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NEUROMARKETING STUDY: THE EFFECT OF JINGLE ON CONSUMER BEHAVIOR

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ABSTRACT

Manuscript type: *Research Article*
Research Aims: *This research investigates the impact of a jingle associated with a top-brand product on consumer behavior, as assessed through short-term memory activity in the brain.*
Design/methodology/approach*: Data were collected from six participants, three men and three women aged 19-24. The Contec KT88-1016 Digital 16-Channel EEG machine and the Mapping System device were used to retrieve the data. The channel selection was employed to identify the optimal channel based on L2-norm energy calculations performed on the EEG channels within the short-term memory area.*
Research Findings: *The frontal area exhibited higher energy levels than other areas, with the highest point observed in channel F4. A jingle in a product was found to stimulate short-term memory, influencing consumer behaviour. This influence was evidenced by the representation of channel energy in the EEG, showing a higher value compared to the average energy value in general.*
Theoretical Contribution/Originality: *This study successfully demonstrated that EEG signals stimulated by jingles could assess consumer behaviour responses when provided with auditory incentives. The findings are explicitly linked to activating the brain's short-term memory area.*
Practitioner/Policy Implication*: Brands with top brand categories have higher signal energy than non-top brands.*

Research limitation/Implications: *Only limited to the data collection process carried out by environmental engineering, which is made closer to the actual situation.*

Keywords: *16-channel EEG; neuromarketing; branding; jingle; short-term memory*

INTRODUCTION

The development of the times demanded intense competition in various fields, especially in the economic area. Targeted marketing strategies are another factor affecting competition in the globalisation era (Kotler et al., 2017). Marketing strategies can detect and meet consumer needs, supported by advances in technology and knowledge. One of them, through neuroscience, especially neuromarketing, with this knowledge, is expected to meet the needs and desires of the market. Market research depends on data obtained using various methods such as questionnaires, interviews, and others (Brenninkmeijer et al., 2020).

Neuromarketing is a field of study that studies neuroscience methods to analyse and understand human behaviour toward markets and their changes (Vecchiato et al., 2013). Neuromarketing aims to optimise marketing methods, including advertising, product information, etc. In addition, it is used to influence consumer purchasing decisions. Neuromarketing provides information on a product's smell, colour, sound, and packaging. Neuromarketing shows that emotional and rational thinking can influence economic choices by attracting people's attention. (Badescu & Pelau, 2021). Neuromarketing has three disciplines: marketing, psychology, and neuroscience (Alvino et al., 2020). This method helps

marketing research increase trade and capture consumers' emotions, attention, and concentration (Rasyid & Djamal, 2019). We can use neuromarketing to analyse the influence of colours, images, jingles, music, and videos on human behaviour (Vecchiato et al., 2013) (Stadelhofer et al., 2017). Neuromarketing aims to understand different areas of the brain when consumers are exposed to market stimuli and to help marketers correlate with consumer behaviour (Iloka & Onyeke, 2020). The field that examines the biological aspects of the brain and a psychological perspective is neuroscience. Neuroscience enlightens marketing and helps analyse consumer behaviour (Bočková et al., 2021). Many methods can be used to determine consumer behaviour characteristics, including polling, interviews, and signal analysis of the electroencephalograph (EEG) (Vecchiato et al., 2013). EEG is preferred because of its low cost, and EEG is used as an alternative approach to conducting consumer research (Lin et al., 2018). EEG investigates brain activity in the perception of marketing messages occurring on the left and right of the brain spectrum. A higher emotional impact is associated with suitable brain activity (Bočková et al., 2021).

EEG is a tool that measures brain waves produced by neurons or nerve cells. Neurons

