

The 7th International Conference on Economics and Social Sciences
Exploring Global Perspectives:
The Future of Economics and Social Sciences
June 13-14, 2024
Bucharest University of Economic Studies, Romania

**The Application and Efficiency of Neuromarketing Tools
in Marketing Research: A Comprehensive Review
and Future Research Agenda**

Elena GOGA^{1*}, Mihai Cristian ORZAN², Camelia GOGA³,
Claudia Cristina (BIZON) STAN⁴, Danut TRIFU⁵

DOI: 10.24818/ICESS/2024/090

Abstract

Neuromarketing, with its automated and implicit processes, has a profound impact on understanding customer decision making and unveils concealed insights into consumer behaviour. There is an increasing interest among researchers in exploring how consumers' brain responses influence their decision-making processes. A primary goal in today's market is understanding what motivates consumers to choose one product over another. Although neuromarketing positions itself as a key research field to achieve this goal, it remains a relatively young and rapidly evolving discipline. Therefore, it is useful to present a comprehensive review of the scientific studies concerning the application of neuromarketing, with special attention to its diverse tool and outlining the distinct benefits that ensure the rigorous execution of high-quality neuromarketing research. The purpose of the present study is to provide a "comprehensive overview of the application of neuromarketing tools - classification of neuroimaging and physiological tools" - on the practice of marketing research. Thus, literature review was covered aiming academic papers, scientific articles and relevant sources in this field and using the methodology text-mining. The papers were selected between 2010 and 2023 using the search for "neuromarketing tools" in valid databases. Valuable results are provided especially for the use of "electroencephalography" (EEG) and "functional magnetic resonance imaging" (fMRI) regarding cost efficiency. Overall, this paper seeks to serve as a valuable resource for understanding the array of neuromarketing tools available and their advantages, achieved through bibliometric and content analysis studies. What distinguishes this research is its up-to-date review of neuromarketing tools and their proven effectiveness in targeted domains. Consequently,

¹ Bucharest University of Economic Studies, Bucharest, Romania, goga.elena@gmail.com.

* Corresponding author.

² Bucharest University of Economic Studies, Bucharest, Romania, mihai.orzan@ase.ro.

³ Université de Franche-Comté, Besançon, France, camelia.goga@univ-fcomte.fr.

⁴ Bucharest University of Economic Studies, Bucharest, Romania, crystinaclau@yahoo.com.

⁵ Bucharest University of Economic Studies, Bucharest, Romania, dan.trifu@consultapro.ro.

it provides valuable insights and guidance for both academic and business endeavours, aiming to enhance efficiency in marketing research and inspire future investigations.

Keywords: consumer behaviour, decision-making process, neuromarketing, “electroencephalography” (EEG), “functional magnetic resonance imaging” (fMRI).

JEL Classification: M31, O32.

1. Introduction

Antonio Damasio, a well-known neuroscientist and appreciated author once said, “We are not thinking machines that feel, we are feeling machines that think”. According to Damasio and many others, despite our admiration for cognitive abilities, the brain has long depended on instinctual reactions for millions of years. Regarded from a neuromarketing point of view, it suggests that certain principles should be employed in advertising messages to enhance information processing at the brain level (Morin, 2011). There is an increasing interest among marketing researchers and academics for this young neuromarketing field that helps in finding concealed insights into consumer behaviour and in understanding customer decision making.

1.1 Context

At Harvard University, “Neuromarketing” as an idea was created by therapists in 1990 (Cuesta et al., 2018; Singh et al., 2023). However, in 2002, Ale Smidts, a Dutch organisational theorist who was also a marketing professor, presented the term “Neuromarketing” (Boriceanu, 2009). A year later, in 2003, researchers utilised fMRI brain imaging techniques to investigate and comprehend consumers' preferences for common beverages such as Coca-Cola and Pepsi (McClure et al., 2004). This study, through its incomplete elucidation of consumer decision-making prompted a quest for deeper insights into this emerging research field (Stasi et al., 2017). “Neuromarketing” is part of the “Neuroscience” research domain that aims to anticipate the consumer’s behaviour through the cerebrum’s basic actions and responses. It is demarcated as the field of study of the cerebral apparatus to comprehend consumers’ behaviour to advance a business’s marketing strategies (Boriceanu, 2009).

