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Comparison of Beta Brain Waves in Seeing Famous and Fameless People - A Prestudy

Gülsüm Akdeniz*
Department of Biophysics, Electroneurophysiology Lab, Yenimahalle Training and Research Hospital, Medicine Faculty, Ankara Yildirim Beyazit University, Ankara, Turkey

***Corresponding author**
Gülsüm Akdeniz

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Abstract: In recent studies, specific neurons were discovered in the brain which is devoted to a single person or object. For example, various pictures of Jennifer Aniston elicited a response in the same specific neuron unit inside the temporal lobe. In this study, I aimed to explore the relationship between beta waves and famous face processing by electroencephalography (EEG). Two healthy volunteers participated in this study (one male). EEG recordings were taken from while they were watching pictures of famous (20) and fameless (20) people pictures with a 32 channel EEG recording system. Beta power values in the temporal lobe were analyzed from the EEG data. Beta power values were 20, 15μV^2 and 12, 25 μV^2 for famous people and fameless people, respectively. Face-specific neurons are located in the temporal lobe and beta wave considered related to higher cognitive functions. I concluded higher beta power value for famous people as famous-specific neurons create more electrical activity than non-specific visual neurons in the temporal lobe. This was a prestudy and I believe that this study paves the way to explore the role of the beta wave in processing 'Jennifer Anderson photos'.

Keywords: EEG, Beta waves, Temporal lobe, Visual neurons.

INTRODUCTION

The perception of faces is of critical importance in social behavior in humans as well as in nonhuman primates. Face processing has been studied using several neuroimaging techniques, including electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and magnetoencephalography (MEG) [1-6].

Electrophysiological studies in primate studies and in humans suggest that certain brain regions are specialized for the processing of faces [7]. Perret *et al.* studied with male rhesus monkeys to reveal if there were specific areas for face processing by recording 497 single neurons in the superior temporal sulcus (STS) [8]. They presented geometrical stimuli; high contrast square wave gratings, bars etc, over 1000 three-dimensional objects in different size, shape and color, and face stimuli which consist both real human faces and photographs of faces. They reported at least 48 cells were selectively active during the presentation of faces and their responses to faces were larger than those to geometrical stimuli and objects. As indicated by these findings there are "face specific" neurons in the temporal lobe [8].

In their study Fried et al. investigated medial temporal neuronal activity for faces and objects with nine epilepsy patients [9]. They showed that specific neurons in the medial temporal lobe (MTL) discriminated faces from inanimate objects [9]. In various studies it has been suggested that this specialization of temporal lobe was not just for faces but for familiar faces [10-12]. A study conducted with temporal lobe epilepsy (TLE) patients revealed that left temporal lobe played a crucial role in coding famous faces. This result has implied the major role of temporal lobe in recogniton of familiar or famous faces and particularly left temporal lobe is related to semantic retrieval of knowledge of famous faces [11].

Beta waves are one of five brain waves they have high-frequency, low-amplitude and they are commonly observed in an awaken state. Beta waves are related high cognitive functions such as conscious focus, memory, and problem solving [13]. In this prestudy I aimed to explore bioelectrical aspects of this phenomena by EEG by analysing beta power value in diffrent brain areas.

PATIENTS AND METHODS

Two healthy volunteers (1 male and 1 female) aged between 19 and 20 years, with a mean age of 19.5 years, participated in the present study. They were free from neurological and psychiatric disorders.

I took fameless face photos from the Centro Universitário da FEI, Sao Paolo and famous photos were downloaded from the internet (Figure1). Stimuli were presented on a 19 inch LED computer monitor at a viewing distance of 100 cm in an isolated room. 2 consecutive parts of 20 trials were presented with a rest period of one minute in between parts. In the first part there were 20 famous photos, the second part there were 20 fameless photos. Stimulus duration was 500 ms and the images were selected randomly. Participants were not instructed to do anything, but watching the screen carefully.

EEG was recorded the Faraday cage using a 32-channel ActiCamp (Brain Products GmbH, Gilching, Germany) electrode cap, with impedance below 5 kΩ. Two electrodes were placed above and below the right eye to record the electrooculography (EOG). Signals were amplified, filtered at 0.16 to 0 Hz, and at a sampling rate of 1 kHz.