will create a frequency of 0-30 Hz, and from these frequencies can be known several types of brain signals, namely, alpha (8-12 Hz), beta (13-24 Hz), theta (4-7 Hz), delta (0.5-4 Hz) and gamma (25-40 Hz) (Vecchiato et al., 2013). The jingle is a psychological method applied to customers to remember a product and increase market sales (SHAKIL & Siddiqui, 2019). Jingle forms a unique image in the minds of consumers about the product the brand offers. Popular music advertisements provide a more effective stimulus to attract attention (Dianty & Magnadi, 2020). Although the electric waves generated by each person will be different, these stimuli will form specific signal patterns. Music's emotions and memories will provide electrical surges in the brain or brainwave Music evokes feelings and brings new meaning. Therefore, music becomes essential to advertising communication (Cuesta et al., 2019). Schaefer (2011) argues that music significantly increased post hoc EEG amplitude in the frontal alpha and midline theta bands (Cheah et al., 2020). Music is a very reliable way to study the function of the human brain because listening to music can increase emotions (Avinash et al., 2018). Signal patterns generated by the EEG will be processed and analysed to determine the effect of jingles on consumer behaviour. Signal patterns generated by the EEG will be processed and analysed to determine the impact of jingles on consumer behaviour. Consumer behaviour can be in the form of long-term memory or a person's short-term memory. Based on previous research, the influence of jingles on a person's emotions can be measured using a questionnaire (Stadelhofer et al., 2017).

Based on this research, the questionnaire cannot explain preferences explicitly, so we need another method to analyse consumer behaviour. Based on the stimulus, the technique investigates brain signal activity in active and brand areas (Yadava et al., 2017). Measurement of brain signals using the EEG Contec KT88 1016 Digital 16-Channel EEG Machine and Mapping System.

I. LITERATURE REVIEW

Consumer Perception

Consumer perception is a process that makes someone choose and is closely related to the buying process. Consumer perception is significant to understanding the process of acquisition, consumption, and treatment. The method of consumer perception provides stimuli in the form of colours, packaging, and situations. There are several stages in consumer perception; the first stage is the physical process, which captures the stimulus with the human senses. The second stage is a physiological stage that continues the sensory stimulus. The stimulation stage of the psychological process raises individual awareness of the stimulus received from the receptor. The last stage is the perception process through responses and behaviour (Camila, 2018). Two factors can influence consumer perceptions: internal factors, which include experiences, needs, and expectations, and external factors, which are the product's appearance, the nature of the stimulus, and the environmental situation. The formation of these perceptions responds to purchasing decisions by consumers. Purchasing decisions are steps taken by consumers before deciding on a product. The decision-making process consists of five processes.

The first is the introduction of needs. The second process is searching for information stored in memory (internal search) and seeking input from outside (external). The third process, evaluation of alternatives, evaluates the choice of products and brands to the wishes of consumers. The fourth process is a decision in purchasing. Consumers will determine their attitude in deciding whether to buy or not. The last process is post-purchase consumers. This stage provides information on consumer satisfaction. The role of consumer perception affects purchasing decisions, and this is because everyone has a different perception of the same object (Camila, 2018). Short-term memory is related to consumer purchasing decisions because it refers to consumers' information. The techniques used for the short run are generally relatively short. Thus, short-term memory is more suitable to measure.

Neuromarketing

Neuromarketing is derived from neuro and marketing, combining two fields of study: neuroscience and marketing (Aldayel et al., 2020). Neuromarketing is a field of study that studies neuroscience methods to analyse and understand human behaviour markets and their changes (Vecchiato et al., 2013). Neuromarketing is a tool used to gain popularity among marketers and consumers to influence consumer behaviour et al. (Nazarova & Lazizovich, 2019). The area that examines the biological aspects of the brain and a psychological perspective is neuroscience. Neuroscience enlightens marketing and helps analyse consumer behaviour (Aldayel et al., 2020). The

literature on neuromarketing explores how new observations of consumers through imaging techniques have shaped this consumer definition (Levallois et al., 2021). Neuromarketing combines marketing methods and neuroscience to observe the neural procedures that control a person's choices (Nilashi et al., 2020). Neuromarketing compares and evaluates different brands according to the consumer's point of view (Khurana et al., 2021). Neuroscience studies the nervous and neuron systems regarding choices in the human subconscious when making decisions (Aldayel et al., 2020). Neuromarketing techniques are needed to analyse consumer behaviour (Oon et al., 2018). Consumer behaviour is impossible to predict through questionnaires, interviews, verbal or communication. Neuromarketing gives meaning to the marketing industry as it will continue and grow.

