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Electroencephalographic Signaling Approach in Determining the Emotional Situations of People

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Abstract:

The brain is the control center of the human body. The working structure of the brain is provided by communication between neurons. The electrical movements of neurons are called "brain waves". Brain waves can be recorded by Electroencephalography (EEG). With the analysis of brain waves recorded with EEG, changes in the emotional states of people can be analyzed. In this study, the emotional changes of colors and shapes of people of different ages and sexes are analyzed.

Keywords: Brain Computer Interface, (BBA), Electroencephalography, (EEG), Emotiv EPOC +, MindWave Mobile Title, NeuroSky, Neuro Marketing

1. Introduction

The brain is the control center of the human body. The brain performs all the controls of the sensory and muscular system with a number of neurons called neurons. Neurons perform electrical and chemical communication. Brain waves can be recorded by Electroencephalography (EEG). The wave frequency of EEG signals recorded in different states of consciousness is shown in units of Hertz (Hz), wave intensity in units of Microvolt (μV). Brain signals differ according to Hertz values. The microvolt values allow us to be informed about the activation time [1].

People often live without awareness of what influences their decisions are. The stimuli that stimulate all sensory organs, such as an audible sound, a scent received, visuals in the environment, colors, heat sensation, wind, etc., are the most basic influences of many decisions that people think they give with rationality. The pastel colors of the Crayola brand are sold as fragrant and odorless. It appears that there is a significant sales difference in the sales of the products. But consumers are unaware that they prefer to smell the paint. The study is an example of this topic [2]. Another study, the writing of warnings on cigarette packets, has been found to have the opposite effect as a result of examining the effects on the head, although people are designed to not smoke [3]. There are studies in the literature that investigate the effects of human sentiments with brain signal analysis in different ways [1] [4-16].

Color is the perception that different waves of light create in retracing the eye. Color is perceived by light, eye and brain .The influence of colors on people is based on an ancient past that stretches from ancient times to day-to-day. Although there are social differences in the effects of colors, the place of colors in people's psychology has a big precaution. According to a study

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conducted by the University of London, those who prefer black in clothing are charismatic , those who prefer green in clothing are energetic, red is preferred to influence a person and to represent love, purple color represents richness [17]. Colors often affect people's preferences and moods without being aware of it in their life cycle. The effects of colors on psychology are shown in Table 1.

Table 1 Colors and meanings [17,18]

Color	Meaning
Red	It has features like vitality, activity, exciting and appetizing. It can cause nervousness when over looked.
Yellow	Yellow color intelligence, delicacy, practicality, temporary and remarkable meaning. The light yellow has a relaxing personality.
Green	Green color means harmony, peace, understanding, trust.
Blue	Blue color means calm, peaceful.
Dark blue	Dark blue means clarity, clarity, eternity, authority and efficiency.
Purple	Purple color is known as wealth, splendor color. It is evocative of nobility and glory.
Black	Black color expresses situations such as power, passion, ambition, concentration, mourning.
Grey	Gray immobility means slowness, seriousness.
Brown	Brown reality represents being scheduled to be programmed. At the same time, mobility and comfort are known as a color that makes us feel informal.
White	White color It means clean, unreachable, not deceived, like eternity.
Pink	The pink color symbolizes situations such as shyness, romanticism, comfort, relaxation, love and charity.

Changes in people's emotional states can be achieved as a result of the evaluation of brain waves obtained by EEG. The basis of this work is the study of the human brain's response to different colors and shapes. In this study, Emotiv EPOC+ device, which is a mobile system, is used to obtain EEG signals to analyze emotional state changes of people.

2. Material and Method

The measurement of brain waves in the evaluation of emotional changes in humans is carried out with the Emotiv EPOC+ instrument, which can quantify brain signals from 14 points and transmit the data wirelessly to the management panel in the cloud system.

2.1. Emotiv EPOC+

The Emotive EPOC+ is a signal measuring device that can transmit data wirelessly, with 14 signal collection points and 2 reference points placed in front of the computer. Assessment of brain signals determines face expressions, mental commands, performance measures, and emotional states. Emotive EPOC+ is a high-resolution, multi-channel, portable system. In Figure 1 there is an image of an Emotive EPOC+ device.

Figure 1. Emotiv EPOC+ device

2.2. Emotic EPOC+ Technicial Specifications

The technical specifications of the Emotiv EPOC+ device and the system requirements of Windows is given in Table 2 [19]. Windows system is used in this study.

