

# Comparison of cognitive and emotional cerebral variables in Eastern subjects watching TV advertisements: a case study

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**Abstract.** Advertisements are intensively presented on the usual TV programs worldwide. Recent functional neuroimaging studies have begun to investigate how commercial brand information is processed in the brain. While the role of prefrontal cortices is then highlighted in the generation of appreciation for a brand, it is not really addressed the issue how this appreciation is spread across different cultural models, i.e. across different Western and Eastern people. In this study we investigated the cerebral activity of a group of Eastern people during the fruition of a Western and an Eastern version of the same TV commercial related to very popular smartphone. We used EEG technologies since it is now known that it is possible to investigate the activation of prefrontal cortex also by using advanced processing techniques. By comparing the theta, alpha and heart rate activity of the population investigate, we analysed the level of memorization, attention, pleasantness and emotion perceived. Results present and increase of the pleasantness index and emotion perceived while watching particular scenes of interest of the Eastern version of the commercial. These findings, focused on the prefrontal cortex and obtained with EEG measurements, suggest that this kind of technology is able to track variation of the cerebral activity related to cognitive and emotional processing across TV commercials. Moreover, there is the possibility to investigate frame segments of particular interest for marketers that could be properly adapted according to the cultural context in which the advertising campaign will be promoted.

**Keywords:** EEG; neuromarketing; memorization; attention; emotion.

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## 1. Introduction

Advertisements are intensively presented on TV programs and magazines worldwide. Recent functional neuroimaging studies have begun to investigate how commercial brand information is processed in the brain [Deppe et al., 2005; Paulus and Frank, 2003]. Although the experimental designs vary, each of these studies report activity in ventral and/or medial prefrontal cortex during the contemplation or consumption of familiar brand-name products. Since lesion studies indicate ventromedial prefrontal cortex (VMPC) is critically involved in emotion, emotional regulation and decision-making [Koenigs and Tranel, 2007; Koenigs et al., 2007] ventromedial prefrontal activations can be interpreted as evidence for emotion playing a pivotal role in brand preference [Deppe et al., 2005; Paulus and Frank, 2003]. Psychological studies that document the use of emotional appeal in

advertisements further support the significance of emotion in brand preference formation [Anderson et al., 2005].

Nowadays, researchers are attempting to investigate the signs of the brain activity correlated with an increase of attention, memory and emotional engagement during the observation of commercial advertisements [Vecchiato et al., 2010; Langleben et al., 2009]. In fact, indirect variables of emotional processing could be gathered by tracking variations of the activity of specific anatomical structures linked to the emotional processing activity in humans, such as the pre- and frontal cortex (PFC and FC respectively; [Davidson, 2004]). The PFC region is structurally and functionally heterogeneous but its role in the generation of the emotions is well recognized. Specifically, findings suggest that the left PFC is an important brain area in a widespread circuit that mediates appetitive approach, while the right PFC appears to form a major component of a neural circuit that instantiates defensive withdrawal [Davidson, 2004]. In addition it is very well known the role of the frontal areas in cognitive processes such as memory and attention in complex tasks [Werkle-Bergner et al., 2006; Klimesch, 1999]. Moreover, by monitoring autonomic activity such as the heart rate (HR) it is possible to assess the emotional state of the subject. In fact, the link between the heart rate and emotions has been already suggested [Montano et al., 2009].

While the role of prefrontal cortices is then highlighted in the generation of appreciation for a brand, it is not really addressed the issue how this appreciation is spread across different cultural models, i.e. across different Western and Eastern people. In fact, it is well known as different cultural model in Western and Oriental culture leads to different appraisal of the same experience or situation. Hence, it is of value to understand if people educated in different culture could differently react to the same advertisement from a cerebral point of view.

In this scenario, our purpose is to investigate the modulation of the Global Field Power (GFP) of the EEG rhythms elicited in the FC and PFC during the observation of commercial advertisements. In particular, the aim of the present study is to analyze the level of memorization, attention and emotion perceived while Eastern subjects are watching an Eastern and a Western version of the same TV commercial.

## **2. Material and Methods**

### **2.1. Experimental design**

Twenty healthy undergraduate students of the Hangzhou Dianzi University (Hangzhou, Zhejiang, China) have been recruited for this experiment (age  $22.95 \pm 1.09$ ; ten males). The task consisted in watching a ten minutes long documentary in which we inserted one advertising break, in the middle of the movie, formed by six TV commercials as experimental stimuli. The advertisements selected are related to three different international brands advertising sport equipment, hi-tech products and clothes, respectively. For each brand we have chosen a western and an eastern version of the clip containing no speech but advertising the item just by images and sounds. The reason why we made this decision lies in obtaining marketing messages which are understandable by both eastern and western populations. Randomization of the occurrence of the commercial videos within the documentary was made to remove the factor “sequence” as possible confounding effect in the following analysis.

