Correlation of Neuromarketing to Neurology

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Abstract: The aim of this research work is to identify the most preferred brand of soap in New Delhi through wireless EEG signal through Neuromarketing. A group of four major soap brands advertisements i.e. Pears, Lux, Cinthol and Dove are considered for this research. The advertisement (video) of above these brands are used to stimulate the subjects (9 male and 9 female with age range of 22-30 years) The brain signal responses for the stimuli were collected using a 14 channel wireless headset with a sampling frequency of 128 Hz. The acquired signals are preprocessed using fourth order Butterworth band pass filter. Then feature extraction is done to extract desired features from the EEG signal. The mean value and then power of mean value of each soap brand is calculated. The frequency spectrum of above soap brands is obtained through time-frequency analysis using Short Time Fourier Transform (STFT). The results so obtained are plotted in graphs for final analysis. The present experimental results are analyzed and it is indicated that the subjects are mostly inspired on Dove brand of soap compared to other brands.

Keywords: EEG, STFT, Neuromarketing, EEG signal.

I. INTRODUCTION

Neuromarketing is a novel field of marketing research which is being used to study the consumer behavior such as their demands, needs and intentions of buying the products using neuro-scientific methods. The researcher mainly studied the consumers' sensorimotor, cognitive, and affective response of the product advertisements. There are various ways to measure changes in the activity from various parts of the brain, among them are functional magnetic resonance imaging (fMRI), electroencephalography (EEG) and steady state topography (SST), etc. The methods to measure changes in the activity from various parts of the brain will compute the activities in specific regional spectra of the brain and measure changes occurring in the physiological state. These methodologies are used to examine the marketing stimuli of different types such as visual (image /posters), audio (radio/music), audio-visual (video). Neuromarketing is used to investigate the consumer behaviour in non-invasive way in cases where the consumer is unable to convey their intentions if asked explicitly. The researcher is interested in examining the reasons why consumers make the decisions they do and which parts of the brain get activated while making the decision to buy a particular product.
The conventional methods of marketing by means of advertisements in multimedia sources such as radio, television (TV), newspapers, etc do not induce a strong intention on all the consumers in order to convince them to buy the product. Nowadays, Neuromarketing has become a very popular tool as most of the famous product manufactures have started utilizing the Neuromarketing strategies to assess the potential of their product advertisements before the launch of their product in market. The strategies of Neuromarketing are used to evaluate the potential of multimedia content of the product advertisements and the consumer behaviour about their product. Neuromarketing is a rising field of research, where researchers analyze the EEG signals for Neuromarketing field by focusing on the brain regions which get activated during the marketing stimuli.

Electroencephalograms (EEG) are the recording of the electrical signals of the brain over the entire scalp. These signals are the variations in voltage which results from ionic current flow in the neurons of the brain. EEG is highly chosen by research in the literature to study various clinical and engineering applications such as Neuromarketing has several advantages such as (i) Non-Invasive, (ii) Low Cost, (iii) Simplicity, (iv) Higher Temporal Resolution.

EEG signals are usually analyzed over following frequency bands of information: Delta waves, slowest EEG rhythms, generally have the highest amplitude EEG waveforms observed (about 250-325 uV) with all the frequencies below 4 Hz, Theta waves typically of higher amplitude and frequencies, 4 Hz - 8 Hz, Alpha waves- this rhythm occurs during relaxed and alert stages, are regular rhythms of 8 Hz - 12 Hz Beta waves- this band is of smaller voltage and high frequency rhythms (14 to 32 Hz, sometimes as 50 Hz).

In attention associated studies, the research is done on analyzing the theta to alpha waves information to classify the consumer’s physiological state change while giving marketing stimuli. In the present work, the researcher is mainly interested to investigate the spectral changes of alpha wave and theta wave of the subject while giving the stimuli (video advertisements) inducement on selecting the most preferred brand of soap among four different brands.

EEG signals were taken from all the 18 subjects over the entire protocol duration. The acquired EEG signals were preprocessed using Butterworth filter. Short Time Fourier Transform (STFT) is used to obtain the statistical features of the alpha wave and theta wave from each subject.

II. DESIGN & IMPLEMENTATION

1. DATA EQUISITION

A. Stimuli and Protocol Design

In this work, the researcher aimed to study the consumer’s most preferred soap brand in New Delhi. This work considers the four most popular brands of soap in Delhi namely, Lux, Pears, Dove and Cinthol. Several numbers of video clips are collected from each soap brand from various sources such as company websites, You tube, etc. At last, four video clips of each brand are scrutinized based on the sound quality, display resolution, and its content. Since, the better
sound quality and good resolution video might induce better physiological behaviour inside the subjects. Each video clip under each brand reflects the product and the video clips duration is not at all constant. Thereby, the four different products under each brand are shown to the subjects for evaluating the subject’s behavior. The protocol is started with a set of instructions, followed by relaxation scenes and then product advertisements of each brand. All the subjects are seated comfortably on the chair placed in front of the LCD screen and asked them to control their muscular/wrist/ocular movements during the experiment. After the completion of viewing each brand video clips, there will be a short session of self-assessment, whereby a few questions will be asked to the subjects such as (i) like or dislike the advertisement (ii) intensity of like or dislike (iii) the emotion experienced while watching the video clip.