Table 2. Emotiv EPOC + technical and windows system features

FEATURES	**Emotiv EPOC +**
Number of sensors	14+2 reference
Sensor	AF3, AF4, F3, F4, FC5, FC6, F7, F8, T7, T8, P7, P8, O1, O2
References	In the CMS/DRL noise cancellation configuration P3/P4 locations
Sampling method	Sequential sampling. Single ADC
Sampling rate	28 SPS or 256 SPS* (2048 Hz internal)
Resolution:	14 bits 1 LSB = 0.51μV (16 bit ADC, 2 bits instrumental noise floor discarded), or 16 bits*
Bandwidth	0.2 – 43Hz, digital notch filters at 50Hz and 60Hz
Filtering	Built in digital 5th order Sinc filter
Dynamic range (input referred)	8400μV(pp)
Coupling mode	AC coupled
Wireless	Bluetooth® Smart
Proprietary wireless	2.4GHz band
Battery	Internal Lithium Polymer battery 640mAh
Battery life	up to 12 hours using proprietary wireless, up to 6 hours using
Situations that can be determined	**Face expressions:** Blink, Left eye blink, Right eye blink, Frown down, Lift eyebrows (surprised), Smile, Squeeze teeth (Squeeze one's face), Glance to the left, Glance to the right, Laugh with a loud voice, Fake smile (To the right), Fake smile (To the left) **Emotional Expressions:** Sudden excitement, Long-term excitement, Frustration, Loyalty, Diving in thought, To attract attention **Mental commands:** Neutral **Up to 4 pre-graduated 13 status lists:** Pushing, Pulling, Lifting, Leaving, Left, Right, Turning clockwise, Turn clockwise in the opposite direction, Turning forward, Turning backward, Turning left, Turning right, Destroy
User Configurable Options	14 bit / 16 bit voltage resolution, Individual motion sensors active / Disabling individual motion sensors (Accelerometer, gyroscope, magnetometer), (With expander accessory) External hardware trigger option, Data flow to SD card (With expander accessory)
Windows system requirements	GHz Intel Pentium 4 processor (or equivalent), Microsoft Windows XP with Service Pack 2, Windows Vista, Windows 7, or Windows 8, 2GB RAM, 200MB available disk space, USB 2.0 ports (depending on the number of neuroheadsets you wish to use simultaneously).

3. Application

The study consists of 10 male and 10 female subjects aged between 25 and 35 years. In the emotional analysis of the subjects, Emotiv EPOC+ is used. In the study, the person to be

emotionally analyzed is placed in front of a computer screen and the Emotiv EPOC+ heading is placed per person. The red circle, red square, green circle and green square shapes are displayed for 5 seconds. After the red circle and red square, the subjects are shown black screen for 10 seconds and the brain is rested. After, subjects are shown the green circle and green square shapes. The ones emerging in the brain are studied instantaneously.

When working with EEG signals, the signals are firstly freed from noises. Methods such as independent component analysis, filtering, wavelet transform, basic component analysis are used to clean the noises [20] After the attribute extraction process, classification algorithms such as artificial neural networks, k-means classification algorithm, data mining, genetic algorithm, quadratic discriminant analysis, discriminant analysis, support vector machine (SVM) and k-nearest neighbors (KNN) are used [21] [22] [23]. According to the classification process, it is possible to achieve different results even in the same study. In this study, after extracting the feature by removing the noises from the EEG signals respectively, the obtained feature vectors are classified by the k-NN algorithm. The KNN algorithm is a method that processes based on the distance value between the two. Classification is done by choosing the nearest k points in the classification process and taking the k point into consideration. The K values should be determined to be less than the square root of the number of all data used. When the K value is determined, different distance formulas such as euclidean, manhattan, gauss are used. Generally, k values are obtained using Euclidean in computer interface studies. This algorithm is more suitable for low dimensional feature vectors.

The fluctuations in the brain are evaluated according to the wave frequency and wave intensity of the brain signals. According to Hz values, brain waves are shown in Table 3 [24].

Table 3. Brain waves

	Hz	Explanation
Delta	0-4	Deep sleep
Theta	4-8	Dreaming
Alpha	8-13	Relaxation
Smr	12-15	Concentration
Beta1	15-18	Problem solving
Beta2	18-25	Anxiety

The placement of the EMOC EPOC+ in the skull is important for accurate measurements. The device is shaped like a cap and should be placed on top of the skull. Figure 2 shows the placement of the EMOC EPOC+ head.

The placement of the electrodes in the device is arranged according to the international 10-20 system. According to this system, the signal points to be obtained are as AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4.