2. Problem Statement

Year by year the number of papers focused on this young domain grows, and that is why it is very hard to get a clear overview of the neuromarketing tools and afterwards to keep up with the proven efficiency of every single one of them obtained in specific studies. That is why it is necessary to provide a user-oriented presentation of the neuromarketing literature. For a newcomer in neuromarketing field, there is a great need for a detailed guide for high-quality research. “Therefore, we discuss the different steps a newcomer is likely to take when moving into the neuromarketing

field, along with their informational needs at various stages of their development as a neuromarketing researcher” (Lee et al., 2018). The added value of this study is to present the application and the efficiency of the neuromarketing tools to marketing research demonstrated in papers published in well-regarded and influential marketing journals.

3. Aims of the Research

The objective of this research project is to provide a better understanding of the application and efficiency of neuromarketing tools in marketing research. This goal can be achieved by getting a comprehensive overview of the field: from the past up to the present and setting the future agenda. So, the contribution of this study would be to present an up-to-date review of the specialised literature and provide a set of directions for future improvement of the research in the field of neuromarketing, as discovered from the literature review (Lee et al., 2018; Sánchez-Núñez et al., 2021).

4. Research Methods

In pursuit of an exploratory approach, a research based on secondary sources was chosen, in order to obtain insights about the use of “neuromarketing tools in marketing research”. To achieve this goal, the search for papers was started by establishing the keywords: “neuromarketing”, “neuromarketing tools in marketing research”, “application of neuromarketing tools”, “EEG”, and “fMRI”. The first criterion used to select the papers for this secondary data research was related to the publishing year: the interval between 2010 and 2023 was chosen. The second criterion was represented by the scientific databases, where the keywords provided valuable results: Springer Open, Wiley Online Library, Sagepub, Emerald, MDPI, and Elsevier. In the end, a total of 20 papers were returned according to the required criteria and were included in the present analysis.

5. Findings

The articles included in this study have had performed different types of researches: comprehensive analysis using keyword cooccurrence analysis and science mapping tools; text-mining; systematic reviews; “Preferred Reporting Items for Systematic Reviews and Meta-Analyses” (PRISMA) framework; Themes, Contexts, Characteristics and Methodology framework (TCCM) or bibliometric analysis.

5.1 Literature Review - Background

Studies using neuroimaging methodologies provide insight into the real-time consumer response to a specific stimulus (Burgos-Campero & Vargas-Hernandez, 2013). What is needed before sophisticated brain imaging studies is strong theory which predicts specific neural activation differences, rather than exploratory work aiming to map “what happens in response to a marketing stimulus” (Lee et al., 2010).

The neural measures are better predictors of population-level data than self-report measures. Marketers can apply these tools to gain insights about the consumers' intention towards their products and services, and it can help them test their branding and marketing strategies before actually implementing them in the target market (Agarwal & Dutta, 2015). Neuromarketing techniques can be split into two main categories: "neuroimaging" and "non-neuroimaging" techniques (Martínez-Navarro et al., 2019). "Neuroimaging techniques" involve monitoring brain activity and electrical signals, whereas "non-neuroimaging techniques" do not engage with neurological activity (Gill & Singh, 2020). Calvert et al. (2004), Kenning and Plassmann (2005), Zurawicki (2010) and Bercea (2012) helped with further detailing this classification as presented below.

"Neuroimaging Techniques"

A. "Recording Metabolic Activity in the Brain":

- **fMRI** ("functional Magnetic Resonance Imaging"): measures the oxygen used by different areas of the brain (it measures: "memory encoding, sensory perception, trust and brand engagement, loyalty, preference, recall").
- **PET** ("Positron Emission Tomography"): "is a clinical imaging symptomatic method used to quantify the body's metabolic movement" (it measures: "memory encoding, engagement, emotional engagement, attention, processing visual input").

