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Neuromarketing insights for effective advertising strategies: a review and future research agenda

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Abstract

This study tries to illuminate the most prominent contributions of neuromarketing and its tools in advertising from 1976 to 2023. The present study addresses research questions. Data was collected over the timespan from 1996 to 2023 and focused on high-quality research articles published in the English language from subject areas like business, management & accounting, social science, psychology, neuroscience, art, and humanities from the Scopus database. For further analysis, the PRISMA framework, Bibliometrix, and Vosviewer were used. The study highlights that neuromarketing in advertising can go beyond the traditional boundaries providing a sense to the consumer responses and competitive behavior that is revolving in the landscape of advertisement. Further, the study indicates that the researchers have worked on themes like neuromarketing, consumer neuroscience, electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and decision-making, and the themes on which the researchers can focus in the future are emotions, advertising effectiveness, pattern recognition, and storytelling.

Keywords: neuromarketing; advertising; consumer decision-making; mapping facial coding; emotions

1. INTRODUCTION

Advertising can be defined as a paid form of communication that aims at informing, creating awareness, or persuading consumers about a product brand, or service (Rodgers & Thorson, 2012). In advertising, diversity has been examined through various aspects such as gender roles, culture, and religious perspective (Eisend, 2019; Milfeld et al., 2021; Northey et al., 2020; Waller & Casidy, 2021). In recent years neuroscience has also played a role in advertising, where researchers have shown the effect of advertising on potential consumers with the help of neuroscience. The concept of neuromarketing comes from the combination of neuro and marketing which is the fusion of two major fields i.e. neuroscience and marketing (Morin, 2011). The fusion of neuroscience technology and business research has emerged as neuromarketing, a response to the quest for deeper understanding and prediction of consumer behavior in the fiercely competitive market landscape. Neuromarketing is a dynamic field within marketing that leverages insights from neuropsychology to analyze consumers' cognitive, sensorimotor, and affective responses to marketing stimuli. Employing neuromarketing techniques and methodologies can empower marketers with more effective strategies, mitigate product and campaign failures, and shape consumer desires in aligning neuromarketing with marketing objectives. Marketing has traditionally concentrated on the value and competitive advantages of a product or service. However, a more holistic approach to marketing, including the emotional component of the decisionmaking process is gaining considerable ground in contemporary marketing (Suomala et al., 2012). Over the last decade the number of publications related to neuromarketing has significantly increased indicating the growing interest of scholars (Alsharif et al., 2020). Many authors have highlighted the advantages of neuroscientific methods to understand consumer behavior (Lee et al., 2017; Ramsoy, 2015; Songsamoe et al., 2019). Similarly, the number of companies working on neuromarketing has also increased, highlighting the importance of neuromarketing in industrial areas (Rawnague et al., 2020). To improve traditional methods and to tackle marketing challenges neuromarketing research has become popular among companies and scholars.

The Neuromarketing Market size is estimated at USD 1.57 billion in 2024 and is expected to reach USD 2.41 billion by 2029. Neuroscience is beneficial in interpreting and studying consumer perceptions and has played a major role in enhancing the behavioral predictions of consumers (Neuromarketing Market Size & Share Analysis - Growth Trends & Forecasts, 2024 – 2029, Mordor Intelligence).

Research by Agarwal & Dutta (2015), Alsharif (2021), and Brierley (2017) has demonstrated that a substantial portion of consumer behavior and

decision-making occurs beneath conscious awareness, exerting a significant influence on purchasing choices. This revelation underscores the significance of neuromarketing, situated at the crossroads of marketing, neuroscience, and psychology (Alvino et al., 2020; Alsharif et al., 2021a). In contrast to conventional research methodologies like surveys and focus groups, which rely on conscious self-reporting and awareness of consumer actions, neuromarketing recognizes the limitations of such approaches (Alsharif et al., 2021b, Alsharif, Salleh, Baharun & Effandi, 2021). This discrepancy between expressed opinions and actual behavior has contributed to the high failure rates of products and advertisements within the initial year (Jordao et al., 2017; Vecchiato et al., 2015). A considerable proportion of consumer behavior, encompassing decision-making and perception, unfolds at an unconscious level, eluding prediction through traditional methods (Alsharif, Salleh, Baharun & Effandi, 2021).

