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An EEG Analysis on the Perception of the Consumers Regarding Video-Commercials from the Automotive Industry

Cristiana Chiriac
The Bucharest University of Economic Studies
chiriac.i.cristiana@gmail.com

Ștefan Grapă
Mens Sana Clinic
stefangrapa@yahoo.com

Mihai-Cristian Orzan
The Bucharest University of Economic Studies
mihai.orzan@ase.ro

Abstract
Nowadays, every human individual interacts with video-commercials on digital devices such as TV, laptop, smartphones. The persona that watches the video-commercials may be or not able to react and perceive the subconscious emotions that are send once with the verbal message and the exposure of the product. The research explained in this article uses the cognitive neuroscience applied in marketing to see the effects of the video-commercials onto the human brain and how the attention of the consumers is influenced by certain stimuli, like sound on and off, the narrative speech of one auto brand in the native language (Romanian) of the participants involved in the experiment, and also a foreign language(English), the speed of the movie, the intensity of the light in the room. In this research was used the NeuroSpectrum 2 electroencephalograph, which provided useful information regarding the states of the human mind and the impact of the video-commercials for two types of audience: healthy brain subjects and subjects with certain neurological brain damages. The first objective of this research based on medical tools, is to see what modifications appear in the electrical activity of the brain of the participants before and after watching the commercials. The second objective is to detect certain feelings that make the commercial be likable, such as the states of happiness and calmness that the video-commercials produces to the subjects exposed to the video-commercials. The main results obtained after the experiment are that the movie induces to all the subjects a state of relaxation and meditation leading in some cases to a better, nearly normal cognitive activity for the participants with brain damages, by inducing them the state of calmness and finally leading them to sleep.

Keywords: EEG, video-commercials, brainwaves, neuromarketing research.

JEL classification: C45, D87, M31, M37.

Introduction

The following article is structured in three sections: the introduction, which contains the theoretical aspects about the medical tool used and relevant information about cognitive neuroscience applied in marketing, the methodology which presents the techniques used in this research and the conclusions and recommendations section that are drawn from the report analysis of the EEG.

The Nobel Prize Winner, Gerald Edelman presents in his work the scientific information of Darwin and he refers to them as neural Darwinism which show how the human brain influences our decisions in the daily life. He debates that "each individual brain, even before birth, uses a process that resembles natural selection to develop during its own lifetime" (Course Hero, 2018). This consumer science has a great impact on the marketing research

studies, and it is considered that "the theoretical, empirical and practical scope of neuromarketing" (Bercea, 2013) are still in continuous improvement.

A specialist in this consumer science "considers that there is an important opportunity for this field, by better understanding the neural world of consumers, we can help them and the brands that serve them better adapt to an increasingly complex and overwhelming world" (Bercea, 2013). This network of connections between neurons shapes the choices of people in life. This starts from small things such as taking objects to the decisions that influence the cultural and social settings. Although, the pattern of connections in a brain is unpredictable. The human brain is not a "hard-drive" on a computer. It is flexible and is designed by the natural environment that surrounds the consumer. Sometimes the neural networks made by the human brain that lead to the final decision are not always right due to other factors involved in the process. Watching a video-commercial on online media sharing platforms by a consumer fulfills their needs of entertaining and finding the desired information. But the customers will adapt their decision to fit what works to the specific situation. As Angus Jenkinson states the "consumer is an individual with one brain processing all" (Jenkinson, 2007) the information on online environment (an online video commercial, a promotional message) with different purposes, but them "both manifest as facets of mental experience" (Jenkinson, 2007).

The emotional response of the individual when watching a video-commercial may be seen in the electrical activity of the occipital lobe that receives visual information from the eyes. From a medical perspective, the electroencephalograph is made to measure the brain waves of the subject and detect certain anomalies that appear during neurological diseases. First time, when the EEG was used to measure the brain electric activity in relation with the rational and emotional brain of the people was in "1979 by Davidson" (Vechiatto, et al., 2010). The device used to get the results has electrodes that are placed on an individual's head and linked "by using a helmet or a band" (Vechiatto, et al., 2010). It registers the brainwaves triggered by the subject that is tested and the device "can record up to 10,000 times per second" (Morin, 2011) at small time intervals. Electroencephalogram is basically a method of "reading the mind" and transpose it into actual writing of the electric activity of the brain.