B. "Recording Electrical Activity in the Brain":

- **EEG** ("Electroencephalogram") test: it evaluates the electrical signals sent from one neuron to another (it measures: "attention, engagement, excitement, emotional valence and cognition, memory encoding, recognition").
- **fNIRS** ("Functional near-infrared spectroscopy"): is an optical technique for monitoring brain activity, that utilises near-infrared light.
- **MEG** ("Magnetoencephalography"): analyses and maps brain activity using a cap equipped with 100-300 sensors (it measures: "perception, attention, memory").
- **SST** ("Steady-State Topography"): it measures: "sensory perception, valence of emotions".
- **TMS** (Transcranial Magnetic Stimulation)

"Non-Neuroimaging Techniques"

- **ET** (Eye tracking): This records individuals' eye movements during an eye-tracking task (it measures: "visual search, fixation position, eye movement patterns, spatial resolution, excitement, pupil dilation").
- **Facial coding or Facial Expression**: It detects subtle muscle movements when individuals react to marketing stimuli (it measures: "unconscious reactions, emotions").

- **fEMG** (facial Electromyography): it employs facial sensors to record the electrical response generated by facial muscles contractions (it measures: “unconscious and subconscious reactions, valence”).
- **Galvanic Skin Response (GSR) or Skin Conductance:** researchers employ GSR to assess the level of customer excitement following the exposure to external stimuli (it measures: “emotional engagement, valence and arousal of emotions”).
- **Heart Rate**
- **Implicit Response Tests:** another type of tools that provides subconscious data on behaviour or attitude (it measures: “reaction time, underlying attitudes/evaluation”).
- **Measuring physiological responses.**

5.2 Neuromarketing Tools in Marketing Research: Up-to-date Review

Yadava et al. (2017) in their study utilised an affordable setup to analyse brain activity through EEG signals, which provided high temporal resolution, was more cost-effective than fMRI and used fewer electrodes - only 14. He demonstrated that these parameters expanded the application of EEG from the laboratory to everyday practice. The main contribution of that study was offering a neuromarketing framework that could be utilised to develop market strategies, conduct research and predict market success by enhancing existing models (Yadava et al., 2017). Lin et al. (2018) concentrate on “various ways in which EEG research can inform marketers, such as research on attention, memory, attitudes, decision-making, emotions and more”, while Hakim and Levy (2018) try to establish the specific application of EEG in predicting the preferences.

Neuromarketing field provides promising results as Ruanguttamanun (2014) shows in his study that fMRI offers a new cutting edge method that is able to shed light on subconscious processes, which could substantially increase the effectiveness of advertising messages.

According to Shahriari et al. (2019), marketers must comprehend the subconscious aspects of consumer behaviour to fulfil their needs, as the majority of cognitive processes occur subconsciously, making it difficult for consumers to express their preferences explicitly. Neuromarketing is the side of neuroscience research that focuses on understanding the consumer behaviour through the brain's instinctual processes and responses (Gill & Singh, 2020). Their research adds value to marketing research by offering an efficient method to measure the customer's unconscious reactions. In their study, Singh et al. (2023) demonstrate that neuromarketing methods excel in gauging customer responses to marketing actions. Their neuromarketing study “conveys valuable insights to scholars, researchers and marketers by offering comprehensive future research perspectives and theoretical evolution for augmenting their overall understanding of the neuromarketing discipline” (Singh et al., 2023).

5.3 Neuromarketing Tools in Marketing Research: Future Agenda

Similar to other technologies, neuroscience technology meets a significant challenge: the ethical considerations, such as maintaining privacy and confidentiality, protecting vulnerable groups, and ensuring the honest interpretation of research findings (Shahriari et al., 2019). Ethical issues act as a barrier in the development of neuromarketing, but to a certain extent they are regulatory mechanisms for the progress of the field (Bercea Olteanu, 2015; Vlasceanu, 2014). In their paper, Ulman et al. (2014) suggest that “neuromarketing technologies should be sufficiently discussed in public spheres and its use on humans should be fully carried out according to the ethical principles and legal regulations designed in line with human rights and human dignity”.