Understanding the consumer's hidden reactions encompassing sensitive and cognitive responses towards marketing stimuli, Neuromarketing has garnered significant attention (Hamelin et al., 2017). Neuromarketing's core aim is to understand the role played by emotions, memory, and attention while making decisions after watching an advertising campaign (Alsharif, Salleh, Baharun & Effandi, 2021; Alvino, 2019). To understand these emotions different tools of neuromarketing can be employed by the marketer for further consumer behavior study. In recent studies, researchers have worked on neuromarketing tools to enhance their studies and have also addressed limitations (Alsharif et al., 2020; Morin, 2011; Sebastian, 2014). Neuromarketing tools are categorized into four main groups: neuroimaging tools, physiological techniques, self-report measures, and behavioral assessments (Ramsoy, 2015). For example, physiological tools help to measure consumers' breathing rate, eye movement, and activity of facial muscles during exposure to the advertisement (Hamelin et al., 2017). The psychological tool helps marketers to understand the interest of the consumer in an ad and this can help them in revising their advertisement strategy and creating eye catchy advertisements. To measure emotion attention, or memory engagement in response to advertisement neuroimaging tools can be used (Alsharif, Salleh, Baharun, Hashem et al., 2021; Cherubino et al., 2019). By examining these activities marketers can gain deeper insights into how consumers react to various marketing stimuli. Among all the neuromarketing tools, Eye-Tracking holds notoriety as a widely adopted physiological tool (Alsharif, Salleh, Baharun, Hashem et al., 2021; Alsharif et al., 2020). All these tools can make consumers feel the right emotion at the right time which will marketers in selling the product more effectively.

Emotions play a pivotal role in consumer decision-making, with the

brain's emotional learning system pivotal in forming product attitudes (Argo et al., 2009). Emotions wield substantial sway in advertising, with potent positive emotions eclipsing weaker counterparts (Zajac & Rose, 2004). The confluence of cognitive and emotional processing, underscored by social cognition, drives economic decision-making, as proposed by Fehr & Gächter (2002). In today's modern marketing, to create strategies marketers must understand how consumers respond to external stimuli. Understanding consumer's neurological approach can be valuable for market researchers. Neuromarketing relies on insights from a neuro-information system (Aldayel et al., 2020). Rajab & Sharma (2017) demonstrate that the information derived from neuro-information systems can be used to tackle various marketing tactics.

Previous studies have shown that these studies have helped marketers to understand people's emotions. The mental cognitive dissonance of neuromarketing customers significantly influences their engagement with purchases. To have an effective marketing strategy we can combine neuromarketing with facial recognition, emotions, and facial expressions. Despite this, there's a lack of a comprehensive literature review on the subject. To address this gap, we aim to unravel the breadth, depth, and impact of neuromarketing in advertising. The exploration starts with the scope of neuromarketing in the advertisement approach. Further, we want to explore the total quantity and diversity of neuromarketing in advertisement research published by period, country, and journal. Next, we delve into the papers and authors that had the greatest effect on neuromarketing in the advertisement, relying on citations and at last primary areas that researchers have studied and what areas can be studied in the future.

The purpose of this research is to gain a comprehensive understanding of the area of neuromarketing in advertising. The primary contributions of this study outline a thorough review, analysis, and discussion of the latest studies related to neuromarketing, and neuromarketing tools explored in advertising from 1976 to 2023. Secondly, the analysis aims to illuminate the most prominent contributions in the field of neuromarketing during the specified time frame, providing insights into the prevailing trends.

To have a better understanding, the paper is divided into sections. Section 1 focuses on an introduction with the research questions and the aim of the study, section 2 outlines the methodology and data collection techniques, while Section 3 focuses on the analysis of the gathered data. Section 4 is dedicated to the discussion of the study, respectively.