Neuromarketing is used to understand consumer behaviour better, including subconscious aspects and emotional responses. (Yazid et al., 2020). Some examples of tools used to record nerves in Neuromarketing research include Functional magnetic resonance (fMRI), electroencephalography (EEG), magnetoencephalography (MEG), the transcranial magnetic stimulator (TMS), positron emission tomography(PET), functional near-infrared spectroscopy (fNIRS), etc. (Rawnaque et al., 2020). Neuroscientific techniques like fMRI and EEG are used to understand how the brain represents decisions and how brands enhance different brain responses (Alvino et al.,

2018). Neuromarketing is investigated because human behaviour cannot explain why they chose the product. In neuromarketing, we can directly explore the mind without cognitive assistance (Babiloni, 2012). There are two aspects of neuromarketing research: qualitative and quantitative aspects. Qualitative elements include content, media, and delivery methods, while quantitative aspects cover the duration of exposure to advertisements to consumers (Devaru, 2018).

Electroencephalograph

An electroencephalograph (EEG) is a tool that determines the electrical activity in the brain (Vecchiato et al., 2013). EEG has a small amplitude and complex shape. One of the characteristics of the EEG signal is its weak signal. The EEG signal is obtained by recording the electrical activity of the brain. Detecting various diseases, neuromarketing, and visual, auditory, audiovisual, focus, smell, etc., are methods that use EEG signals—electrical activity, evaluating variations in the voltage acting on the brain. The EEG device relates to consistent electricity between the electrodes and the scalp. Can accomplish this in various ways, including Soft gel-based, saline solutions, dry EEG devices, and others (Soufineyestani et al., 2020). A cap-like device connects the electrodes (Aldayel et al., 2020). EEG sensors measure various electrical signals created by neurons' activity on the brain's surface over a while (Soufineyestani et al., 2020). The advantage of the EEG method is that it is relatively inexpensive and flexible to measure brain waves on the scalp's surface. EEG is beneficial for capturing data directly and objectively and assisting researchers in understanding the processes involved in decision-making (et al., 2018).

The brain has a signal pattern with different frequency ranges, alpha (8-13 Hz), beta (13-30 Hz), theta (4-8 Hz), delta (1-5 Hz), and gamma (25-40 Hz). Each signal has different characteristics, depending on the stimulus (Jain et al., 2018). Alpha waves are generally found in adults when they are relaxed and awake. Delta waves are present in subconscious bodily functions. Theta waves are low-frequency patterns, usually when adults are sleeping. Beta waves occur when receiving stimuli or expending energy to remember, and Gamma waves occur when doing activities. However, EEG devices cannot read gamma waves (Jain et al., 2018). EEG technique is real-time measurement. The general procedure is to place electrodes on the scalp while sitting in a chair and move as little as possible. Then, the electrodes are connected to a brain wave amplifier. Furthermore, brain waves are recorded in a real-time (Shaw & Bagozzi, 2018).

Spatial Selection

Spatial selection is a process for normalising data on EEG signals and includes energy calculations. One energy calculation is based on L2-Norm. L2-Norm can be formulated as follows.

$$P_j = \frac{\sum_{i=1}^{m} A(i,j)^2}{\sum_{i=1}^{m}\sum_{i=1}^{m} A(i,j)^2} \qquad (1)$$

P represents the energy value, i is the row, and j is the column. A is the matrix in the data, while m and n represent rows and columns (Fauzi et al., 2018). EEG Channel selection is a technique for selecting optimal channels without the influence of

classification accuracy. The way channel selection works is that the selection of energy is calculated and ordered based on the highest to low energy values. Energy channel selection is also called the selected channel (Fauzi et al., 2018).

Related Work

Some researchers reveal that neuromarketing has a bright future. By applying neuromarketing, marketers can strategise and improve their marketing (Mansor & Isa, 2020). Previous research in marketing, questionnaires, polling, and Neuromarketing (Vecchiato et al., 2013). Neuromarketing is a field of study that studies ways to analyse consumer behaviour using EEG signals (Vecbehaviourbehaviour013). According to Vlăsceanu's (2014) research, neuromarketing can determine the behaviour of consumers and make decisions using the subconscious mind, emotions, feelings, and desires to make decisions. Therefore, it can influence someone to buy the product (Giraldi et al., 2017). According to Stadelhofer, Neuromarketing research can be measured using several devices, namely magnetic encephalography (MEG), Electroencephalograph (EEG), and functional magnetic resonance imaging (fMRI) (Stadelhofer et al., 2017). Besides being used as medical devices, these three tools can also measure brain signal activity (Stadelhofer et al., 2017). According to Vecchiato, brain signal activity can be recorded using EEG and analysed to obtain correlations between brain signals with emotion, attention, and short-term memory activities (Vecchiato et al., 2013). Various studies have investigated music's effects on memory, but the results have been mixed.

