

## EEG BASED GAP PERCEPTION IN HUMAN BEINGS

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### ABSTRACT

*An electroencephalogram (EEG) is a test to measure the electrical activity of the brain. Evoked potential (EP) tests measure the electrical activity of the brain in response to stimulation of specific sensory nerve pathways. P300 component of evoked potentials are observed to find out the subject ability in perception of gap for given auditory stimulus. EEG was recorded by presenting an auditory stimulus to the subject. Oddball paradigm of auditory stimulus was used. Auditory stimulus is Gaussian noise embedded with silent interval nothing but 'gap'. A positive response by the subject with respect to the presence of gap was noted down. Simple segmenting and averaging techniques using Matlab were used to obtain P300 wave. And also various parameters like curve fitting, correlation factor, p test were determined which accounted for comparing perceived and non-perceived averaged waveforms. We could observe that the P300 component was obtained in the range of 250ms to 500ms. P300 of perceived wave was more prominent compared to non-perceived.*

**Keywords-**auditory stimulus, gap, evoked potentials, P300 wave.

### INTRODUCTION

In crowded environment people usually find difficult to hear or decode the speech what others would have said. So our test leads in determining the ability of person to hear what he wants by avoiding all other sounds or noises. This test also tells the concentration level of person.

As we know EEG is the most convenient and non-invasive used method to understand brain activity and its responses to certain stimuli such as visual, audio etc. Evoked potentials play a very important role when we are recording EEG and simultaneously presenting input stimuli to the subject.

P300 component of evoked potentials which is non-invasive stimulated the use of brain recording methods to assess human cognition. P300 component appears at around 300ms with the latency from stimulus onset.

**History:** P300 was first reported by Sutton, Braren, Zubin & John in 1965. Its origins stemmed in part from the confluence of information theory on psychological research and increased

technological capability for signal averaging of human neuroelectric measures. In our daily life, we are surrounded by various sensory stimuli and perceive them.

The ability to make fine temporal discriminations of acoustic signals contributes to a number of auditory perceptions including speech discrimination and the localization of sound. Typically in gap detection broadband noise is interrupted (producing a gap or silent period) and measurements are made of the minimal gap interval that can be discriminated. It is seen that for normal hearing subjects the gap threshold is 3-4ms (milliseconds). Besides physiological and psychological investigation P300 components can also be used in detecting various ailments such as Alzheimer's disease, Parkinson's disease, amount of depression and many other related ailments.

## METHODOLOGY

### A. Stimulus

The auditory stimulus used for the protocol is a tone designed using Matlab which includes Gaussian noise embedded with silent interval gap. Gap introduced are of 2ms, 8ms and 16ms. These 3 tones with varying gap length are looped so that the entire length of sound is 18 min.

### B. Subjects

As we have done pilot test the number of subjects on which this test is done is 8. Subjects considered are both male and female. Age considered is 20-30 years.

### C. Experiment

The auditory stimulus is presented to subject based on oddball paradigm. Oddball paradigm is the way of designing sound which includes target and non-target sound stimulus. Subject is asked to respond for target sound. Our target sounds are tones with gap length of 16ms & 8ms. Non-target sound is tone with gap length of 2ms.

EEG recording is done based on standard 10-20 electrode system. The lobes that show prominent P300 wave are temporal lobe, central lobe, and frontal lobe. So we have preferably chosen these lobes. The recordings are done while simultaneously presenting the stimulus to the subject. His responses are also noted down. Since the EEG is recorded from standard sophisticated machine the problem of noisy EEG is eliminated.

The recorded file is loaded on to Matlab and is further processed. Based on the sound and response we have segmented the EEG and categorised into 4. First wave is called true positive (TP) which is segmented if the sound has gap and subject response is correct; second wave is called true negative (TN) which is segmented if the sound has gap and subject response is wrong; third wave is false positive (FP) which is segmented if the sound has no gap and subject assumes that there is gap and will respond. And the last one is false negative (FN) which is segmented if

the sound has no gap and also subject doesn't respond. These waves are observed thoroughly and decisions are taken accordingly.

## RESULTS

A pilot test on subjects was done and the results were successfully obtained. The segmented and averaged waves of four types are shown below.

We have calculated the correlation between 4 set of response namely true positive, true negative, false positive and false negative. It was seen that correlation with respect to true positive rest three is less than 1. From this we can observe that true positive nothing but perceived wave is more prominent and dominating the rest 3. The values and waveforms are shown below.