The role of the EEG in this marketing research is to see the links between the two-cerebral hemisphere and how the activity of the brain reacts to different triggered stimuli when watching a video commercial.

In the EEG report of the electrical activity of the brain can be present the following brainwaves: alpha, beta, theta and delta. "Alpha waves are EEG oscillations at approximately 10 Hz that are typically largest at posterior electrode sites and occur most frequently when subjects are tired or have their eyes-closed" (Luck, 2014).Beta waves are EEG fluctuations ranging between 12 to 38 Hz. The alpha-waves recorded in the left frontal hemisphere indicates positive emotional state and reactions, subjective preferences and the ones in the right frontal hemisphere indicate the opposite ones. This kind of emotions have a great influence on our daily decisions such as: eat, buy a product, watch the commercials that motivates you to choose that product or service instead of others.

"Beta brainwaves dominate our normal waking state of consciousness when attention is directed towards cognitive tasks and the outside world" (Brainworks, 2007). "Beta brainwaves are further divided into three bands; Lo-Beta (Beta1, 12-15Hz) can be thought of as a 'fast idle' or musing. Beta (Beta2, 15-22Hz) is high engagement or actively figuring something out. Hi-Beta (Beta3, 22-38Hz) is highly complex thought, integrating new experiences, high anxiety, or excitement" (Brainworks, 2007).

Gamma waves are EEG fluctuations with the following frequencies 38 to 42 Hz. This brainwaves are specific for "pass information rapidly and quietly" (Brainworks, 2007) and making "new brain cells in the frontal cortex, thus increasing our capacity for intelligence"

(Pennington, Mitchell, & Dupuy, 2007) which are representative for "mental lucidity, clarity, creativity, insight, a relaxed sensory awareness, and access to delta's psychic awareness and empathy" (Pennington, Mitchell, & Dupuy, 2007).

Delta waves are EEG fluctuations with these frequencies 0.5-3 Hz. This waves are defined as "a high amplitude electrical rhythm of the brain with a low frequency of less than four cycles per second that occurs especially in slow-wave sleep, is most prominent in infancy and early childhood, and may exhibit abnormal activity in various conditions (such as traumatic brain injury or dementia)" (Merriam-Webster, 2019) and were first used using this definition in 1936.

"Theta rhythm (4-7 Hz): This rhythm is recorded during low brain activities, sleep, or drowsiness" (Aamidfar, Heysieattalab, Azimi, & Roohi-Azizi, 2017).It is connected "with inhibition of elicited responses (has been found to spike in situations where a person is actively trying to repress a response or action)" (Aamidfar, Heysieattalab, Azimi, & Roohi-Azizi, 2017) in a normal electrical activity of the brain.

Besides these findings, "Ambler" (Wang, Chang, & Chuang, 2016) discovered that video commercial online which have a greater emotional impact "may increase activity in the orbitofrontal region and the amygdala" (Wang, Chang, & Chuang, 2016).The frontal brain sections present asymmetric psychological functions, while the right one indicates the negative emotions, the quitting state the left frontal side represents the motivation, the positive feelings, the commitment to do the specific thing which they have in mind.

A video-commercial can be analyzed by splitting the 1-minute video in time-frames of 2 seconds each overlapping by 1 second. While the video commercial is shown on a computer, the device is recording the brain activity and is transposing into a written report by using Fast Fourier Transformation (FFT) and create frequency-amplitude charts. After this it is interpret the report using the following instruments: "The frontal asymmetry index which indicates a person motivations, emotions and engagements" (MarketingMind, n.d.).The formula is as follows: "Frontal Asymmetry Index (FAI)= log(alphapowerrightF4/alphapowerleftF3) " (MarketingMind, n.d.). This can show negative emotions, such as fear, anxiety, anger, sadness, but also positive emotions such as joy, excitement, satisfaction.

(Brown, Randolph, & Burkhalter, 2012) made a neuromarketing research on the printed ads of two soft drink brands, using EEG device from the Kennesaw State University BrainLab. The research involved 12 participants,8 female and 4 males. This study enhanced the fact that neutral emotions are experienced by the participants, rather than a positive or negative preference for one of the two soft drink brands.