Music is characterised as having an important impact on memorisation. Short-term memory refers to storing information for a short period (Alagoz & Bray, 2021). Short-term memory refers to the ability to store small amounts of information quickly. Short-term memory is crucial because it can form the ability to learn, understand, and store information important in everyday life (Alagoz & Bray, 2021). According to existing research, neuromarketing can be investigated using shopping items and TV advertising (Vecchiato et al., 2013) (Yadava et al., 2017). From previous research, neuromarketing was conducted to identify the advantages that affect the application of this technique in marketing. Neuromarketing is constantly evolving. Neuromarketing's contributions to marketing research are classified into advertising, product development, product design, pricing, and decision-making (Nilashi et al., 2020).

RESEARCH METHOD

There are three stages in finding patterns from short-term memory of jingle. The first stage is pre-session. Pre-session is the process of data retrieval by pretesting the respondents to listen to the jingles of six products. Subjects listened to jingles randomly in hopes of remembering the product. Subjects were then given a post-test to listen to one random jingle and given time to remember. On this post-test, subjects were paired with an EEG to confirm the processed signal whether the subjects remembered the jingle or not. The next stage is a session. Subjects were given a different jingle in the session stage, like the previous process. They answered the jingle question about the

brand's product. The last stage is data processing. This stage calculates the energy in each channel and sees the highest energy. At this stage, it is proven whether the highest energy is in the alarm memory area if a proven jingle means helping consumers to remember the product.

Data Recording

Data was collected on six subjects: three men and three women. The subject is an engineering student, undergraduate level, with an age group of 19-24 years. There are no limits on subjects, but the pattern of signals in this research will be seen not to require too many subjects. Also, EEG signals are stationary and nonlinear. That is, one session of EEG signalling will be different from another, even if the stimulus and subject are the same. Also, EEG signals are stationary and nonlinear. The six subjects represent spectral and spatial analysis for $16 \times 24 \times 13.500 = 5.184.000$ EEG signal processes. There are no restrictions on background, gender, race, and beliefs in this study—retrieval of data using Contec KT88-1016 Digital 16 Channel EEG Machine and Mapping System device.
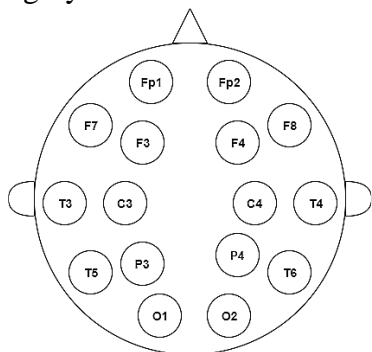

Figure 1. Contec KT-88-1016 Digital 16-Channel EEG Machine And Mapping System

Data were collected at the soundproof studio in the Digital Signal Processing Laboratory, Faculty of Electrical Engineering, Telkom University. The subject sat in a chair with armrests. The monitor for displaying instructions will be in front of the subject's seat. The researcher will adjust the distance between the chair and monitor according to the subject's comfort, given the visibility of each issue is different. Then there are the speakers that are used to play the jingle.

Figure 2. Timing Diagram

Pre-Session

Activities performed by the subject during the pre-session are seeing and hearing. Respondents are given a stimulus in the form of five jingles from five brands of instant noodles, which can be seen in Table 1. The brand category displayed is instant noodles in packaging—the mark is based on a survey conducted by the Top Brand Award. According to the website (Top Brand Award, n.d.), Indomie and Mie Sedaap are the top brands of instant noodles in bag packaging in 2021, with the percentage of Indomie being 72.9% and Mie Sedaap 15.2%. When the first jingle is playing, researchers record the signal. The song is played according to duration; the pre-session recording duration is 60 seconds.

Table 1. Jingle of Brands

Brand	Top Brand Category
Indomie	Top Brand
Mie Sedaap	Top Brand
Sukses	Non-Top Brand
Lemonilo	Non-Top Brand
Maggi	Non-Top Brand

After the pre-session, the subject is given time to rest for ten seconds. Subjects were asked to calm down before entering the next session.

