with and without contralateral noise. *Study sample:* It includes five subjects, ten ears. *Results:* P300 latency and amplitude is increased in the presence of contralateral noise stimulation.

Keywords: Long Latency Auditory Evoked Potentials, Event related potential, P300, P3

1. Introduction

The Long Latency Auditory Evoked Potentials [LLAEPs] provide a non-invasive technique that reflects the neuro-electrical activity in the cortex as a response to a given stimulus.

LLAEPs is an objective measure of cognitive process to assess the auditory abilities such as discrimination, memory, attention and detection of stimuli. Auditory evoked potentials are one of the most promising electrophysiological tests for evaluation of central auditory nervous system dysfunction and/or changes. LLAEPs are represented by a series of positive and negative waves [10].

LLAEPs are of two types. They are exogenous potentials [P1, N1, P2, and N2] which are sensitive to physical characteristics of the eliciting stimulus and endogenous potential [P3 or P300] which is influenced by internal cognitive processes such as attention and stimulus categorization. The P300 component [P3], or cognitive potential, is a positive potential elicited by the recognition of a rare stimulus within a series of frequent stimuli [oddball paradigm]. It corresponds to the largest positive wave after the N1-P2-N2 complex [6].

The P300 wave is usually identified as a parieto- central deflection in the Event Related Potential (ERP) waveform that varies with the probability of the eliciting stimulus [1]. It depends upon some abilities, such as attention, discrimination and memory, and reflects cortical activity [18].

The classical P300 deflection emerges in a time locked-recorded as a positive peak typically appearing between 300 to 400 ms following stimulus presentation. Amplitude of P300 varies from 5 μ V to 20 μ V for auditory and visual evoked potentials [2].

Three positive waves overlap during the P300 latency range; P3a peaking near 250 ms, P3b peaking near 350 ms and a positive slow [3, 17]. The P3a is more frontal in its scalp distribution than the P3b, whereas the slow wave is more parietal. The P3a is not affected by whether the subject is

attending to the stimuli, whereas the P3b and the slow wave are larger with attention [16].

The term P300 used generally refers to the P3b sub component [19]. These potentials are generated by several systems, primarily the thalamo-cortical and cortico-cortical auditory pathways, the primary auditory cortex and associative cortical areas [10].

LLAEPs depend on the maturation of peripheral and central nervous system. Cognitive potential P300 is present in children from 5 to 7 years of age with reduced amplitude and increased latency, with complete maturation occurring around adolescence [4]. Cortical potential values at 14 and 16 years of age are equivalent to adult values [5]

P300 provides a general index of cognitive processing. A normal P300 wave may therefore indicate that the subject is cognitively processing the evoking stimulus. This may be helpful in demonstrating the brain's ability to discriminate between stimuli. The P300 latency can be used to demonstrate cognitive dysfunction in conditions such as early dementia or the cognitive dysfunction that occurs with metabolic disorders [19].

2. Aim

The aim of the present study was to evaluate the effects of contralateral noise on P300 in normal hearing subjects. This was done under two different conditions: without and with contralateral noise.

3. Methods

Participants:

Five subjects aged from 12 to 19 years old [number of ears ten] were taken. All participants were native Tamil speakers, right handed and had normal hearing. Inclusion criteria were defined as: normal hearing as assessed by pure tone audiometry, speech audiometry, tympanometry and contralateral acoustic reflexes, no history of neurological disorders and no language or learning complaints reported [7,8]. Those subjects who presented alterations in one or more of the above auditory assessment procedures were not

included in the study and were referred to the Otorhinolaryngology department.

Procedures and measures:

P300 was recorded in a sound-attenuated and electrically shielded room in which patients remained awake throughout the procedure while comfortably lying on bed. Inter-electrode impedance ≤ 5 KOhms was ensured prior to testing. The active electrode was positioned on the vertex (Cz), the reference electrodes on the right (M2) and left (M1) mastoids and the ground electrode at Fz position, according to the International System 10–20. The equipment used was a two-channel device (Neuro Soft NEURO-AUDIO) and a bandpass filter of 1–30 Hz was used. The elicitor stimulus was delivered monaurally through insert earphones at 75 dB HL and the oddball paradigm was used to elicit P300. The acoustic stimulus was the tone burst (TB) at the frequency of 2 kHz infrequent stimulus (target), presented randomly at a probability of 20% and mixed with a frequent tone burst of 1 kHz (non-target), presented with

80% probability [9]. Stimulus rate was one stimulus per second, with a total of 300 sweeps. Subjects were instructed to mentally count the target tone every time they discriminated it. In addition, subject was asked to keep their eyes closed in order to avoid eye movement artifacts. After the conventional recording, there was a 10-minute break and then the assessment was repeated with the introduction of contralateral white noise. Noise was delivered continuously through insert earphones in the contralateral ear at 75 dB HL.

A 700 msec time window was used and analysis was based on the numerical values of the latencies (ms) and amplitudes (μ V) in both evaluation conditions: in the presence and in the absence of contralateral white noise [9]. P300 was identified as a positive deflection after N1-P2-N2 complex.