(Melody, 2013) made a neuromarketing research in collaboration with 2 firms, Plastic Mobile and True Impact Marketing on the perception of the consumers regarding mobile apps for pizza. The research methodology had 4 main factors to be analyzed: "advantages and obstacles in user experience, impact on brand emphasis, engagement, qualitative versus quantitative" (Melody, 2013). It revealed that the consumers are more emotionally engaged in proceeding to checkout for one of the pizza applications.

(Atilla & Ahmed , 2019) made a neuromarketing research on brand perceptions on automotive industry based on information about 6 auto brands: Fiat, Ford, Hyundai, Renault, Volkswagen and Toyota. The research revealed that the consumers identify the Volkswagen brand with quality service dimension, prestige dimension and performance dimension. In this research "a 10 channel-EEG device was used" (Atilla & Ahmed , 2019) to analyze data of "30 participants from the students and academicians at Fırat University" (Atilla & Ahmed , 2019).

Methodology

The research made with the Neuro Spectrum 2 electroencephalograph took place at the private clinic Mens Sana from Târgoviște, Dîmbovița county. The research sample was of 16 people, from which 10 females and 6 males. The subjects for the experiment belong to the following age gaps:18-28 years old, 40-50 years old, 51-61 years old and over 61 years old. These subjects are divided in 2 groups: people with brain damages and people without brain damages. These subjects were chosen to see specific changes in brain activity regarding the following criteria's: age, gender, people with normal EEG activity and pathological EEG activity. In our research, we choose this people due to their agreement to participate in this experiment and to their availability to come at the clinic.

The subject had to wear a helmet on which were mounted 16 electrodes, montage type, monopolar 16, connected at Neuro-Spectrum 2 electroencephalograph during the period when he or she watched the movie with the video-commercials. In this experiment, we use repetition priming, which is the process when a person is experiencing a certain stimulus(in our case the video-commercial with the sound on)and this will make it "easier for a person to process the same stimulus later*"* (Krauss Whitbourne Ph.D., McDonald Ph.D., & Yellowlees Douglas Phd., 2019) *(in our case the first video-commercial with the sound off).*The electroencephalography analysis was recorded following this methodology:

- EEG analysis performed for 1 minute without the movie, during which the participant was with eyes-closed and in a physical and mental resting state
- EEG analysis performed 5,36 minutes, during which the participant viewed the movie with the video-commercials
- Report analysis comparison of the brain activity with and without video-stimulus.

Research results

During the movie with the video-commercials, the participants brain activity registered slow theta, delta, alpha and beta waves combined with high beta waves frequencies. This means that the commercials induced them an alpha state of relaxation and calmness and high positive arousal which lead to sleep and meditation towards the pleasant images and sounds from the movies.

The activity most requested was of the occipital lobe, which is responsible for the visual function in combination with the temporal lobe, which is responsible for the auditory function. These two lobes were activated, because people wanted to make sense of what they watch.

On the frontal lobe, most of the participants, during the visualization of the movie with the Mercedes-Benz and Volkswagen video-commercials, experienced slow delta waves and slow theta waves and beta rhythm. This is a sign of a deep, dreamless sleep, a deep relaxation and deep subconscious creativity of the mind. The left frontal lobe is responsible for positive emotions, while the right frontal lobe is responsible for negative emotions. The high order functions of the brain like the ability of solving a logical scientific problem, philosophical issues, the capacity to understand and analyses the specific movie and the social environment.

The brain activity of most of the participants in the parietal lobe, recorded slow delta and theta waves and alpha and beta rhythms. In the occipital lobe, most of the participants, recorded the following rhythms: slow delta and theta waves, alpha rhythm in the O1-Occipital and beta rhythm in O2-Occipital.

On the temporal lobe, most of the participants during the visualization of the movie, experienced in their brain activities alpha rhythm, beta rhythm and slow delta waves in the regions T3, T4, T5 and T6.