Session

The activities carried out by the subject during session one are seeing, hearing, and remembering. Researchers will rotate one jingle randomly. Jingles played from sessions one to three, consisting of one song from the top brand category and two from the non-top brand category. Each subject will receive a screening of one top brand category in Indomie or Mie Sedaap and two non-top brand categories in the form of Maggie-Sukses, Sukses-Lemonilo, or Maggi-Lemonilo. After the jingle is turned on, the screen will turn blind (black) for 15 seconds to remember the song played. The blind screen is the stage where the subject can recall (recall) the stimulus that has been given. After the blind screen, subjects were asked to fill in the mark of the jingle screened in the questionnaire after providing the data acquisition. After session one, subjects were given time to rest for 10 seconds. Subjects were asked to return relaxed before entering the next session.

Data Processing

Data processing is performed using spatial signal processing, processing data sets of EEG signals in amplitude values over time. Active channel processing is the processing of EEG channels used with 16 tracks. The channels are Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T4, T5, and T6. Active channel filtering eliminates noise and attenuation of the EEG signal. Noise can be in the form of movements made by the subject and can also be caused by noise during data retrieval. In this final project, a Butterworth bandpass filter of Order four eliminates high and low-frequency noise. The cut-off frequency used is in the alpha band, 8-12 Hz. After entering the filtering stage, the data will be sorted using Channel selection to choose the optimal channel using the average energy (average energy) based on the L2-norm.

Active channels are selected using channel selection with a threshold of 10 tracks. The number of channels is thresholded based on reference channels, namely channels F3, F4, C3, C4, P3, P4, T3, T4, T5, and T6. The channel selection or selected channel results are sliced with a reference channel. Active channel results from cut channel selection with reference G channels for each subject accumulated. Most channel appearances are common active channels on 16 tracks. About channel processing, the active medium is sliced with a reference channel. Each brand has ten reference channels which are then searched for the average energy value in each channel. In channel selection, channels searched for average energy values are ranked or sorted from highest to lowest

average energy. One channel with the highest middle point is chosen due to channel selection. The channel that has the highest power of all sessions on each subject is the standard active reference channel. The same energy average or the average energy brand on different issues is averaged again. Calculating the average energy on the active channel is the same as the reference channel, which distinguishes only the number of channels. In the reference channel that is averaged, only ten reference channels. These averages obtained average energy values for each brand from highest to lowest.

RESULT AND DISCUSSION

Testing is done by taking data derived from questionnaires and EEG. The questionnaire data is qualitative data taken from the answers to the subject questionnaire, as in Table 2.

Correct answers can be associated with brands remembered by the subject, and wrong answers can be related to brands that need to be recognised by the subject. Based on six subject questionnaire data retrieval results, no subject answered correctly in three sessions. All top brand categories were answered correctly by all six subjects. The most incorrect answer obtained for instant noodles with the type of non-top brand is Maggi. They don't remember the subject of the Maggi brand because the Maggi brand is a brand from Switzerland with the most extensive marketing in India.

Table 2. Results of Subject Questionnaire Data Retrieval

Subject	Session	*Jingle Stimuli*	Answer	Result
1	1	Lemonilo	Lemonilo	True
	2	Maggi	Sukses	False
	3	Sedaap	Sedaap	True
2	1	Indomie	Indomie	True
	2	Maggi	Maggi	False
	3	Lemonilo	Lemonilo	True
3	1	Maggi	Sedaap	False
	2	Indomie	Indomie	True
	3	Sukses	Gerogol	False
4	1	Sukses	Sukses	True
	2	Lemonilo	Maggi	False
	3	Indomie	Indomie	True
5	1	Sukses	Maggi	False
	2	Sedaap	Sedaap	True
	3	Lemonilo	Sukses	False
6	1	Sedaap	Sedaap	True
	2	Sukses	Sukses	True
	3	Maggi	Lemonilo	False