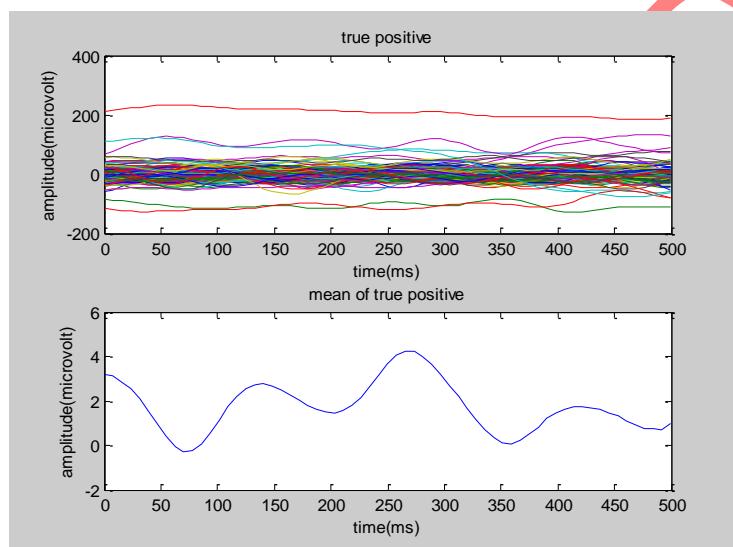


Fig1: the TP waveform. Above represents segments and below is its averaged wave nothing but TP wave.