In the following we are going to compare the neurophysiological activity of experimental subjects while watching two versions of a hi-tech advertisement. The plot of these two commercials is the same: a father is far from home and celebrates his daughter by means of the advertised smartphone. Hence, it has been possible to define, for both commercials, seven segments of interest defined as following: Testimonial (comprising the whole ad except the exposition to the brand), Brand (exposition to the brand), Dad (scenes in which the only father is presented), Mum + Daughter (both mother and daughter are on the screen), Dad on smartphone (scenes in which the father is seen through the smartphone), Mum + Daughter on smartphone (scenes in which both mother and daughter are seen through the smartphone), Daughter (the only daughter appears on the TV screen). For each segment we compared the mean cerebral and heart rate activity in both advertisements as illustrated in the following.

### **2.2. EEG recordings and signal processing**

Informed consent was obtained from each subject after explanation of the study, which was approved by the local institutional ethics committee.

All subjects were comfortably seated on a chair in front of a computer screen showing the experimental stimulus. We collected the EEG activity at a sampling rate of 256 Hz while the impedances kept below 5 k $\Omega$  by means of the gUSBamp amplifier (g.Tec medical engineering GmbH).

The montage we employed refers to the 10-10 International System with the following recording channels: Fpz, AF3, AF4, F3, Fz, F4, T7, C3, Cz, C4, T8, P3, Pz, P4, Oz.

Raw EEG traces were first band pass filtered (hp=2 Hz; lp=30 Hz) and the Independent Component Analysis (ICA) was then applied to detect and remove components due to eye movements, blinks, and muscular artefacts. The extra-cerebrally referred EEG signals have been transformed by means of the Common Average Reference (CAR) and the Individual Alpha Frequency (IAF) has been calculated for each subject in order to define the frequency bands of interest according to the method suggested in the scientific literature [Klimesch, 1999]. In particular we defined the following three frequency band: theta (IAF-6, IAF-4) i.e. theta ranges between IAF-6 and IAF-4 Hz, lower alpha (IAF-4, IAF) and upper alpha (IAF-2, IAF+2). EEG traces were then segmented to extract and analyse the cerebral activity during the observation of TV commercials. Each EEG trace has been band pass filtered in order to isolate the spectral components in the theta, lower alpha and upper alpha bands from the whole EEG spectrum.

The filtered traces have been employed to calculate the Global Field Power [GFP; Lehmann and Skrandies, 1980]. Since for the phenomena we would like to investigate a clear role of the frontal areas have been depicted [Werkle-Bergner et al., 2006; Davidson, 2004; Klimesch, 1999] we used the frontal electrodes to compute the GFP indexes used in the following of this study. In order to summarize the properties of the cerebral activation for the analysed ads we used the theta, lower alpha and upper alpha bands to define the Memorization, Attention and Pleasantness indexes, respectively [Vecchiato et al., 2011, 2010; Werkle-Bergner et al., 2006; Davidson, 2004; Klimesch, 1999]. The filtered EEG traces were subjected to the computation of the GFP by taking into account the signals coming from the following frontal and prefrontal electrodes of the 10-10 International System: AF3, F3 to compute the Memorization Index (MI); Fpz, AF3, F3, AF4, F4, Fz to calculate the Attention Index (AI); homologous channels AF3, AF4, F3, F4 to evaluate the Pleasantness Index (PI). As to the Attention Index, we reversed the GFP waveform in order to have the activity of de-synchronization pointing up. As far as concern the Pleasantness Index, it has been defined by taking into account the frontal EEG asymmetry's theory by Davidson [2004] as already investigated in a previous study [Vecchiato et al., 2011]. Hence, the formula defining the PI is the following:

$$PI = GFP_{dx} - GFP_{sx} \quad (1)$$

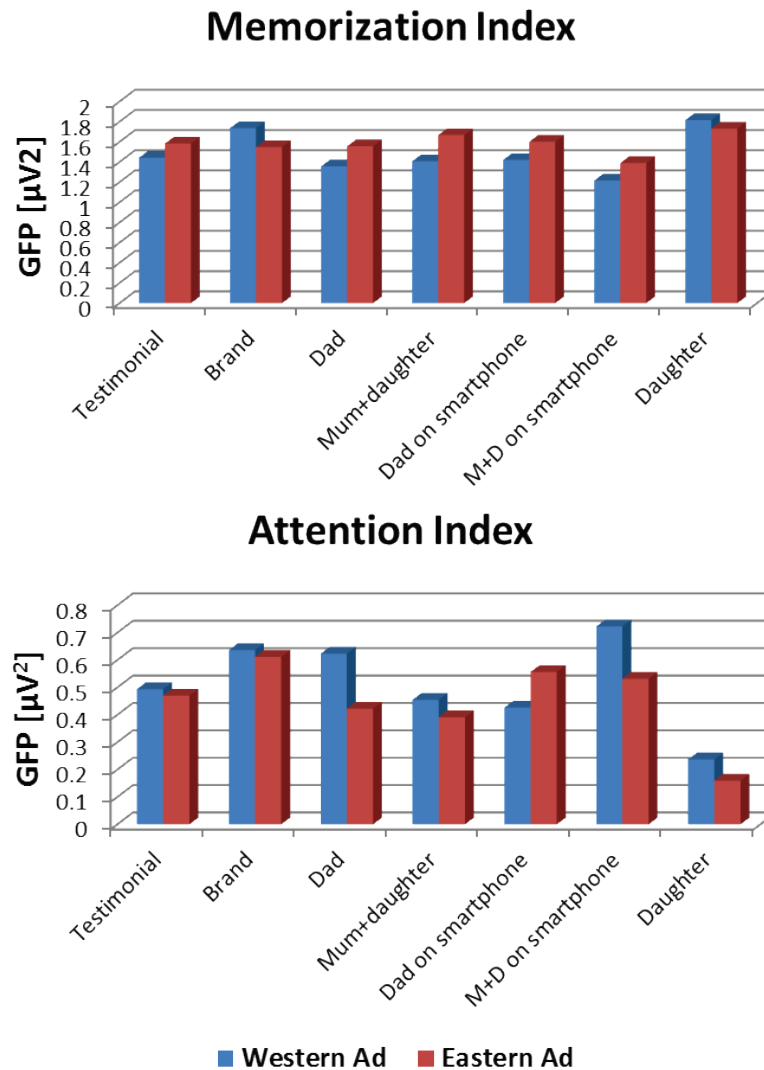
Where the  $GFP_{dx}$  and  $GFP_{sx}$  stand for the GFP calculated among right (AF4, F4) and left (AF3, F3) electrodes, respectively. The GFP signals of each subject have been averaged to obtain a mean waveform to be compared between the two commercials. Statistical analyses will be performed by using t-test at  $p < 0.05$  after the execution of the Bonferroni correction for multiple test.

### 2.3. Autonomic recordings and signal processing

We recorded the electrical activity from the left wrist of all subjects in order to extract the heart rate signal. The recorded signal has been processed in order to extract the peak-to-peak distance from the R-waveform visible on the EKG signal. From this information we calculated the heart rate tachogram (HR) by computing the reciprocal of the previously defined peak-to-peak distance. The HR signals of each subject have been averaged to obtain a mean waveform to be compared between the two commercials.

## 3. Results

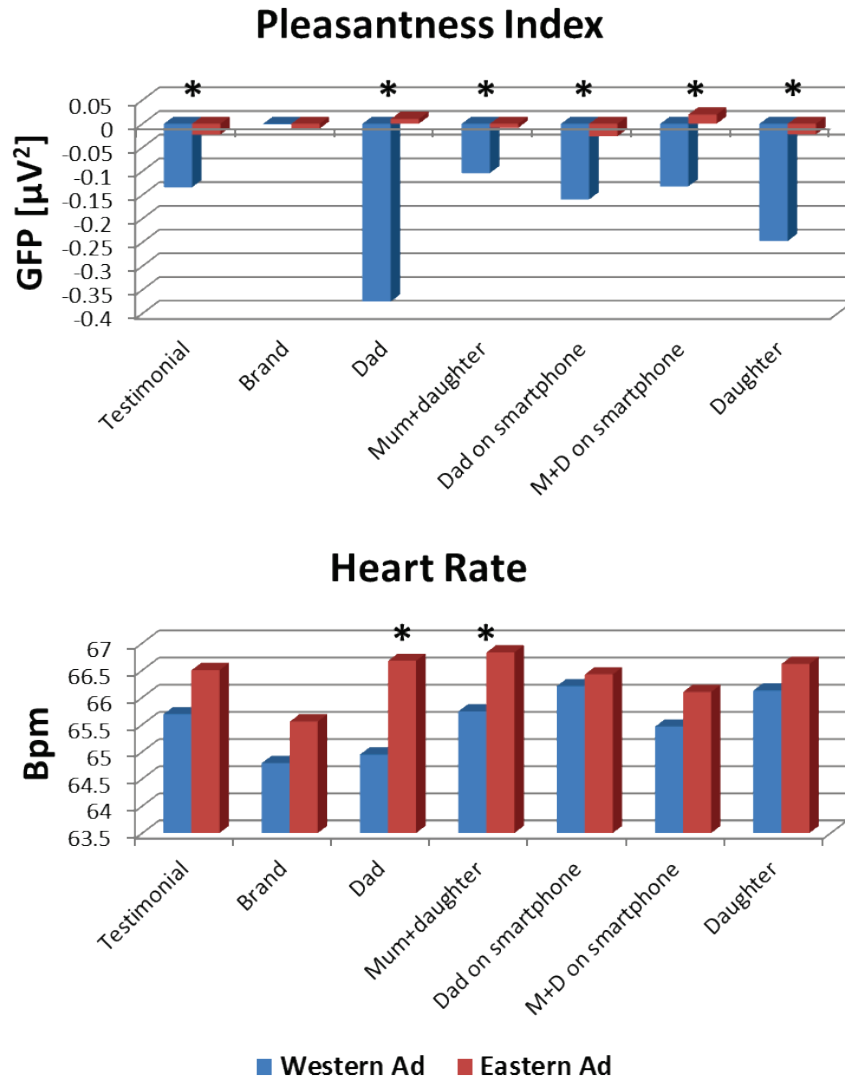
In the present paragraph we are going to illustrate the results we achieved in the experiment described above. The following figures show the values of MI, AI, PI and HR in the seven segments of interest by comparing the Western and the Eastern version of the analyzed TV commercials.