Since 2015, the application of Machine Learning in neuromarketing focuses especially on “like/dislike classification problem” and “predicting consumer choice problem” (Rawnaque et al., 2020). For instance, using “advanced neural recording method” and “signal processing tools”, researchers can analyse EEG signals and determine how they relate to marketing stimuli. This demands the implementation of advanced “Machine Learning algorithm application” in Neuromarketing. According to Rawnaque et al. (2020) the most utilised classification algorithms in Neuromarketing experiments over the last five years included: “Support Vector Machine” (SVM), “Linear Discriminant Analysis” (LDA), “Artificial Neural Network” (ANN), “Naïve Bayes”, “k-Nearest Neighbor” (KNN) and “Hidden Markov Model” (HMM).

In their study, Alsharif et al. (2023) emphasise the neural responses related to consumer behaviour such as attention, emotions, perception, reward processing, and motivation, to be taken into account in the marketing mix, and EEG was the most involved tool in this research. “The frontal and temporal gyri were correlated with pleasure/displeasure and high/low arousal; the occipital lobe is linked to attention processes, while the hippocampus relates to long and short-term memory”. Gill and Singh (2020) state in their study that the EEG test holds an advantage over fMRI due to its portability, enabling it to test individuals in public locations such as shops and cinemas. Along with EEG, fNIRS is one of the most commonly used noninvasive neuroimaging techniques that can be applied in portable environments.

Casado-Aranda et al. (2023) stated that “fMRI and EEG stand out in providing a comprehensive insight into the brain processes underlying the processing of communication”. The activation of “deep emotional, mentalising, memory and valuation networks in communication contexts may strongly predict behavioural tendencies, persuasion, and conversion”. The added value provided by this study is the valuable overview of suitability and cost efficiency of neuromarketing tools.

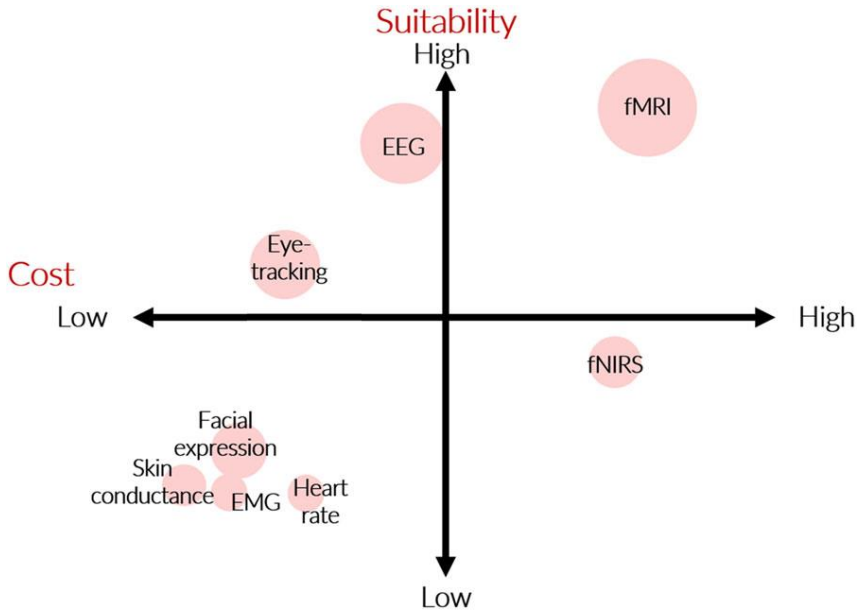


Figure 1. ‘Most relevant neurophysiological tools by cost and suitability in communication research’

Source: Casado-Aranda et. al., 2023.

In their paper (Mileti et al., 2016), the researchers introduce “the integration of neuromarketing and nanotechnologies that could start a new field of research, which is termed nanomarketing”. Nanomarketing makes possible “noninvasive and nonintrusive experiments in shopping places” and real-time monitoring of consumers' mental processes. The added value for our research: wireless and remote-controlled nanodevices could facilitate a continuous monitoring of the neurophysiological processes of the subjects. This eliminates the limitations and artificiality of laboratory studies and makes the results more applicable to everyday life conditions. So, using portable/wearable or environmental devices could significantly enhance companies' abilities to comprehend, predict and adapt to market changes.