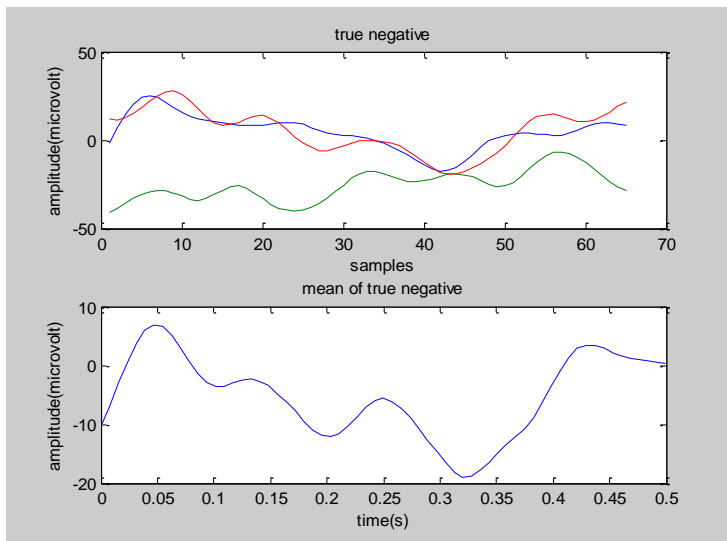


Fig2: segmented and averaged TN waveform

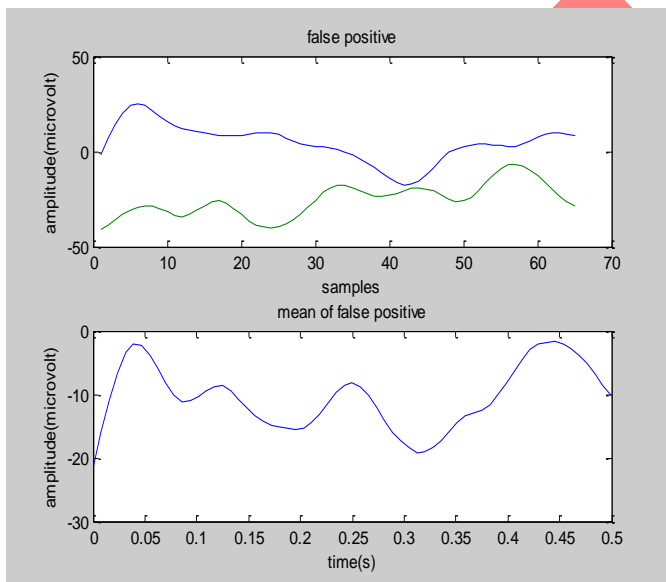


Fig3: segmented and averaged FP waveform

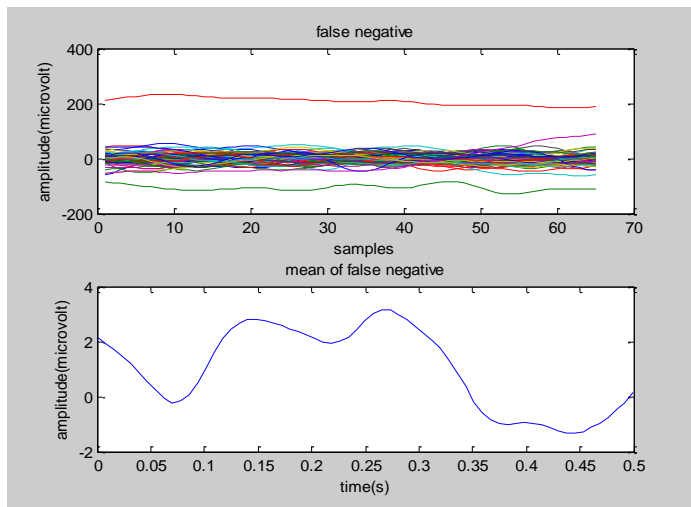


Fig4: segmented and averaged FN waveform

The averaged values of subject is as follows

TABLE I

AVERAGED VALUE

TP	TN	FP	FN
		-	
3.2031	10.2133	-21.22	2.1649
		-	
3.1444	-6.9978	15.9633	1.944
2.8665	-2.9893	-10.888	1.7207
2.5504	0.5987	-6.57	1.4758
2.1096	3.828	-3.418	1.2126
1.5423	5.8853	-2.108	0.8839
0.9575	6.916	-2.232	0.5631
0.3799	6.6267	-3.76	0.2175
-0.0612	5.2093	-6.01	-0.076
-0.285	3.0613	-8.236	-0.218
-0.2327	0.7227	-10.026	-0.1655
0.0472	-1.4587	-11.096	0.0596
0.5626	-2.968	-11.044	0.5113
1.1556	-3.6907	-10.382	1.0561
1.7259	-3.5693	-9.546	1.593
2.2247	-2.9133	-8.74	2.0894
2.5787	-2.392	-8.598	2.454
2.7457	-2.272	-9.376	2.6678

2.7747	-2.6187	-10.736	2.8007
2.6765	-3.4773	-12.152	2.8244
2.4918	-4.876	-13.454	2.7547
2.2638	-6.2693	-14.288	2.677
2.0219	-7.796	-14.812	2.6004
1.797	-9.4133	-15.15	2.4766
-	-	-	-
1.6248	10.8867	-15.36	2.3631
-	-	-	-
1.4826	11.7667	-15.508	2.25
-	-	-	-
1.4463	12.1667	-15.268	2.1024
-	-	-	-
1.5578	11.6733	-14.51	1.9833
-	-	-	-
1.7885	10.3707	-13.092	1.9355
2.1596	-8.72	-11.438	2.0014
2.6673	-7.0787	-9.632	2.1642
3.201	-5.8773	-8.58	2.4721
3.6709	-5.5053	-8.1	2.7613
4.051	-6.1347	-8.888	3.0348
4.2488	-7.2013	-10.214	3.1732
4.2083	-8.7387	-12.108	3.1613
3.9922	-10.584	-14.07	2.9842
3.6564	-12.656	-16.04	2.7942
3.2065	-14.548	-17.342	2.5372
2.6898	-16.476	-18.47	2.2626
-	-	-	-
2.2092	18.0947	-19.172	2.0362
-	-	-	-
1.7065	18.9467	-19.13	1.7543
1.167	-18.796	-18.442	1.3148
-	-	-	-
0.705	17.8107	-17.238	0.8386
-	-	-	-
0.359	16.4227	-15.846	0.3601
0.0977	-14.912	-14.45	-0.1757
-	-	-	-
0.0488	13.4747	-13.416	-0.6065

0.219	-12.164	-12.848	-0.8402
-			
0.494	10.8093	-12.48	-0.9754
0.8188	-8.8747	-11.624	-1.0365
1.194	-6.3067	-10.204	-0.9705
1.4708	-3.5307	-8.408	-0.9372
1.6398	-0.8773	-6.428	-0.974
1.7302	1.408	-4.414	-1.0306
1.7506	2.8387	-2.946	-1.1284
1.7047	3.416	-2.16	-1.2441
1.6001	3.2693	-1.868	-1.3183
1.471	2.844	-1.64	-1.3231
1.3129	2.1693	-2.076	-1.2636
1.1243	1.6627	-2.728	-1.1187
0.8986	1.196	-3.754	-0.9802
0.7714	1.032	-5.034	-0.7425
0.7386	0.8013	-6.74	-0.4672
0.6924	0.6356	-8.5333	-0.2251
0.9606	0.3333	-10.18	0.168

From this table we can see that values of TP are greater than the rest three and hence dominating as said above.

The correlation values of subject is as follows

TABLE III  
CORRELATION VALUE

	TP	TN	FP	FN
sub1 (TP)	1	0.8886	0.4168	0.4075
sub2	1	0.4141	0.3484	0.1355
sub3	1	-0.1921	-0.1928	0.7378
sub4	1	0.1535	0.3362	0.8368
sub5	1	0.5328	0.213	0.514
sub6	1	-0.0482	-0.062	0.4314
sub7	1	0.0184	0.0721	-0.0915
sub8	1	0.7501	0.803	0.3979

From the table we can see that the correlation values for TN, FP, and FN are less compared to TP.

## CONCLUSIONS

From figures and tables it can be seen that P300 wave was successfully obtained and the results obtained for 8 subjects are also similar. Hence we can conclude that these subjects could discriminate the gap accurately. More results are to be analyzed by conducting more number of tests. And also different age groups are to be considered.

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