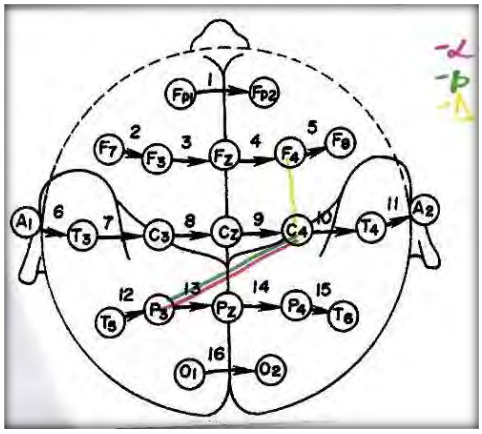
The central lobe of the brain of the subjects registered mostly alpha and beta rhythm. In

both hemispheres where registered slow frequency of alpha rhythm and high frequency beta rhythm. The "alpha state", feelings of calm, release of the worrying state and the induce of the state of happiness and calm were recorded at the participants when viewing the movie. This lobe and this combination of waves shows that the human body is in a general resting state. In the C3 area of the central lobe, some of the participants experienced alpha, beta rhythm and slow delta waves and in C4 are of the central lobe, some of the participants experienced beta rhythm, slow delta waves and slow theta waves.

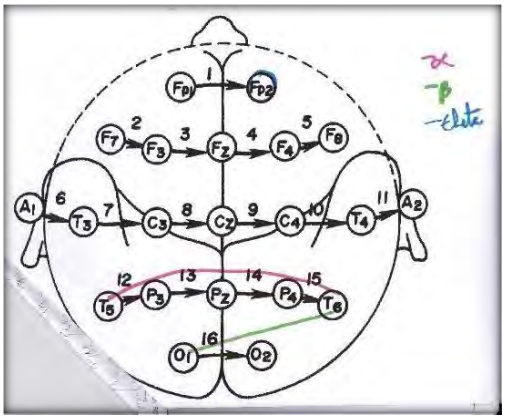
The 1st female participant tried to understand and make sense of what she saw in the movies, facts that were shown by the activation of the central lobe and temporal lobes, where the EEG registered the flat alpha waves, which represent the state of calm of the brain. The right hemisphere of the brain which coordinates all the functions of the creative mind (imagination, music, awareness, creativity, shape of the forms from the video) were in a "state of alert", focus and high arousal combined with positive emotions, due to the presence of the low-frequency beta-rhythm and flat alpha-rhythm. This combination of flat alpha and high beta waves show that the subject experienced positive emotions of calm, relaxation, but she was in a state of concentration, focus and alert when she saw the video. The 2nd female participant registered low alpha rhythm in occipital and frontal lobes which leads to a calm and relaxed positive state of feeling and in occipital lobe registered high frequency beta rhythm which indicates high arousal impact on the eyes from a visual perspective and focus. The 3rd. female participant registered slow theta and delta waves-fall asleep and meditation in the frontal and temporal regions which were cumulated with the state of calmness emphasized by the low alpha rhythm. In the temporal lobe, high beta frequency rhythm was observed, which means that this person was feeling irritated by the music. The 4th female registered high frequency beta rhythm in the central and occipital lobes which may signify that she was focused at what she sees and induce her a state of excitement. The slow waves of theta and delta in all the hemispheres suggests that she fall into a state of meditation and is in a deep relaxation state, this thing induced also in the frontal and temporal lobes, mostly. Everywhere in the brain the alpha rhythm is present, which indicates positive feelings of calm, relaxation and tranquility. The 5th female registered alpha rhythm in the occipital and temporal lobes-primary visual cortex connected to the identity of seen objects correlated with the audio information's about the brands Volkswagen and Mercedes-Benz and music in the short-term memory. In the frontal lobe, slow theta waves were registered which indicates a state of meditation and relaxation, reasoning towards the information's received. The 6th female registered alpha rhythm in the parietal lobes which may indicate that she perceives and makes sense of the information's from the commercials and the language used and this induces a feeling of calmness and tranquility. The frontal lobe registered high frequency beta rhythm which leads to the fact that the person is analyzing what she sees and causes her excitement and high arousal sensations.

