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MAPPING THE LANDSCAPE OF NEUROMARKETING: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

Aim/Purpose	Neuromarketing transforms marketing by offering deeper insights into consumer behavior and emotions, enabling more effective but challenging marketing practices. Businesses must leverage these insights, adapt strategies, and explore innovative approaches to drive growth. Despite its rapid development, research in this field remains limited and calls for deeper exploration.
Background	Neuromarketing's growing relevance in marketing makes exploring its theoretical foundations and application important. Understanding neuromarketing's intellectual structure is essential to guide businesses in leveraging these insights and adapting their strategies.

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Methodology	The researchers applied VOSviewer and Biblioshiny software to perform a range of examinations, including encircling keyword scrutiny, bibliographic coupling assessment, citation scrutiny, and three-field plot investigation.
Contribution	To fill this knowledge gap, this study examines the intellectual structure of neuromarketing and identifies avenues for future research.
Findings	The identification of seven distinct clusters within the neuromarketing domain is the key outcome of the study, namely "Integration of Neuroscience Techniques in Marketing," "Pervasive Cues in NM," "Modalities in NM," "Boundaries and Frontiers of NM," "NM in practice," "Inferences of NM Data," and "Novel metrics of NM." Future research directions are offered for each of these clusters, followed by a discussion of the consequences for management and research, a conclusion, and an acknowledgment of the study's limitations.
Future Research	Employing cutting-edge tools like VOSviewer and Biblioshiny, the research meticulously scrutinizes the current literature landscape, elucidating prominent patterns and pinpointing promising avenues for future exploration.
Keywords	bibliometric analysis, bibliographic coupling, Biblioshiny, disruption strategies, neuromarketing, VOSviewer

INTRODUCTION

Marketers continually seek fresh methods to understand and anticipate consumer behavior, with neuromarketing emerging as the newest tool in this endeavor. Traditional marketing strategies focus solely on conscious consumer behavior and overlook the unconscious, resulting in a disparity between what consumers say and what they do. This is due to the fact that most consumer behavior occurs subconsciously, which makes it impossible to accurately predict using conventional research techniques (Ducu, 2016).

Neuromarketing provides a more detailed understanding of consumer behavior than traditional market research by using strategies sensitive to consumer behavior, preferences, and trends (Bayle-Tourtoulou & Badoc, 2020). These strategies employ intangible information to gauge a customer's emotions and potential reactions, providing precise insights into consumer behavior by uncovering subconscious insights and brief reactions that people do not remember (Ahmed et al., 2022). This paradigm primarily employs biometric methods such as galvanic skin response (GSR) and eye tracking (ET) (Azman et al., 2019) in addition to neuroimaging modalities like electroencephalography (EEG) and functional magnetic resonance imaging (FMRI) (Srivastava & Bag, 2023).

Although neuromarketing is a relatively new field, there has been a rise in published articles recently, with more than 140 reported by Scopus in 2022 alone. As the field continues to expand, it is important to understand the fragmented disposition of neuromarketing research and its development. To gain a comprehensive understanding of the domain, researchers have employed bibliometric analysis methods that are believed to be unbiased and independent of researcher subjectivity (Baumgartner & Pieters, 2003).

A bibliometric approach is particularly well-suited for gaining a deeper understanding of the neuromarketing field for several compelling reasons. First, it allows for the exploration of the intellectual landscape in the domain by identifying influential authors, countries, institutions, potential collaborations, and networking patterns. Second, it facilitates the identification of prominent research topics by pinpointing clusters within the discipline. Third, employing a bibliometric method that covers 19

years of scholarly investigation on neuromarketing provides valuable perceptions into the progression of the literature, highlighting both matured and emerging areas of this field. Last, in addition to unveiling the present condition, themes, and expansions within the field, bibliometric study facilitates the establishment of foundations for forthcoming research by outlining research gaps and promising avenues for further exploration.

In summary, this comprehensive bibliometric study of 299 articles on neuromarketing represents this domain's first systematic and quantitative examination. The analysis aims to address the subsequent research questions:

RQ1: Which authors, journals, articles, countries, and organizations have made the most significant contributions to the research on neuromarketing and thus can be considered the most dominant in this field?

RQ2: What are the existing research themes in the field of neuromarketing? How can these themes progress in the future? Have their prevalence and significance undergone changes over a period of time?

RQ3: What are the key terms or keywords that dominate neuromarketing research, and how have they evolved over time?

RQ4: What are the potential research areas in neuromarketing for the future?

Thus, the article aims to construct the cognitive framework of the NM domain by comprehending its core knowledge structure. Additionally, it seeks to identify significant content, prolific and highly cited researchers along with their affiliations, and author and journal webs, aiming to promote collaboration among existing and aspiring researchers in the field. Furthermore, the research provides detailed recommendations for forthcoming research to pave the way for further advancements in the ever-evolving nature of the field.

METHODOLOGY

The current study adhered to Donthu et al.'s (2021) suggested approach for conducting bibliometric analysis. Specifically, the study progressed through the following five stages.

STAGE 1: DATA COLLECTION

The Scopus database from Elsevier was utilized for the research. Scopus is a renowned citation and abstract database that comprises significant works from leading scholars and journals (van Eck & Waltman, 2014). At the beginning of 2023, Scopus had integrated over 27,950 journals (about 26,591 of which were peer-reviewed), comprising more than 90.6 million publications (Elsevier, 2023). Scopus was chosen over other popular databases like Web of Science (WoS) and PubMed for several reasons. While both WoS and Scopus offer multidisciplinary exposure, PubMed is primarily focused on life sciences (AlRyalat et al., 2019) and biomedical research. Furthermore, Scopus possesses a wider range than WoS, with more than 26,591 journals compared to WoS's 22,691(Elsevier, 2023; WoS, 2023). After conducting this analysis, the researchers opted to continue utilizing Scopus to collect the data.