4. Results

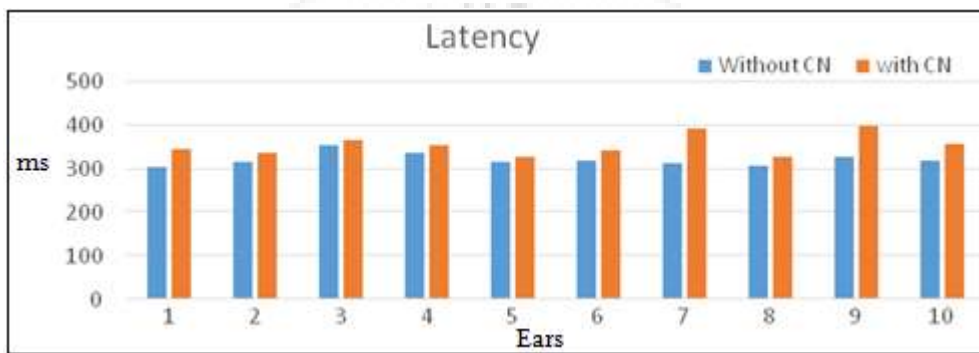


Figure 1: Latency graph of P300 without and with contralateral noise (CN)

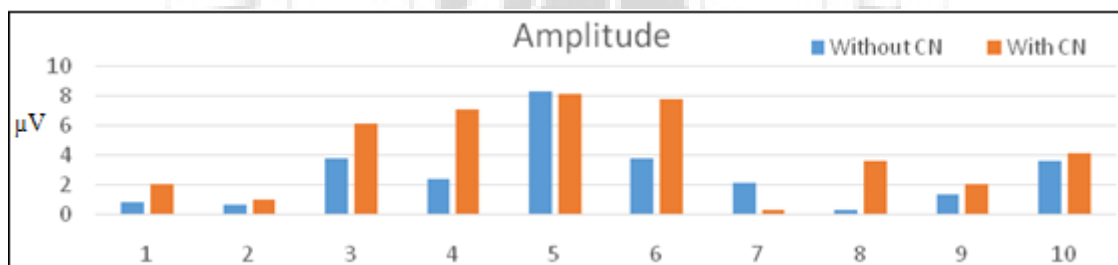


Figure 2: Amplitude graph of P300 without and with contralateral noise (CN)

Figure 1 and 2 shows the latencies and amplitudes of the P300 wave without and with contralateral noise for normal subjects. There is increase in latency and amplitude of P300 with contralateral noise.

Table 1: Shows the Mean, Standard Deviation (SD) and p-value for P300 latency and amplitude without and with contralateral noise

| | Without contralateral noise (CN) | | With contralateral noise (CN) | | p-value (p<0.05) |
|-----------|----------------------------------|--------------------|-------------------------------|--------------------|------------------|
| | Mean | Standard Deviation | Mean | Standard Deviation | |
| Latency | 320.7 ms | 15.08 ms | 353.51 ms | 24.35 ms | 0.00512 |
| Amplitude | 2.7 μ V | 2.37 μ V | 4.22 μ V | 2.91 μ V | 0.03612 |

Wilcoxon Signed Rank Test was used with IBM-Statistical package for the Social Sciences 20.0 software for the study. The results were statistically significant for P300 latency and amplitude at $p < 0.05$.

5. Discussion

P300 assesses the hearing cognitive process which provides information about the central auditory nervous pathway integrity. In this study, P300 responses to target tones were different in the presence and absence of contralateral noise stimulation. Results suggest that latency and amplitude measures show more vulnerability to the effects of noise on P300 responses.

The P300 amplitude is increased in the presence of contralateral noise is supported by Salo et al [11]. The P300

latency is increased in the presence of contralateral noise is supported by Polich et al [12] and Salisbury et al [13].

Rabelo et al. observed that P300 latency increased in the presence of contralateral noise in a group of professional musicians [14].

Ubiali et al (2016) observed that contralateral white noise stimulation can delay P300 latency in normal hearing children, when assessed by an oddball paradigm with easily discriminable tones [9].

The effects of noise on P300 amplitude could be different if a more complex task was used, such as a three-tone discrimination task, or less readily discriminable target and standard tones [13].

Noise stimulation activates the medial olivocochlear bundle in a reflexive manner, reducing the cochlear amplifier gain and decreasing otoacoustic emissions amplitude. Reductions on cochlear micromechanics may reduce the primary afferent neurons firing, which would reflect on P300 latencies due to a delay on signal transmission throughout the entire ascending pathway in the presence of noise [13,15].

The increase in the amplitude of P300 with contralateral noise is related to the allocation of greater attentional and discrimination resources necessary to respond to targets in the noise condition. The presence of noise may have made the oddball task more difficult so the subjects had to make greater effort to perform the task [13,15].

6. Conclusion

The mean P300 latency values obtained in this study corresponds to 320.7ms and 353.51ms without and with contra-lateral noise stimulation respectively. The mean P300 amplitude is 2.7 μ V and 4.22 μ V without and with contralateral noise stimulation respectively. The results obtained in the present study suggest that contralateral white noise stimulation can delay P300 latency and increase the amplitude in normal hearing subjects.

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