2. Method

The present study uses the PRISMA framework. PRISMA establishes standardized guidelines for conducting systematic reviews and meta-analyses in research. This framework guided the selection process of empirical articles that employed the aspects of neuromarketing in research during the period from 1996 to 2023. Data was collected over the timespan from 1996 to 2023 and with a focus on high-quality research articles published in the English language from subject areas like business, management & accounting, social science, psychology, neuroscience, art & humanities. For this study, articles that were published as conference papers, reviews, and book chapters were eliminated. Even those articles that were not available as full-text articles and were outside the scope of the present study were also eliminated. Table 1 provides a summary of the selection criteria undertaken by researchers. CSV format was used to import the data extracted from the Scopus database. To obtain bibliographic data Bibliometrix (R studio) and Vosviewer tool were used to do a comprehensive mapping of the data obtained from Scopus.

For this study, the total articles that were identified from the time frame of 1996-2023 were 141 from the Scopus database, and after screening we were left with 80. Further 36 articles were removed as it does not fit our investigation to maintain the quality and reliability of the dataset. Finally, 44 articles were used for further study. To find articles relevant to our study, we used a keyword search method, as this helped us identify publications that are directly related to our research (Almeida, 2018; Kaushik & Rahman, 2014). Boolean operator search techniques is a strategy that limits or widens our search. So, for this study, we used a boolean operator strategy (e.g., "AND," "OR"). The primary search string used was TITLE-ABS-KEY (neuro* AND marketing* AND advertisement*) AND [LIMIT-TO (SUBJ-AREA, "business, management & accounting) OR LIMIT-TO (SUBJ-AREA, "social-science") OR LIMIT-TO (SUBJ-AREA, "psychology") OR LIMIT-TO (SUBJ-AREA, "neuroscience") OR LIMIT-TO (SUBJ-AREA, "art & humanities")] AND [LIMIT-TO (DOCTYPE, "article")] AND [LIMIT-TO (LANGUAGE, "English")].



Figure 1. The PRISMA flow diagram

| Table 1. | Criteria | for | integration | and | elimination | of | `data |
|----------|----------|-----|-------------|-----|-------------|----|-------|
|----------|----------|-----|-------------|-----|-------------|----|-------|

| Integration Criteria | Elimination Criteria |
|----------------------|--|
| | Conference papers |
| Articles | Review papers |
| English Language | Articles outside the scope of neuromarketing |
| Journals | Book Chapters |
| | Articles not available as full-text |
| | |

Note. The table shows the criteria for integrating and eliminating articles for the study

2.1 Data analysis

As per the aim of the study to gain an insight of neuromarketing in advertisement, all 44 documents were included in the Scopus index made up of the "data" that was used for analysis. These "meta-data" contained the author names, titles, and publication dates, the documents' authorship information, and numerous citation details. A time span of twenty-seven years was considered, from 1996 to 2023, owing to the availability of data in the Scopus database after applying the inclusion and exclusion criteria(s). The literature was exposed to bibliometric analysis using the Bibliometrix (Aria & Cuccurullo, 2017) and Vos viewer to identify patterns of knowledge production. Descriptive statistics was used in analyzing the trends in the development and geography writings related to neuromarketing in an advertisement by bibliometrix using R studio. Further to give the visual presentation of the data we have used VOS Viewer.