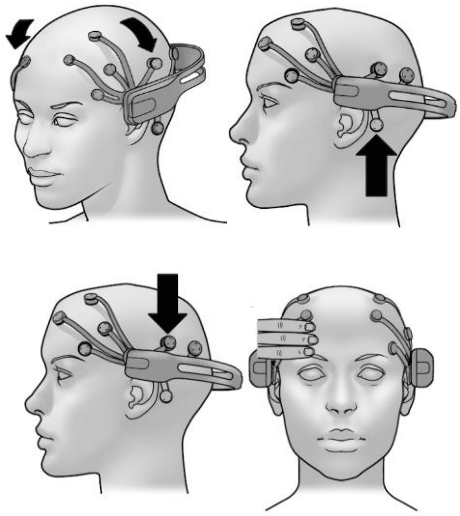

Figure 2. Emotiv EPOC + title placement[25]

3. Result

In this study, emotional state analysis 25-35 year old male and female subjects against color is evaluated by instant observation of brain signals. Firstly, the Emotiv EPOC+ device is correctly positioned and connected to the control panel.

The red circle, red square, green circle, green square images are shown for male subjects in the age range of 25-35 years. The results obtained are assessed instantaneously. The evaluation results of the data are as follows.

Male subjects were shown with red circles and red squares. The dominance of Beta waves is observed. In the first few seconds when the person was exposed to color, the level of attention increased, while the increase in the period of looking at the color showed a rise in the beta signals. As a result, it is observed that when the red color is overexposed, it causes an increase in feelings such as discomfort and stress in the person.

There was no difference between red square and red circle colors in male subjects.

When green circles and green square images are shown in male subjects, a rise in alpha waves is observed. The green color on the person has a full sense of peace and relaxation. It is observed that the person has a complete resting state.

There was no difference between green square and green circles in male subjects.

As a result of showing the red circles and red square colors in the female subjects, a rapid increase in beta waves was observed compared to male subjects. It is observed that female subjects who showed red color experienced more intense emotions such as attention, excitement

and distress than male subjects.

As a result of showing the green circles and green square colors in female subjects, a rise in alpha waves is observed. The effect of green color on male and female subjects is equally observed.

The effect of square shapes on female subjects is observed to increase the tension on the person against the effect of circle shapes.

As a result of this study, it is seen that the effects of colors and shapes on emotional state on women are more effective than emotional state on men.

References

[1] Uzun S. S. EEG işaretlerinden duygu kestirimi. Yüksek Lisans Tezi. Mustafa Kemal Üniversitesi Fen Bilimleri Enstitüsü. Hatay 2012; 1-45.
[2] Aytekin P., Kahraman A. A New Research Approach In Marketing: Neuromarketing. Journal of Management, Marketing and Logistics 2014;1:48-62.
[3] https://pazarlamaturkiye.com/pazarlama/bilim-ve-pazarlamanin-evliligi-noro-pazarlama/, Bilim ve Pazarlamanın Evliliği: Nöro Pazarlama, 20 Ocak 2013, [Ziyaret Tarihi: 16.05.2017].
[4] Lee H. The brain and learning examining the connection between brain activity,spatial intelligence, and learning outcomes in online visual instruction. Doktora Tezi. Kent State University Instructional Technology, Ohio, ABD 2013;1-113.
[5] Manchala V. K. Human computer ınterface using electroencephalography. Yüksek Lisans Tezi. Arizona State University. Tempe, AZ 85281, ABD 2015; 1-139.
[6] Giray, C., ve Girişken, Y. Gözün bilinç seviyesinde duyumsayamadığı uyaranları beynin algılaması mümkün müdür? nöropazarlama yöntemi ile ölçümleme üzerine deneysel bir tasarım. 18. Ulusal pazarlama kongresi. Kars: bildiri: kitabında, p.608-618.
[7] Utkutuğ Ç. P. Nöropazarlama kapsamında tüketicilerin televizyon reklamlarına gösterdikleri duygulanım ve bilişsel tepkilerin değerlendirilmesi: Yüz kasları hareketi analizi ile anket yönteminin karşılaştırılması.Doktora Tezi. Gazi Üniversitesi Sosyal Bilimleri Enstitüsü. Ankara 2014;1-257.
[8] Yorgancılar F. N. Tüketici davranışı nörolojisi: Nöroekonomi-EEG yöntemi ile nöromarketing uygulaması. Doktora Tezi. Selçuk Üniversitesi Sosyal Bilimleri Enstitüsü. Konya. 2014;1-311.
[9] Dokuzlar B. K. Sosyal sorumluluk projesi olarak grafik tasarım ve belgeleme, Sanatta Yeterlik. Anadolu Üniversitesi Güzel Sanatlar Enstitüsü.Eskişehir.2015;1-264.
[10] Polat H. Görsel-işitsel uyaranlar kaynaklı oluşan duyguların EEG işaretleri ile sınıflandırılması. Yüksek Lisans Tezi. Dicle Üniversitesi Fen Bilimleri Enstitüsü. Diyarbakır.2016; 1-83.
[11] Maraş A. EEG alt bandlarının tekil spektrumu ile duygu durumları arasındaki ilişki. Yüksek Lisans Tezi. Bahçeşehir Üniversitesi Fen Bilimleri Enstitüsü.İstanbul 2016;1-57.
[12] Şimşek A. İ., Tüketicilerin otomobil markaları üzerindeki algılarının nöropazarlama açısından ölçülmesi: Elazığ ilinde yapılan deneysel bir çalışma.Yüksek Lisans Tezi. Fırat Üniversitesi Sosyal Bilimleri Enstitüsü. Elazığ 2016;1-149.
[13] Oralhan Z. Durağan Hal Görsel Uyaran Tabanlı Beyin Bilgisayar Arayüzü İçin Optimum