6. Conclusions and Implications

This study revealed the application and increasing efficiency of “neuromarketing tools in marketing research”, offering a better understanding of their use in decoding the emotions that trigger the decision-making process. Using neuromarketing tools in marketing research has significant managerial implications and here are some of them: improved marketing strategies, competitive advantage, enhanced consumer insights, product development, cost efficiency, and ethical considerations.

This research has certain limitations that need to be acknowledged. Firstly, the study relied on secondary data sources, such as academic articles, which may have limited the depth of the analysis. Secondly, the criteria used for selecting articles for the analysis may have introduced a degree of subjectivity, which could potentially affect the comprehensiveness of the findings. Although efforts were made to ensure a representative sample, the inclusion and exclusion criteria might have affected the results.

As a future research direction, it should be taken into account organising an up-to-date expertise of the technological advancements of EEG test.

Bibliography

- [1] Agarwal, S. Dutta, T. (2015). *Neuromarketing and consumer neuroscience: current understanding and the way forward*, Published online: 18 November 2015, Springer, DOI 10.1007/s40622-015-0113-1.
- [2] Alsharif, A.H., Zafir Md Salleh, N., Abdullah, M., Khraiwish, A., Ashaari, A. (2023). *Neuromarketing Tools Used in the Marketing Mix: A Systematic Literature and Future Research Agenda*. <https://creativecommons.org/licenses/by/4.0/>.
- [3] Bercea, M.D. (2012, august 9-10). *Anatomy of methodologies for measuring consumer behavior in neuromarketing research* [Conference session]. LCBR European Marketing Conference, Ebermannstadt, Germany.
- [4] Bercea Olteanu, M.D. (2015). *Neuroethics and Responsibility in Conducting Neuromarketing Research*, Neuroethics, Springer Science+Business Media Dordrecht 2014.
- [5] Boriceanu, V. (2009). *How to Understand the Consumer's and the Market's Way of Thinking*. *Mark. Inf. Decis.*, 2, 95-104.
- [6] Burgos-Campero, A.A., Vargas-Hernandez, J.G. (2013). *Analytical approach to neuromarketing as a business strategy*, *Social and Behavioral Sciences* 99 (2013), 517-525, Published by Elsevier Ltd.
- [7] Calvert, G., Spence, C., Stein, B.E. (2004). *The Handbook of Multisensory Processes*, MIT Press, Cambridge, MA, USA.
- [8] Casado-Aranda, L.A., Sánchez-Fernández, J., Bigne, E., Smidts, A., (2023). *The application of neuromarketing tools in communication research: A comprehensive review of trends*, *Psychology & Marketing* published by Wiley Periodicals LLC., DOI: 10.1002/mar.21832.
- [9] Cuesta, U., Martínez-Martínez, L., Niño, J.I. (2018). *A case study in neuromarketing: Analysis of the influence of music on advertising effectiveness through eye-tracking, facial emotion and GSR*. *Eur. J. Soc. Sci. Educ. Res.*, 2018, 5, 73-82.
- [10] Gill, R., Singh, J. (2020). *A study of neuromarketing techniques for proposing cost effective information driven framework for decision making*. *Mater. Today Proc.*, 49, 2969-2981, <https://doi.org/10.1016/j.matpr.2020.08.730>.
- [11] Hakim, A., Levy, D.J. (2018). *A gateway to consumers' minds: Achievements, caveats, and prospects of electroencephalography-based prediction in neuromarketing*. 2018 Wiley Periodicals, Inc., <https://doi.org/10.1002/wcs.1485>.
- [12] Kenning, P., Plassmann, H. (2005). *NeuroEconomics: an overview from an economic perspective*, *Brain Research Bulletin*, vol. 67, no. 5, 343-354.