Correlation Between Jingle and Active Areas of Brain Signal

Analysed correlation between jingles and the active area of brain signals was from the common active channels of the six subjects during the session and pre-session. The number of channel appearances is in Figure 3.
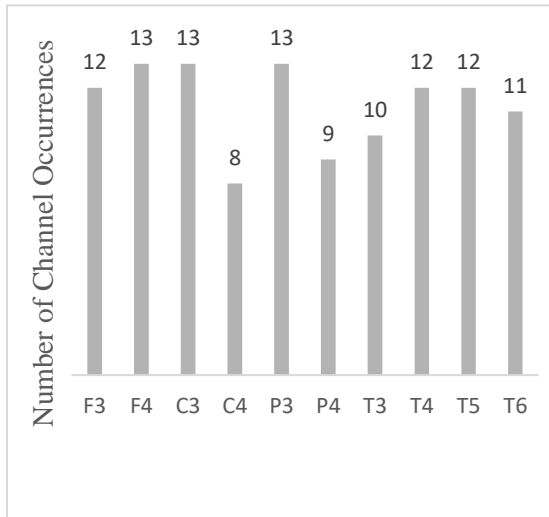
Figure 2. Number of Channel Appears During Pre-Session

In six subjects during the session, the F4 channel is the standard active channel because it has the highest appearance compared to other media. Channel F4 confirms dynamic energy in the short-term memory area. In the six subjects' pre-session, the P3 channel is the least active channel, with a few channels appearing on the sliced result between the selected channel and reference channel compared to other media. F4, C3, and P3 are common active channels in the pre-session pipeline. They have the most tracks appearing compared to other channels, and C4 is the least active channel due to the minor channel appearances compared to other media. Channel F4 confirms the process of remembering in the short term (short-term memory). In contrast, channel C3 ensures sensorimotor from the right brain, and channel P3 confirms perception from the right brain.

The Effect of Jingle on Memory
The influence of jingles on memory can be measured by the relationship between each brand's average or average energy. The average power of each brand is in Figure 4.
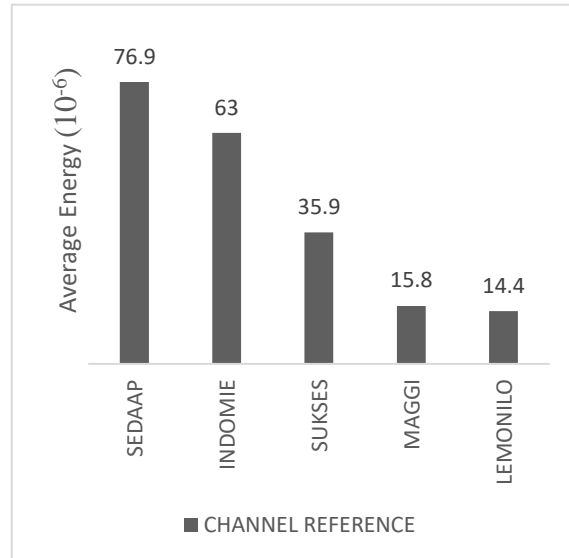

Figure 3. Value of Average Energy for Each Brand

The average energy brand of six subjects is sequentially based on the top and non-top brand categories. Instant noodles dominate the first and second ranks in packaging with the top brand category, Mie Sedaap and Indomie. The third rank is Mie Sukses, which has been in Indonesia for a long time but is not included in the top brand category. The fourth rank is Maggi, a noodle from Switzerland with the biggest market in India and Pakistan, which are generally not well known by the people of Indonesia. In the fifth rank, Lemonilo is a noodle that appeared in Indonesia and has not been categorised as a top brand.

Of the six subjects, the post-test results proved that they found high energy in the

short-term memory area or the F4 channel. A jingle can make it easier for people to remember the product. The highest accuracy and validation are found in the top brand, while the smallest falls on Maggi. It strengthens that the jingle is influential as a form of marketing that can be considered. Jingle is a reasonably effective tool used in a product. Evidence in academic implications shows that memory can objectively and quantitatively measure a person's memory objectively and quantitatively with calculations using a mathematical formula, namely EEG.

CONCLUSION

Several conclusions were obtained from analysing six subjects' short-term memory EEG signal profiles with auditory stimulus.

Namely, all issues were answered right when the top brand category questions were asked. At the same time, we found incorrect answers for the six subjects with non-top brand categories. It can conclude that the top brand category is more remembered than the non-top brand category. Based on the analysis results, the active area of brain signals is based on the correlation with the jingles of the active channel. The active area in the frontal area confirmed that the F4 channel has the highest energy. This channel follows the function of the F4 track, which is short-term memory. Based on the measurement results of six subjects from the EEG, in the form of the average brand energy in the active channel, we can say that the top brand category has higher average energy than the non-top brand category.