The 1st male is paying attention at the video, and experiences positive feelings of calm and high arousal, excitement, all triggered by the visual stimuli shown in the commercials, thing emphasized by the low alpha and high beta rhythms from the occipital and parietal lobe. Slow theta waves are present onto the frontal lobes which may indicate that the individual is in a state of meditation and reflection towards the information's which are shown. The 2nd male registered high frequency beta rhythm in the occipital and parietal lobes which leads to an excitement of the visual and sensory area that may signify that he enjoys seeing the movie. In the frontal and occipital lobe registered slow theta waves, which signifies a state of meditation and relaxation during the visualization of the movie commercials.

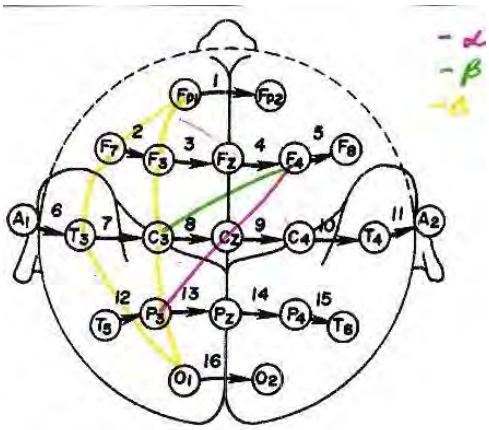
The following neural networks were obtained during the visualization of the video-commercials for the participants:



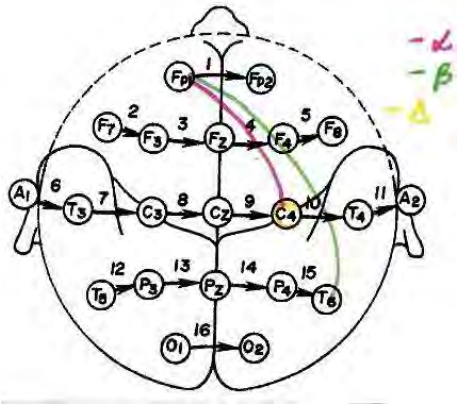
7.Female EEG with video stimulus



8.Female EEG without video stimulus



10.Male EEG with video stimulus



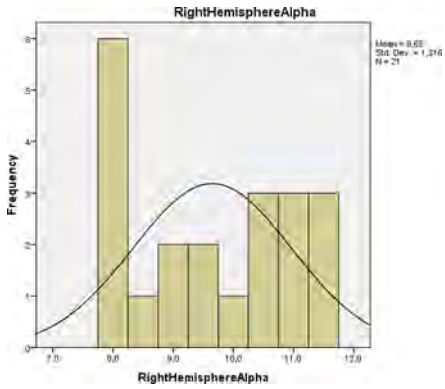
11.Male EEG without video stimulus

The analysis for EEG using Radial Basis Function in SPSS and Frequencies table

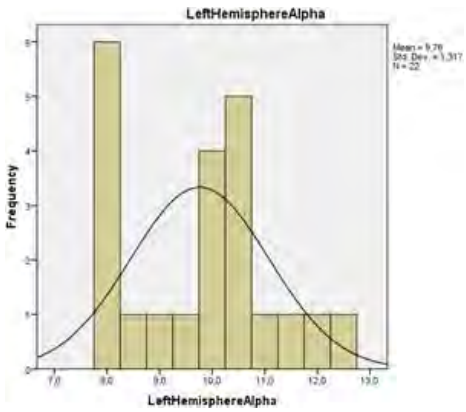
The overall analysis for all the participants for the alpha rhythm frequency waves presents the mean of 9,76Hz for left hemisphere versus 9,65Hz for right hemisphere. This suggests the presence of low alpha waves rhythm for all the participants during the commercial which means that the video-commercial induces a state of calm and relaxation. The minimum frequency for the alpha rhythm waves is the same for both hemisphere on all the participants no matter the difference between ages. But, the maximum frequency for the alpha rhythm waves is greater on the left hemisphere, rather than on the right hemisphere. At one respondent the alpha rhythm is missing on the left hemisphere, while at the right hemisphere, two respondents lack the alpha rhythm. This means that the both functions of the brain creative and logical are in a state of calm and relaxation.

The overall analysis for the beta rhythm amplitude presents the mean of 9,89 uV for left hemisphere and 11,24 uV for the right hemisphere. The amplitude of beta rhythm in the right hemisphere varies from low to high which means that some people are delighted of what they see, while others are tired, and this commercial induces them poor cognition. As it can be seen, in the graphs above, there are significant differences in the brain of the people, before watching the commercial and in the time when watching the video-commercial.