**Figure 1.** Figure presents the average values of GFP in the theta (MemORIZATION Index, upper row) and lower alpha band (Attention Index, lower row), respectively. Each column refers to a single segment of interest showing the values of the cerebral variables for both Western (blue) and Eastern (red) advertisement. No statistical difference among the experimental conditions.

Figure 1 presents the GFP values for the MemORIZATION and the Attention Index for both advertisements. The seven columns show the difference of the cerebral variables existing between the two TV commercials. For both MemORIZATION and Attention Index it is possible to observe that each segment of interest is characterized by the same average value of GFP. Overall, this result suggest that from a cognitive point of view the two version of the advertisement elicit the same level of memorization and attention in the population analyzed.

Figure 2 presents the GFP values for the Pleasantness Index and Hear Rate measurements for both advertisements. The seven columns show the difference of the cerebral and autonomic variable existing between the two TV commercials. As far as concern the Pleasantness Index, we observe that the Western Ad is characterized by negative GFP values for all segments of interest. According to the definition of the PI, such result means that the whole commercial is mostly perceived as unpleasant for the population analyzed.



**Figure 2.** Figure presents the average values of GFP for the Pleasantness Index (upper alpha, upper row) and Heart Rate values (lower row). Each column refers to a single segment of interest showing the values of the cerebral variables for both Western (blue) and Eastern (red) advertisement. The differences of the Pleasantness Index are statistically significant for each segment except the Brand one (as the symbol \* indicates). The differences of the Heart Rate values are statistically significant for the Dad and Mum + Daughter segments (as the symbol \* indicates), with  $p < 0.05$ .

Instead, the Eastern version of the ad is characterized by values of PI close to the zero and also positive ones. Overall, by comparing the PI values of the two versions of the ad, we can observe that the Eastern TV commercial is perceived more pleasant with respect to the Western one. The difference of the PI are statistically significant in each segment of interest except for the Brand one, where on the screen is presented the same logo for both advertisements. The level of statistical significance was taken as  $p < 0.05$  after Bonferroni correction with respect to the number of test performed.

As far as concern the analysis of the Heart Rate, the two commercials present the same HR values in almost all segments except for the two ones in which the only father appears on the screen and the one in which both mother and daughter act. In both cases the HR values are higher for the Eastern ad. This result suggest that these two segments of the Eastern ad have been perceived with a more positive emotion with respect to the same scenes of the Western ad.

## 4. Discussion

Results above presented highlight how a population of Eastern people differently react, from a cerebral point of view, to the observation of an Eastern TV commercial with respect to a Western one of the same item advertised. In particular from a cognitive perspective, we found out no difference in the Memorization and Attention Index between different scenes of interest of the two commercials. However, significant differences appeared in the emotional variables. Both Pleasantness Index and Heart Rate showed how the Eastern ad is perceived more pleasant [Montano et al., 2009] and with more positive emotion [Vecchiato et al., 2011] with respect to the Western one. Present findings suggest how Eastern population investigated is more attracted from actors and situations they perceive more familiar with respect to ones presented in the Western version of the TV commercial analyzed. This could be of help for marketers since it seems to be important to adapt the commercial campaign according to the country in which it has to be promoted. Further analysis and experiments will be performed in order to better investigate cultural difference and similarity between Eastern and Western population during the fruition of TV commercials.

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