References

Alagoz, J., & Bray, W. (2021). The Effects of Baroque Music on Short-term Memory. *International Journal of High School Research*, *3*(2), 6–9.

Aldayel, M., Ykhlef, M., & Al-Nafjan, A. (2020). Deep learning for EEG-based preference classification in neuromarketing. *Applied Sciences (Switzerland)*, *10*(4), 1–23.

Alvino, L., Constantinides, E., & Franco, M. (2018). Towards a Better Understanding of Consumer Behavior: Marginal Utility as a Parameter in Neuromarketing Research. *International Journal of Marketing Studies*, *10*(1), 90.

Alvino, L., Pavone, L., Abhishta, A., & Robben, H. (2020). Picking Your Brains: Where and How Neuroscience Tools Can Enhance Marketing Research. *Frontiers in Neuroscience*, *14*(December).

Avinash, T., Dikshant, L., & Seema, S. (2018). Methods of Neuromarketing and Implication of the Frontal Theta Asymmetry induced due to musical stimulus as choice modelling. *Procedia Computer Science*, *132*(Iccids), 55–67.

Babiloni, F. (2012). Consumerneurosciencee: A new area of study for biomedical engineers. In *IEEE Pulse* (Vol. 3, Issue 3).

Badescu, R., & Pelau, C. (2021). Consumers' Perception on the Ethics of Neuromarketing. *Collaborative Research for Excellence in Economics and Social Sciences*, 249–255.

Bočková, K., Škrabánková, J., & Hanák, M. (2021). Theory and practice of neuromarketing: Analysing humanbehaviourr in relation to markets. *Emerging Science Journal*, *5*(1), 44–56.

Brenninkmeijer, J., Schneider, T., & Woolgar, S. (2020). Witness and Silence in Neuromarketing: Managing the Gap between Science and Its Application. *Science Technology and Human Values*, *45*(1), 62–86.

Camila, C. (2018). *CONSUMER' S PERCEPTION AND PURCHASE INTENTIONS A Qualitative Study on Second-Hand Clothing Stores Master Thesis in Business Administration*. *May*.

CEYLAN, B., TÜZÜN, S., & AKAN, A. (2020). Detection of Consumer Preferences Using EEG Signals. *International Journal of Applied Mathematics Electronics and Computers*, *8*(4), 289–294.

Cheah, K. H., Nisar, H., Yap, V. V., & Lee, C. Y. (2020). Convolutional neural networks for classification of music-listening EEG: comparing 1D convolutional kernels with 2D kernels and cerebral laterality of musical influence. *Neural Computing and Applications*, *32*(13), 8867–8891.

Cuesta, U., Martínez-Martínez, L., & Ignacio Niño, J. (2019). A Case Study in Neuromarketing: Analysis of the Influence of Music on AdvertisinEffectivenesses through Eye-Tracking, Facial Emotion and GSR. *European Journal of Social Science Education and Research*, *5*(2), 73–82.

Devaru, S. (2018). Significance of Neuromarketing on Consumer Buying Behavior. *International Journal of Technical Research & Science SIGNIFICANCE*, *3*(Iii), 114–121.

Dianty, L., & Magnadi, R. H. (2020). The determinant of brand awareness: Lesson from Indonesia. *Jurnal Manajemen Dan Pemasaran Jasa*, *13*(2), 297.

Fauzi, H., Shapiai, M. I., Shah Abdullah, S., & Ibrahim, Z. (2018). Automatic Energy Extraction Methods for EEG Channel Selection. *Proceedings - 2018 International Conference on Control, Electronics, Renewable Energy and Communications, ICCEREC 2018*, 70–75.

Giraldi, J. D. M. E., De Souza, M. T., De Oliveira, J. H. C., & Jordao, I. L. D. S. (2017). Neuromarketing applied to consumer behaviour: an integrative literature review between 2010 and 2015. *International Journal of Business Forecasting and Marketing Intelligence*, *3*(3), 270.

Iloka, C. B., & Onyeke, K. J. (2020). *Neuromarketing : a historical review*.

Jain, A., Choudhury, T., Singh, R., & Kumar, P. (2018). EEG Signal Classification for Real-Time Neuro Marketing Applications. *Proceedings on 2018 International Conference on Advances in Computing and Communication Engineering, ICACCE 2018*, *June*, 434–438.