Uyaran Özelliklerinin Belirlenmesi Ve Gerçeklenmesi. Doktora Tezi. Erciyes Üniversitesi Fen Bilimleri Enstitüsü Kayseri 2016;1-120.
[14] Sadedil S. N. K. Pazarlama Mesajlarının Etkinliği Açısından Geleneksel Pazarlama Araştırmaları İle Nöropazarlama Araştırmalarının Karşılaştırılması; "Sigara Paketleri Üzerindeki Caydırıcı Mesajların, Sigara Kullanma Alışkanlıkları Üzerindeki Etkisi". Doktora Tezi. Marmara Üniversitesi Sosyal Bilimleri Enstitüsü. İstanbul 2016;1-202.
[15] Düzgün A. Nöromarketing Alanında Marka Algısının Elektrofizyolojik Olarak Beyin Osilasyonlarıyla Ölçümlenmesi: Eeg (Elektroensefalografi) Yöntemi Uygulaması. Yüksek Lisans Tezi. İstanbul Kültür Üniversitesi Sosyal Bilimleri Enstitüsü. İstanbul 2016; 1-145.
[16] Demirtürk H. Nöropazarlama Açısından Bilgilenmiş Kullanıcıların Karar Süreci Üzerinde Koku Etkisinin Ölçümlenmesi. Yüksek Lisans Tezi. Doğuş Üniversitesi Sosyal Bilimleri Enstitüsü. İstanbul 2016;1-405.
[17] Rana N. Rengin Tüketici Satın alma Davranışlarına Etkisi. Yüksek Lisans Tezi. Marmara Üniversitesi Sosyal Bilimleri Enstitüsü. İstanbul 2006;1-188.
[18] http://kisiselgelisimim.com/renklerin-dili-ve-anlamlari/. Renklerin Dili Ve Anlamları. [Ziyaret Tarihi: 16.05.2017].
[19] https://www.emotiv.com/epoc/ [Ziyaret Tarihi: 29.05.2017].
[20] Aydemir, Önder, and Temel Kayıkçıoğlu. "EEG tabanlı beyin bilgisayar arayüzleri." Akademik Bilişim'09-XI. Akademik Bilişim Konferansı Bildirileri 11-13 Şubat, Harran Üniversitesi (2009).
[21] Uçar, M. K., Bozkurt, M. R., Polat, K., & Bilgin, C. EEG Sinyalleri Kullanılarak Uyku Evrelerinin Sınıflandırılmasında Sayısal Filtrelemenin Etkisi Effect of Digital Filtering to Sleep Stage Classification Using EEG Signals.
[22] Gao, Y., Lee, H. J., & Mehmood, R. M. (2015, June). Deep learninig of EEG signals for emotion recognition. In Multimedia & Expo Workshops (ICMEW), 2015 IEEE International Conference on (pp. 1-5). IEEE.
[23] Vijayan, A. E., Sen, D., & Sudheer, A. P. (2015, February). EEG- based emotion recognition using statistical measures and auto- regressive modeling. In Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference on (pp. 587-591). IEEE
[24] Akhenaton. http://gizliilimler.tr.gg/Beyin- Dalgalar%26%23305%3B,-I.htm. Beyin Dalgaları 2010; [Ziyaret Tarihi: 03.04.2016].
[25] http://www.donutsites.com/emotiv-ftp/Emotiv-EPOC-Product-Sheet-2014.pdf BCI & Practical EEG Research [Ziyaret Tarihi: 04.06.2016].