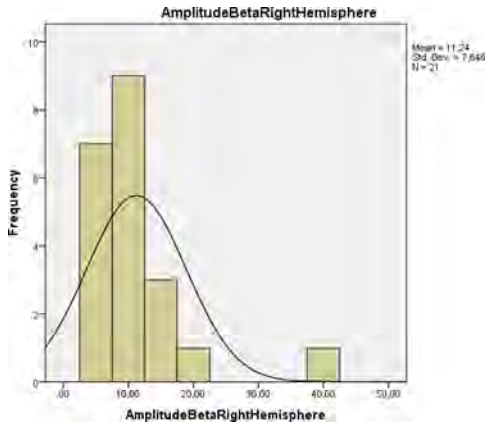
The fluctuation of the frequencies for each brainwave are shown in the following histograms:



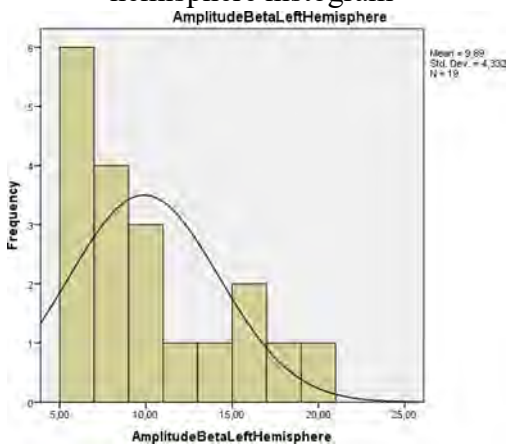
12.Alpha rhythm frequency right hemisphere histogram



13.Alpha rhythm frequency left hemisphere histogram



14.Histogram Beta Amplitude Right Hemisphere



15.Histogram Beta Amplitude Left Hemisphere

Conclusion

Neuromarketing research provides significant data from the viewers perception regarding automotive industry advertisements towards discovering their emotional engagement connected with the specific brands. The video-commercial with a long duration relaxes people, longer than 1 minute, inducing them a state of meditation connected to sleep and calmness. The presence of slow frequency rhythm of the waves delta and theta is significant for the state of deep meditation, when watching these commercials. Another significant aspect is that the amplitude of beta rhythm waves decreases significantly, which means that the respondent attention and concentration decreases.

The music from the video-commercials and the relaxed atmosphere from the clinic makes the respondents with pathological EEG brainwaves from brain damages feel more relaxed when are exposed to it, than during the EEG analysis without the video-stimulus. This may show, that the content of the video, the frequencies of the waves from the music, the voice of the native Romanian speaker from the one of the video-commercials, the friendly atmosphere makes the respondent fill safer from the point of view of the state of feeling that he has during watching the movie.

As a general conclusion, video-commercials need to be adapted not only for the target audience, which are the automotive industry consumers, but also for the public, himself, because it is not known who is watching the video-commercial, and certain stimulus from the video-commercial may affect the consumers with pathological brain damages.

Limitation

Due to the lack of a proper number of respondents which have, this research cannot be generalized. This research was made only for academic purposes.

The present marketing research experiment has several limitations: the participants at the study were mostly people who don't know technical details about the brand models of cars shown in the movie. Another limitation is the age gap for the chosen respondents and the lack of a proper software configuration, in order to gather the required numbers from the EEG analysis and fully interpret them.

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References

Bercea, M. D. (2013, February). Quantitative versus qualitative in neuromarketing research. *Munich Personal RePEc Archive*. Retrieved December 27, 2018, from https://mpra.ub.uni-muenchen.de/44134/1/MPRA_paper_44134.pdf

Pennington, J., Mitchell, H., & Dupuy, J. (2007). *Gamma Brain Waves and What They Do For Our Brains*. Retrieved October 30, 2019, from IAWAKE: https://www.iawaketechnologies.com/gamma-brain-waves-and-what-they-do-for-our-brains/