3. RESULTS

3.1 Main information from the database

44 documents were published in 37 reputed peer-reviewed journals written by 140 authors indexed in the Scopus database that spanned myriad domains like business management & accounting, psychology, neuroscience, social science, art & humanities. Out of the 44 documents published, 5 articles are single-author documents whereas co-author per doc is around 3.43. International co-authorship is also detected and is on the rise with 15.91%. The average citations per doc is 29.7 and the document's average age is around 6.34. Main information about the data can be referred to below in Table 2.

| Description | Results |
|---------------------------------|-----------|
| Main information about data | |
| Timespan | 1996:2023 |
| Sources (Journals, Books, etc) | 37 |
| Documents | 44 |
| Annual Growth Rate % | 4.15 |
| Document Average Age | 6.34 |
| Average citations per doc | 29.7 |
| References | 2529 |
| Document contents | |
| Keywords Plus (ID) | 175 |
| Author's Keywords (DE) | 137 |
| AUTHORS | |
| Authors | 140 |
| Authors of single-authored docs | 5 |
| Authors collaboration | |
| Single-authored docs | 5 |
| Co-Authors per Doc | 3.43 |
| International co-authorships % | 15.91 |
| Document types | |
| Article | 44 |

Table 2. Bibliographic source of articles

Note. The table shows the bibliographic source of articles involved in the study. The time span that has been taken is from 1996 to 2023. A total of 44 documents were studied (source - generated by Bibliometrix R studio)

3.2 Publication trends over the years

According to Scopus data, early research on neuromarketing in advertisements can be traced back in the year 1996 with 1 article by Mooradian (1996), "Personality and ad-evoked feelings: The case for extraversion and neuroticism" published in the Journal of the Academy of Marketing Science. This study highlighted that feelings influence advertising. Between 1997 to 2002, research in this area had zero publications. From 2009 to 2023, there was a gradual increase in publications in this area, with 42 articles published in Scopus during this period. In the year 2022, there were maximum publications with 6 articles in journals like Frontiers in Psychology, Journal of Business Research, Marketing Letters, Physiology and Behavior, and Frontiers in Human Neuroscience and Sustainability (Switzerland). See Figure 2 for details. The steady annual growth rate is indicated by 4.15%. The publication trends highlighted that most of the research work was from the developed country like USA, followed by the developing country like China (Figure 3). The USA has the maximum publication of 24 articles followed by China with 13 publications, Poland with 13 publications, Bangladesh with 12 publications, and the countries like Germany, India, South Korea, Italy, and Japan with the least publications. Moreover, in terms of citations, of the top 10 countries, Poland has the highest number of citations (n = 333) average citation of 111.0 followed by the USA (n = 152) average citation of 30.40 and Australia (n = 129) with an average citation of 43.00 (Table 3). On the contrary, publications originating from the USA and China are not able to create much impact in terms of citation compared to Poland.



Figure 2. The bar chart displays the publication trend over the years (source - generated by Bibliometrix R studio)



Figure 3. The bar chart displays the publication trend of the country (source - generated by Bibliometrix R studio)

| Country | TC | Average article citations |
|------------|-----|---------------------------|
| Poland | 333 | 111.00 |
| Usa | 152 | 30.40 |
| Australia | 129 | 43.00 |
| Iran | 86 | 86.00 |
| Qatar | 34 | 17.00 |
| Lithuania | 27 | 27.00 |
| China | 25 | 8.30 |
| Turkey | 21 | 7.00 |
| Bangladesh | 19 | 9.50 |
| Italy | 16 | 16.00 |

Table 3. Most cited countries

Note. The table above shows the most cited counties with their total citation and average of article citation

(source - generated by Bibliometrix R studio)

3.3 The most relevant and influential author

Authors who have produced good quality work and have contributed towards the growth of research are called as most influential authors. The knowledge of influential authors is of utmost importance as it could further help the researchers to contribute in a better way in a specific field (Rey-Martí et al., 2016). Many authors have significantly contributed to the area of neuromarketing. Table 4 represents the most relevant authors in the field of neuromarketing. Out of 140 authors, Choromanska. is the most relevant and influential author with an h-index of 30 from Poland. An overview of the most relevant and influential authors highlights that most of the authors have been affiliated with Bangladesh and Poland followed by the UK.