B. Subjects
A sum of 18 subjects that consists of nine male subjects and nine female subjects at the age range between 22 and 24 years old considered for this experiment. All the subjects are university students and did not have any history of medical illness such as cognitive/mental/psychological disorders and all of them are non-smokers/drinkers. All the subjects were given a sufficient introduction about this experiment, time duration, purpose of experiment and consent forms are collected from them before entering into the experiment.

C. Data Acquisition Device
Wireless EEG headset is used for collecting the EEG signals from the subject’s using 14 channels. All the electrodes are made up of Ag/Ag-cl material and placed on the subject scalp based on international standard 10-20 electrode placement system. All the electrodes acquired the data from the scalp at the sampling frequency of 128 Hz.

III. METHODOLOGY
A. Preprocessing
The raw EEG signal was processed to remove the unwanted interferences and the non-signal artifacts. The high frequency components such as power-line interferences also severely introduce noise in the EEG signal. The presence of noise will disrupt and corrupt the signal and as a result, this would make the feature extraction and classification less accurate. Butterworth 4th order bandpass filter is used to remove the low and high frequency noises with a cut off frequency of 0.5 Hz – 60 Hz.

B. Framing
The duration of video stimuli are not constant. A minimum duration of video stimuli is 30 sec and maximum of 140 sec. In this work, each stimulus has been framed into a maximum of 5 sec duration without any overlapping. Zero padding is used to make the number of samples on each frame as constant. Since, the intention normally reflects in brain activity of maximum 5 sec duration. Hence, we used to analyze the maximum 5 sec duration of EEG signal on each stimulus in this work. The total number of frames might vary from one trial over other trail and consecutively on brands.
Table I: Mean of Power For Four Brands Of Soap

| Parameter | Lux | Dove | Cinthol | Pears |
|-----------|-----|------|---------|-------|
| Channel   |     |      |         |       |
| 1         | 8.36E+03 | 8.46E+03 | 8.36E+03 | 8.38E+03 |
| 2         | 8.07E+03 | 8.17E+03 | 8.07E+03 | 8.10E+03 |
| 3         | 8.61E+03 | 8.70E+03 | 8.60E+03 | 8.65E+03 |
| 4         | 9.04E+03 | 9.15E+03 | 9.03E+03 | 9.04E+03 |
| 5         | 8.15E+03 | 8.14E+03 | 8.14E+03 | 8.16E+03 |
| 6         | 8.51E+03 | 8.54E+03 | 8.54E+03 | 8.55E+03 |
| 7         | 8.46E+03 | 8.44E+03 | 8.44E+03 | 8.48E+03 |
| 8         | 8.85E+03 | 8.85E+03 | 8.85E+03 | 8.89E+03 |
| 9         | 8.93E+03 | 9.03E+03 | 8.90E+03 | 8.93E+03 |
| 10        | 8.46E+03 | 8.41E+03 | 8.41E+03 | 8.46E+03 |
| 11        | 8.52E+03 | 8.51E+03 | 8.51E+03 | 8.54E+03 |
| 12        | 8.60E+03 | 8.60E+03 | 8.60E+03 | 8.61E+03 |
| 13        | 7.92E+03 | 7.92E+03 | 7.92E+03 | 7.94E+03 |
| 14        | 8.83E+03 | 8.82E+03 | 8.82E+03 | 8.86E+03 |

Fig.1.

IV. RESULTS

This work aims to analyze the spectral features of alpha wave of EEG rhythm for human behavior detection on marketing stimuli. The experimental results are narrowed to investigate the performance of different statistical features of alpha wave and theta wave to understand the consumer’s expectations on various soap brands. The Time-frequency graph indicate that, most of the subject “Liked” the Dove brand in contrast with other soap brands. Though, the
advertisement stimuli of all the brands give more information about several features of soap such as, (i) safety (ii) Hardness (iii) Cleansing (iv) durability (v) Lather (vi) Conditioners (vii) Fragrance (v) cost, etc., but still most of the subjects liked to engage with Dove brand.

Following are the graphs obtained by time-frequency analysis of four soap brands.

Fig.2 (a) The Time-frequency components of Dove Soap (b) The Time-frequency components of Pears Soap, (c) The Time-frequency components of Cinthol Soap, (d) The Time-frequency components of Lux. Among All the graphs the time frequency of Dove soap are higher than that of other brands. Here, the yellow region shows the high-power region and the blue region shows the low power region.
V. CONCLUSION

The present study investigates the consumer’s intention on purchasing of four popular soap brands in Delhi for developing intelligent Neuromarketing system. In this preliminary study, we have collected the EEG signals from 18 subjects through 14 wireless EEG channels. Noises present in the EEG signals were effectively removed using Butterworth band pass filter and Time-Frequency analysis is used to extract the features from upper alpha, lower alpha and theta wave of EEG rhythm. This experimental result indicates that, Dove brand is highly preferred by the subjects compared to other brands since the yellow colour represents the high power. This is a preliminary study narrowed to investigate the consumer’s purchasing behaviour on soap brands in Delhi. Further analysis on EEG signals over frequency bands, other categories of products, more number of subjects with different age, gender, races is required for developing more generalized Neuromarketing system.

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