Aamidfar, M., Heysieattalab, S., Azimi, L., & Roohi-Azizi, M. (2017 , September 3). Changes of the brain's bioelectrical activity in cognition, consciousness, and some mental disorders. *Medical Journal of The Islamic Republic of Iran (MJIRI)*, 6. doi:10.14196/mjiri.31.53

Atilla, Y., & Ahmed , S. İ. (2019, January 29). MEASURING CONSUMER BRAND PERCEPTIONS IN TERMS OF NEUROMARKETING BY USING THE EEG METHOD: AN EXPERIMENTAL STUDY ON THE AUTOMOTIVE INDUSTRY. *Eurasian Journal of Researches in Social and Economics (EJRSE) and Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi (ASEAD)*, 1-14. Retrieved November 06, 2019, from https://www.researchgate.net/publication/330703523_MEASURING_CONSUMER_BRAND_PERCEPTIONS_IN_TERMS_OF_NEUROMARKETING_BY_USING_THE_EEG_METHOD_AN_EXPERIMENTAL_STUDY_ON_THE_AUTOMOTIVE_INDUSTRY

Brainworks. (2007). *What are brainwaves ?* Retrieved October 30, 2019, from Brain works-train your mind: https://brainworksneurotherapy.com/what-are-brainwaves

Brown, C., Randolph, A., & Burkhalter, J. (2012, May). The Story of Taste: Using EEGs and Self-Reports to Understand Consumer Choice. *The Kennesaw Journal of Undergraduate Research, 2*(1), 1-13. Retrieved October 30, 2019, from https://digitalcommons.kennesaw.edu/cgi/viewcontent.cgi?article=1012&context=kjur

Course Hero. (2018). *Neural Darwinism-Gerald Edelman.* Retrieved December 12, 2018, from https://www.coursehero.com/file/p4g2uno/o-Neural-Darwinism-Gerald-Edelmans-theory-Each-individual-brain-even-before/

Jenkinson, A. (2007). Evolutionary implications for touchpoint planning as a result of neuroscience: A practical fusion of database marketing and advertising. Retrieved January 7, 2019, from https://link.springer.com/article/10.1057/palgrave.dbm.3250054

Krauss Whitbourne Ph.D., S., McDonald Ph.D., H., & Yellowlees Douglas Phd., J. (2019). *Priming*. Retrieved November 08, 2019, from Psychology Today: https://www.psychologytoday.com/intl/basics/priming

Luck, S. J. (2014). *An introduction to the event -related potential technique* (2nd ed.). London, England: The Massachusetts Institute of Technology Press.

MarketingMind. (n.d.). *ELECTROENCEPHALOGRAPHY*. Retrieved January 5, 2019, from https://www.ashokcharan.com/Marketing-Analytics/~bm-eeg.php

Melody, A. (2013, September 15). USING NEUROMARKETING TO DISCOVER HOW WE REALLY FEEL ABOUT APPS. *International Journal of Mobile Marketing An Official Publication of the Mobile Marketing Association*, p. 96. Retrieved November 06, 2019, from https://www.mmaglobal.com/files/vol8no1/IJMM-Summer-2013.pdf

Merriam-Webster. (2019). *Medical Definition of delta wave*. Retrieved October 30, 2019, from Merriam-Webster: https://www.merriam-webster.com/dictionary/delta%20wave

Morin, C. (2011, March). Neuromarketing: The New Science of Consumer Behavior. *Neuromarketing: The New Science of Consumer Behavior, 48*(2), 131-135. Retrieved January 5, 2019, from https://link.springer.com/article/10.1007/s12115-010-9408-1

Vechiatto, G., Astolfi, L., Fallani, F., Cincoti, F., Mattia, D., Salinari, S., . . . Babiloni, F. (2010). Changes in Brain Activity During the Observation of TV Commercials by Using EEG, GSR and HR Measurements. *Brain Topography, 23*(2), 165-179. Retrieved January 5, 2019, from https://link.springer.com/article/10.1007/s12115-010-9408-1

Wang, R. W., Chang, Y.-C., & Chuang, S.-W. (2016, November 07). EEG Spectral Dynamics of Video Commercials: Impact of the Narrative on the Branding Product Preference. *Scientific Reports, 6*. Retrieved January 7, 2019, from https://www.nature.com/articles/srep36487