| Authors | Articles | Institute | Country | h-index |
|----------------|----------|---|------------|---------|
| Anwar Sf. | 2 | Institute of Business Administration, University of Dhaka. | Bangladesh | 6 |
| Choromanska A. | 2 | University of Warsaw, Institute for Social Studies, | Poland | 30 |
| Mamun Ka. | 2 | Department of Computer Science and Engineering, United International University, | Bangladesh | 16 |
| Mashrur Fr. | 2 | Advanced Intelligent Multidisciplinary Systems (AIMS) Lab, Institute for Advanced Research (IAR), United International University, | Bangladesh | 5 |
| Miya Mti. | 2 | School of Business and Economics, United International University, | Bangladesh | 3 |
| Ohme R | 2 | Sciences and Humanities, | Poland | 10 |
| Rahman Km. | 2 | School of Business and Economics, United International University | Bangladesh | 7 |

Table 4. Most relevant authors (Year 1996-2023)

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| Revkowska D | 2 | Laboratory & Co 107 | Poland | 3 |
|-----------------|---|--------------------------|--------------|----|
| KCykowska D. 2 | | Jerozolimskie Av., | TOTALIC | 5 |
| | | Department of | | |
| Sarkar E | 2 | Computer Science and | Bangladash | 11 |
| Sarker F. | 2 | Engineering, University | Daligiadesii | 11 |
| | | of Liberal Arts | | |
| | | Department of | | |
| | | Mechanical Engineering | | |
| | | and UK Dementia | | |
| Vaidwanathan D | 2 | Research Institute Care, | United | 6 |
| vanyanaman K. 2 | L | Research and | Kingdom | 0 |
| | | Technology Centre | | |
| | | (DRI-CR&T), Imperial | | |
| | | College London | | |

Note. The table shows the most relevant author from the year 1996 to 2023 in the field of neuromarketing in advertisement. The table also shows the number of articles published by the author in the relevant field and also highlights their h-index (source - generated by Vosviewer)

3.4 Most influential works

Studying the most influential work will provide an understanding of the author's contribution and their contribution to the field of neuromarketing in the advertisement. In addition, it was significant to highlight the most cited paper in the field of neuromarketing. To find the most influential articles published in the field of neuromarketing, we set the cut-off limit to the top 10 citations. Table 5 corresponds to the list of highly cited papers on neuromarketing in advertisement, published in reputed peer-reviewed journals. Analysis of the highly cited papers highlights the fact that Boksem & Smidts (2015) "Brain responses to movie trailers predict individual preferences for movies and their population-wide commercial success" had significantly contributed toward neuromarketing in advertisement. Their contribution stated that electroencephalography (EEG) measures the real outcome, and this outcome helps to understand consumer choice and behavior. The next highly cited article was Ohme et al. (2009), "Analysis of neurophysiological reactions to advertising stimuli using electroencephalography (EEG) and galvanic skin response measures". The authors measured whether neurophysiological measures could capture differences in consumer reactions if the marketing stimuli differ. The highly cited articles helped to understand the areas that are popular across the discipline.

| A 1 | A 1 | C | Total | T.C Per |
|---|--|---|----------|---------|
| Authors | Articles | Source | Citation | year |
| Boksem M.A.S.; Smidts A. (2015) | Brain responses to movie trailers predict individual preferences for movies and their population-wide commercial success | Journal of Marketing Research | 207 | 20.70 |
| Ohme R.; Reykowska D.; Wiener D.; Choromanska A. (2009) | Analysis of neurophysiological reactions to advertising stimuli by means of electroencephalogra phy (EEG) and galvanic skin | Journal of Neuroscience, Psychology, and Economics, | 168 | 10.50 |
| Ohme R.; Reykowska D.; Wiener D.; Choromanska A. (2010) | Application of frontal electroencephalogra phy (EEG) asymmetry to advertising research The application of | Journal of Economic Psychology | 150 | 10.00 |
| Golnar-Nik P.; Farashi S.; Safari M.S. (2019) | electroencephalogra phy (EEG) power for the prediction and interpretation of consumer decision-making: A neuromarketing | Physiology and Behavior | 86 | 14.33 |
| Hamelin N.; Moujahid O.E.; Thaichon P. (2017) | Emotion and advertising effectiveness: A novel facial expression analysis approach | Journal of Retailing and Consumer Services | 77 | 9.63 |