- [13] Lee, N., Butler, M.J.R., Senior, C. (2010). The brain in business: neuromarketing and organisational cognitive neuroscience, Conceptual/Theoretical Paper in Journal für Marketing, Springer-Verlag.
- [14] Lee, N., Chamberlain, L., Brandes, L. (2018). Welcome to the jungle! The neuromarketing literature through the eyes of a newcomer. *European Journal of Marketing*, <https://doi.org/10.1108/EJM-02-2017-0122>.
- [15] Lin, M.H., 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. <https://doi.org/10.1108/EJM-12-2016-0805>.
- [16] Martínez-Navarro, J., Bigné, E, Guixeres, J., Alcañiz, M., Torrecilla, C. (2019). The influence of virtual reality in e-commerce, *J. Bus. Res.* 100, 475-482.
- [17] McClure, S.M., Li, J., Tomlin, D., Cypert, K.S., Montague, L.M., Montague, P.R. (2004). Neural correlates of behavioral preference for culturally familiar drinks. *Neuron*, 44(2), 379-387.
- [18] Mileti, A., Guido, G., Prete, M.I. (2016). Nanomarketing: A New Frontier for Neuromarketing. *Psychology & Marketing*, Vol. 33(8): 664-674 (August 2016), 2016 Wiley Periodicals, Inc. DOI: 10.1002/mar.20907.
- [19] Morin, C. (2011). Neuromarketing: The New Science of Consumer Behavior, SYMPOSIUM: CONSUMER CULTURE IN GLOBAL PERSPECTIVE, Springer Science+Business Media, LLC 2011.
- [20] Rawnaque, F.S., Rahman,, K.M., Anwar, S.F., Vaidyanathan, R., Sarker, T.C.F., Abdullah Al Mamun, K.A. (2020). Technological advancements and opportunities in Neuromarketing: a systematic review. *Brain Informatics*, Springer Open. <http://creativecommons.org/licenses/by/4.0/>.
- [21] Ruangguttamanun, C. (2014). Neuromarketing: I put myself into a fMRI scanner and realized that I love Louis Vuitton ads, *Social and Behavioral Sciences* 148 (2014), 211-218, Elsevier Ltd.
- [22] Sánchez-Núñez, P., Cobo, M.J, Vaccaro, G., Peláez, J.I., Herrera-Viedma, E. (2021). Citation Classics in Consumer Neuroscience, Neuromarketing and Neuroaesthetics: Identification and Conceptual Analysis. *Brain Sciences*, Licensee MDPI, Basel, Switzerland, <https://doi.org/10.3390/brainsci11050548>.
- [23] Shahriari, M., Feiz, D., Zarei, A., Kashi, E. (2019). The Meta-Analysis of Neuro-Marketing Studies: Past, Present and Future, *Neuroethics*, Springer Nature B.V.
- [24] Singh, P., Alhassan, I., Khoshaim, L. (2023). What Do You Need to Know? A Systematic Review and Research Agenda on Neuromarketing Discipline. *Journal of Theoretical and Applied Electronic Commerce Research*, Licensee MDPI, Basel, Switzerland, <https://doi.org/10.3390/jtaer18040101>.
- [25] Stasi, A., Songa, G., Mauri, M., Ciceri, A., Diotallevi, F., Nardone, G., Russo, V. (2017). Neuromarketing empirical approaches and food choice: A systematic review. *Food Research International*, 2017 Elsevier Ltd. <https://doi.org/10.1016/j.foodres.2017.11.049>.
- [26] Ulman, Y.I., Cakar, T., Yildiz, G. (2014). Ethical Issues in Neuromarketing: "I Consume, Therefore I am!", Published by Springer Science+Business Media Dordrecht 2014.
- [27] Vlasceanu, S. (2014). Neuromarketing and Neuroethics, *Social and Behavioral Sciences* 127(2014), 763-768, Published by Elsevier Ltd., doi: 10.1016/j.sbspro.2014.03.351.

- [28] Yadava, M., Kumar, P., Saini, R., Roy, P.P., Dogra, D.P. (2017). Analysis of EEG signals and its application to neuromarketing. Published online: 18 March 2017, Springer Science+Business Media New York 2017.
- [29] Zurawicki, L. (2010). Neuromarketing: Exploring the Brain of the Consumer, Springer Science & Business Media, Berlin, Germany.