Khurana, V., Gahalawat, M., Kumar, P., Roy, P. P., Dogra, D. P., Scheme, E., & Soleymani, M. (2021). A Survey on Neuromarketing using EEG Signals. *IEEE Transactions on Cognitive and Developmental Systems*, *8920*(c).

Kotler, Philip, Amstrong, Gary, Opresnik, M. O. (2017). *Marketing*. 540.

Levallois, C., Smidts, A., & Wouters, P. (2021). The emergence of neuromarketing investigated through online public communications (2002–2008). *Business History*, *63*(3), 443–466.

Lin, M. H. (Jenny), Cross, S. N. N., Jones, W. J., & Childers, T. L. (2018). Applying EEG in consumer neuroscience. *European Journal of Marketing*, *52*(1–2), 66–91.

Mansor, A. A., & Isa, S. M. (2020). Fundamentals of neuromarketing: What is it all about? *Neuroscience Research Notes*, *3*(4), 22–28.

Narayanan, V; N, P. R. (2020). Neuromarketing: The Science of Consumer Behavior. *Society*, 1–4.

Nilashi, M., Yadegaridehkordi, E., Samad, S., Mardani, A., Ahani, A., Aljojo, N., Razali, N. S., & Tajuddin, T. (2020). Decision to adopt neuromarketing techniques for sustainable product marketing: A fuzzy decision-making approach. *Symmetry*, *12*(2).

Oon, H. N., Saidatul, A., & Ibrahim, Z. (2018). Analysis oNonlinearr Features of Electroencephalogram (EEG) Signal for Neuromarketing Application. *2018 International Conference on Computational Approach in Smart Systems Design and Applications, ICASSDA 2018*.

Rano Nazarova, & Tuychiev Komilzhon Lazizovich. (2019). Neuromarketing − a Tool for Influencing Consumer Behavior. *International Journal of Innovative Technologies in Economy*, *5*(5(25)), 11–14.

Rasyid, M. F. A., & Djamal, E. C. (2019). Emotion and attention of neuromarketing using wavelet and recurrent neural networks. *International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, 49–54.

Rawnaque, F. S., Rahman, K. M., Anwar, S. F., Vaidyanathan, R., Chau, T., Sarker, F., & Mamun, K. A. Al. (2020). Technological advancements and opportunities in neuromarketing: a systematic review. *Brain Informatics*, *7*(1).

SHAKIL, A., & Siddiqui, D. A. (2019). How Jingles in Advertising Affect Retention and Recall of the Product. *SSRN Electronic Journal*, 1–24.

Shaw, S. D., & Bagozzi, R. P. (2018). The neuropsychology of consumer behavior and marketing. *Consumer Psychology Review*, *1*(1), 22–40.

Soufineyestani, M., Dowling, D., & Khan, A. (2020). Electroencephalography (EEG) technology applications and available devices. *Applied Sciences (Switzerland)*, *10*(21), 1–23.

Stadelhofer, S. K., Murashko, V., Moog, S., Li, L., & Furtwangen, H. (2017). Neuromarketing Are there certain musical components to successfully transmit brand images through jingles ? *Furtwangen, Hochschule*, *February*, 180.

Top Brand Award. (n.d.). *TOP BRAND INDEX*. Www.Topbrand-Award.Com/. https://www.topbrand-award.com/top-brand-index/?tbi_find=mie

Vecchiato, G., Cherubino, P., Trettel, A., & Babiloni, F. (2013). Neuroelectrical Brain Imaging Tools for the Study of the Efficacy of TV Advertising Stimuli and their Application to Neuromarketing. In *Neuroelectrical Brain Imaging Tools for the Study of the Efficacy of TV Advertising Stimuli and their Application to Neuromarketing*.

Yadava, M., Kumar, P., Saini, R., Roy, P. P., & Prosad Dogra, D. (2017). Analysis of EEG signals and its application to neuromarketing. *Multimedia Tools and Applications*, *76*(18).

Yazid, A. F., Mohd, S. M., Rustum Ali Khan, A. R. K., Kamarudin, S., & Jan, N. M. (2020). Decision-making analysis using arduino-based electroencephalography (EEG): An exploratory study for marketing strategy. *International Journal of Advanced Computer Science and Applications*, *11*(9), 236–243.