Table 5. Most cited paper (Year 1996-2023)

| Vecchiato G.; | | | | |
|---|--|--|----|------|
| Maglione A.G.; Ezquierro M.T.H.; Marinozzi F.; Bini F.; Trettel A.; Babiloni F. (2014) | How to Measure Cerebral Correlates of Emotions in Marketing Relevant Tasks | Cognitive Computation | 65 | 5.91 |
| Craig A.W.; Loureiro Y.K.; Wood S.; Vendemia J.M.C. (2012) | Suspicious minds: Exploring neural processes during exposure to deceptive advertising | Journal of Marketing Research | 60 | 4.62 |
| Morris J.D.; Klahr N.J.; Shen F.; Villegas J.; Wright P.; He G.; Liu Y. (2009) | Mapping a multidimensional emotion in response to television commercials | Human Brain Mapping | 47 | 2.94 |
| Baraybar- Fernández A.; Baños-González M.; Barquero- Pérez O.; Goya- Esteban R.; de- la-Morena- Gómez A. (2017) | Evaluation of emotional responses to television advertising through neuromarketing | Comunicar | 45 | 5.63 |
| Mooradian T.A. (1996) | Personality and ad- evoked feelings: The case for extraversion and neuroticism | Journal of the Academy of Marketing Science | 38 | 1.31 |

3.5 Bibliometric analysis

Bibliometrics is the analysis of published information (e.g., books, journal articles, datasets, blogs) and its related metadata (e.g., abstracts, keywords, citations) using statistics to describe or show relationships between published works. To give the visual presentation of the data we have used VOS Viewer. In this study, first, we performed a co-authorship analysis of the author and countries, secondly, we carried out the analysis of the co-occurrence of the author's keyword, and at the end, bibliographic coupling was performed.

3.5.1 Co-authorship analysis of author and countries

To represent the collaboration between authors, countries, and organizations, co-authorship network is used. Co-authorship network represents collaborative work. To perform the analysis VOSviewer tool was used. Figure 4 shows the network of co-authorship of authors that have at least 1 coauthored and at least 50 times cited between the time frame of 1996 and 2023. The analysis resulted in 6 clusters of a total of 24 authors grouped, each cluster being represented by different colors. Babiloni Fabio, Bini Fabiano, Cherubino Patrizia, Ezquierro Mariatrinidad Herrera, Maglione Anton Giulio, Marinozzi Franco, Trettel Arianna, Vecchiato Giovanni, make a strong network of the co-author with 8 co-authored documents represented by red color. Craig Adam W., Loureiro Yuliya Komarova, Vendemia Jennifer. M.c,. Wood Stacy, make the second strong co-author network with 4 co-authors represented in green color. Figure 5 presents the network of countries having at least 1 publication from 1996 to 2023, with a minimum number of 50 citations of a country applied which resulted in forming 3 clusters and a total of 7 countries. Each cluster was represented by different colors. Australia, Poland, and the USA emerged as the strongest cluster represented by red color followed by Italy and Spain as the second strong cluster with green color.

| | boksem | i, marten a.s. |
|--|---|---|
| | loureiro, yujiya komarova craig, adam w. | moujahid, othmane el hamelin, nicolas |
| safari <mark>, mir s</mark> hahram farash <mark>i, s</mark> ajjad | | |
| € VOSviewer | bini, (abiano vecchiato, giovanni babiloni, fabio miarinotzi, franco | wiener, dawid choromanska, anna ohme, rafal |

Figure 4. The clusters show the co-authorship of authors (source - generated by Vosviewer)

| | iran | |
|---------------|------|---|
| | | |
| | | |
| | | |
| united states | | |
| & VOSviewer | | * |

Figure 5. The cluster shows the co-authorship of countries (source - generated by Vosviewer)