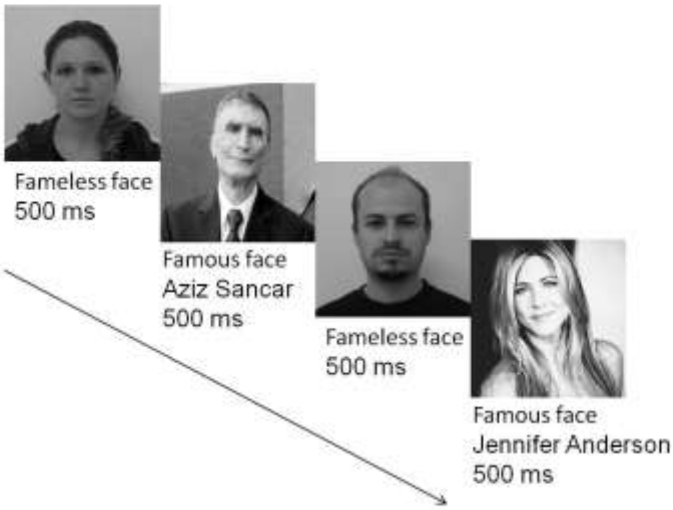

Fig-1: Illustration of the time course of stimulus presentation

BESA Research Software Package (version 6.0; BESA Software, Gräfelfing, Germany) was used for EEG analysis. For the quantitative analysis, artifact-free epochs in the raw data were divided according to the beta band (14.0–30.0 Hz). The power values of the monopolar montages (A1 as a reference) of these bands were analyzed in all 32 channels. The number of channels was reduced to calculate the specific brain regions: temporal area (T3, T4, T7, and T8), parietocentral area (P3, P4, Pz, P7, P8, C3, and C4), frontal area (Fp1, Fp2, Fz, F3, F4, F7, and F8), and occipital area (O1, Oz, and O2).

RESULTS

Calculated beta power values were in frontal, temporal, parietal and occipital lobes for famous and fameless pictures were presented in Table 1. The major beta response difference was observed in the temporal lobe between famous and fameless pictures. However, in the frontal and occipital lobes beta power values were nearly the same for the two stimuli types. The comparison can be seen the figure 2 clearly.

DISCUSSION

As discussed in the introduction, some previous studies have revealed the existence of face-specific areas in the temporal lobe. In the literature, there are studies examined this face specificity in terms of event-related potentials (ERPs) for example N170, and VPP [14-21]. However, roles of brain waves; Delta waves (below 4 Hz), Theta waves (4-7 Hz), Alpha waves (8-13 Hz), Beta waves (13-38 Hz) in face processing have not been studied yet. In this prestudy, I planned to reveal if there is a relationship between the famous face process and temporal beta waves.

Table-1: Beta power values

	Frontal Lobe	Temporal Lobe	Parietal Lobe	Occipital Lobe
Famous people	15,64	20,15	12,05	35,01
Fameless people	14,32	12,25	15,17	34,31

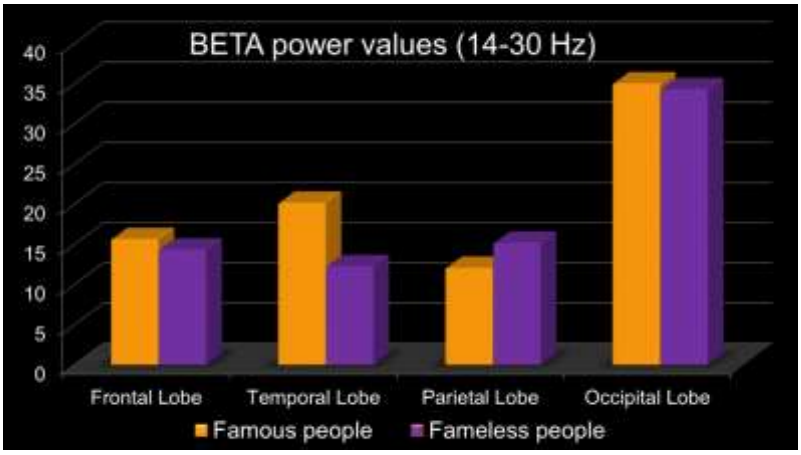

Fig-2: Graph of beta power values according to brain lobe

I observed that beta waves occurred during the presentation of the famous and fameless face were different in the temporal lobe but not in the others lobes. This result is in concordance with the previous studies [22-24]. These studies revealed face specific area; temporal lobe, in the brain. Moreover, Quian Quiroga et al. revealed that there are even certain medial temporal lobe neurons which were activated by specific pictures of given individuals [24]. They conducted this study with eight epilepsy patients who had been implanted with depth electrodes and analyzed neuron responses in the temporal lobe. They discovered that a certain unit of neurons responded to only one individulas picture. For example, a unit responded to several Jennifer Anniston pictures.

Another result of my study was that beta power for famous faces nearly two times larger than for fameless faces in the temporal lobe. Beta waves are associated with memory [25, 26]. In their study Svobodaa et al. used the effect location method of meta-analysis to explore the neuroanatomy of autobiographical memory (AM) includes personal experiences like emotion, visual imagery and as well as semantic memory [27]. They revealed that medial and lateral temporal regions are related to the AM. The difference in terms of beta power in our data, between famous and fameless face processing, supports memory association of beta waves.

CONCLUSION

I hope that after completing this research, the results of my study may contribute to understanding the role of beta waves in the temporal lobe on famous or known face process in the brain.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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