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3.5.2 Co-occurrence network of authors' keywords

To understand the recent topic, an analysis based on the authors' keywords was carried out. VOSviewer was used to generate a co-occurrence network of authors' keywords. In the beginning, we had 137 total keywords and further to generate the network least two occurrences were set as the limitation, which led to an overall of 19 keywords that met the criteria. Figure 6 depicts the network. The network map reveals that "neuromarketing" with the 25 occurrences is a largely studied concept, followed by "EEG" with 8 occurrences, consumer neuroscience with 7 occurrences, and advertising with 6 occurrences. A total of 5 clusters were formed with different colors out of 19 keywords.

The keywords offer some effective comprehension. Initially, it shows that researchers have shown that neuromarketing contributes to consumer behavior, marketing, and advertising. Subsequently, it exhibits that constructs are used interchangeably across diverse studies like advertising effectiveness, electroencephalography (EEG), consumer neuroscience, and TV commercials that have resulted in studying the competition. Thirdly, it shows that research work was largely carried out during COVID-19 when it focused more on decision-making, storytelling, and emotions in recent years.



Figure 6. The network shows the co-occurrence network of keywords (source - generated by Vosviewer)

3.5.3 Bibliographic coupling of documents

When two articles refer to the third article in their work the increase in references strengthens the bibliographic coupling. Beneath bibliographic coupling, similar articles group together and form into clusters. In this study, 44 studies were grouped, and two clusters were formed with a total link strength of 26, as the minimum citation was taken as 50. The bibliographic coupling of documents is represented in Figure 7.

Cluster 1: Role of electroencephalography (EEG) in advertising effectiveness. The red color (Cluster 1) is the leading cluster with 4 documents out of 44 and the maximum citation of 207. This cluster focuses on the electroencephalography (EEG), provides unique information regarding individual and population-wide preference, and can thus be used as a neural marker for commercial success. The maximum number of cited articles in this cluster is Boksem (2015) cited 207 times, followed by Golnarnik (2019), cited 86 times, and Hamelin (2017), cited 77 times, respectively.

Cluster 2: neurophysiological reactions to advertising stimuli by electroencephalography (EEG). The green color (Cluster 2) is the second substantial cluster with 2 documents out of 44 with a maximum citation of 166. This cluster focuses on how marketing may benefit from neurophysiology. The highly cited articles in this cluster are Ohme (2009), cited 168 times followed by Ohme (2010), cited 150 times.



Figure 7. The cluster shows the Bibliographic coupling of document (source - generated by Vosviewer)

3.5.4 Co-citation analysis of the cited sources

In the reference list, if the referring papers have referred to two documents simultaneously, co-citation is said to have occurred (Kumar, 2015). Co-citation analysis must be carried out in a particular research field if the researchers want to study the intellectual structure. If the researcher wants to measure the

appropriate similarity between two documents, then co-citation analysis is an effective tool (Surwase et al., 2011). In this study, with the help of VOSviewer and using the full counting method co-citation analysis was performed. To create a significant co-citation network, a minimum citation of 10 was taken, and out of 1348, 35 sources were selected further resulting in the formation of 6 clusters represented by different colors. Figure 8 shows the co-citation analysis of 35 sources. Red color cluster (1) contains 11 journals, and it is the largest cluster with the wide variety and most impactful journals, which include the Journal of Consumer Research, Journal of Marketing Research, Journal of Advertising, Neuropsychologia, etc. Green color cluster (2) contains 9 journals like the Journal of Consumer Psychology, Journal of Islamic Marketing, Nature Reviews Neuroscience, etc. Blue color cluster (3) consists of 6 journals and the most cited journals included in this cluster are journals like Neuroimage, Neuron, Plos one, etc. Yellow color cluster (4) contains 5 journals, and the most cited journals in clusters are the Journal of Advertising Research, Psychophysiology, International Journal of Advertising, etc. Purple color cluster (5) contains 2 journals, and the most cited Journal of advertising followed by the Journal of Advertising Research. Pink color cluster (6) contains 2 journals, and the most cited is journal is Journal of Marketing Research, followed by the Journal of Advertising Research.



Figure 8. The cluster shows the co-citation analysis of the cited sources (source - generated by Vosviewer)

3.5.5 Co-citation analysis of the cited author

Co-citation analyses was performed by using VOSviewer and the minimum citation of an author must be 10 times. Of the 5116 authors, 46 authors met the criteria. Further, the analysis resulted in the formation of three clusters, shown in three different colors. Figure 9 shows the pattern. Cluster 1 (in red color) contains 23 highly cited authors, and it is one of the largest clusters. In this cluster, the most cited author is Plassmann H., with a citation of 29, followed by Kenning P., etc. Green color cluster (2) contains 12 authors. The most cited author in this cluster is Davidson R.J., with a citation of 38, followed by Astolfi L., etc. Blue color cluster (3) contains 11 authors. This cluster includes authors like Vecchio G., Reykowska D., etc.



Figure 9. The cluster shows the co-citation analysis of the cited author (source- generated by Vosviewer)

4. DISCUSSION

The purpose of this research is to gain a comprehensive understanding of the area i.e. neuromarketing in advertising. The findings reveal that neuromarketing has a significant impact on marketing, consumer behavior, and advertising strategies. Many researchers have studied neuromarketing across diverse areas like EEG (electroencephalography), consumer neuroscience, and

TV commercials. The work in interdisciplinary areas has broadened our understanding of how neuromarketing can analyze competitive dynamics in advertising. The study carried out during COVID-19 shifted focus from consumer behavior to how neuromarketing influences decision-making processes, the impact of storytelling in advertisements, and the role of emotions in shaping consumer responses which in all reflects the consumer. This highlights that neuromarketing industry. Neuromarketing in advertisement can go beyond the traditional boundaries providing a sense to the consumer responses and competitive behavior that is revolving in the landscape of advertisement.

The momentum of neuromarketing is growing, especially in the area of advertising. Over the last few years, it has been seen that there has been a sudden pick in the publication since the year 2008, when the researcher shared their publications in the reputed peer-reviewed journals. After analyzing country-wise publications countries like USA, China, Poland, and Bangladesh are at the forefront. On the other hand, countries like India, South Korea, Japan, and France have limited scientific publications in the area, suggesting the available potential for research in this area. This shows an opportunity for growth and exploration in the area of neuromarketing within advertising. Notably, the work of Mooradian (1996) was among the earliest contributions, laying the groundwork for later empirical studies in neuromarketing for advertising. Keyword analysis helps us to reveal the common theme of research flowing among researchers in the field of neuromarketing in advertisement. It indicates that the researchers have worked on themes like neuromarketing, consumer neuroscience, electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and decision-making, and the themes on which the researchers can focus in the future are emotions, advertising effectiveness, pattern recognition, and storytelling. Further researchers have studied neuromarketing across diverse areas like electroencephalography, consumer neuroscience, and TV commercials.

The present study highlighted a few limitations too. Firstly, for the present study, the literature is constrained to the Scopus database and in this study, authors have excluded conference papers, reviews, and book chapters. For future studies, the researcher can expand the sources by accessing several databases. Other than bibliometrix and Vosviewer, future researchers can also use Bib excel, HistCite, Gephi, etc., for analyzing bibliographic data and also for better visualization and comprehensive review.

Further looking ahead, the future scope of study involves further exploration of untapped regions, such as India, South Korea, and Japan, to foster a more global understanding of neuromarketing. Additionally, collaborative efforts among researchers, institutions, and countries can contribute to the continued growth and impact of this interdisciplinary field. The identified clusters and influential authors serve as a roadmap for future research, guiding scholars toward the most relevant areas within neuromarketing in advertising. As technology and methodologies evolve, ongoing research in this domain will undoubtedly enhance our comprehension of consumer behavior, marketing strategies, and the ever-changing landscape of advertising.

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