STAGE 2: FORMULATING THE SEARCH CRITERIA

The search formula was developed by thoroughly examining the existing literature on neuromarketing. Apart from the widely used keyword "neuromarketing" (N. Lee et al., 2007), other commonly utilized keywords were identified, i.e., "neuro consumer" (Bayle-Tourtoulou & Badoc, 2020) and "neuromarketing." Henceforth, a search query was conducted using the terms "neuromarketing OR neuro AND (marketing OR consumer)."

Stage 3: Collecting and Retrieving the Data

The initial application of the search formula resulted in the identification of 1,392 documents. The researchers did not limit the year of publication, but the subject area of "Business & Management" was specifically focused on limiting the scope of citations in Scopus and leaving 340 documents. To ensure a comprehensive search, book, book chapter, conference paper, and conference review were excluded (Ramos-Rodrígue & Ruíz-Navarro, 2004). After applying exclusion criteria, 316 documents were found. The search was further refined by excluding non-English articles, resulting in 299. Citation particulars, bibliographic facts, abstracts, keywords, plus references for these articles were obtained from Scopus and downloaded in BibTeX format. The process of gathering and selecting literature is summarized in Figure 1.

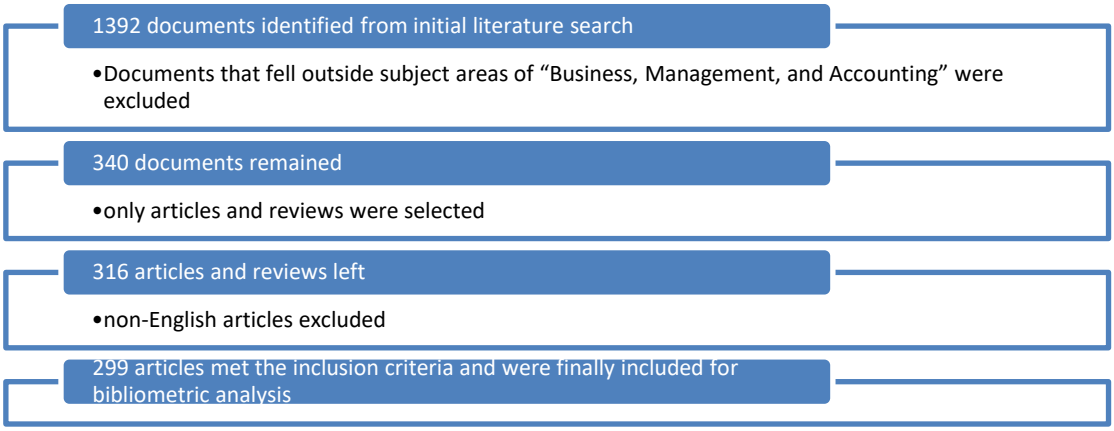

Figure 1. Literature collection and refinement process

Stage 4: Data Analysis

In accordance with the recommendations of Donthu et al. (2021), the present research employed both main and enrichment analyses. The main analyses included performance analysis besides science mapping analyses, while visualization techniques were utilized for enrichment analyses. For the analysis, both Biblioshiny and VOSviewer were utilized. By combining the comprehensive bibliometric techniques provided by Biblioshiny with the network visualization capabilities of VOSviewer, researchers in the field of bibliometrics can effectively harness the strengths of each tool and overcome their individual limitations.

The study employed Biblioshiny and VOSviewer software. VOSviewer helped identify top influential authors, countries, journals, and articles. Keyword analysis via Biblioshiny produced thematic maps, trend matrices, and word clouds.

Stage 5: Identifying Present Trends and Future Research Avenues

To uncover evolving themes and clusters in the field, researchers performed a bibliographic coupling analysis with VOSviewer. These proposed future research directions align with the recommendations by Donthu et al. (2021).

Descriptive information on publications

This analysis reviews the scientific production and citation trends in the neuromarketing (NM) field, focusing on 168 articles. Key findings include the following:

- *Yearly Publication Trends:*
  - Research in neuromarketing began in 2014 with eight articles.

  - Significant growth occurred after 2016, with 36 articles published in that year.
  - 2020 and 2022 saw high publication numbers, with 36 and 42 articles, respectively, demonstrating an annual growth rate of 4.15%.

- *Citation Trends:*
  - Highest average citations per year:
    - 2010: 8.03 citations
    - 2012: 6.75 citations
    - 2009: 5.34 citations
  - The most cited article is by Reimann et al. (2010) (283 citations), followed by Plassmann et al. (2012) (277 citations), and Berns and Moore (2012) (174 citations).

- *Document and Author Interconnections:*
  - Of 155 documents with at least three citations, only 52 were interconnected, suggesting two major influential research pieces.
  - Alsharif et al. (2022) and Duque-Hurtado et al. (2020) are noted as key contributors.
  - Among 282 authors, 123 had at least one document with five citations, author-wise analysis using VOSviewer.
  - Reimann et al. (2010) have the highest citation count, with 283 citations, followed by Plassmann et al. (2012).
  - Seven authors contributed two articles each.
  - Pileliene and Grigaliunaite (2017), despite co-authoring four articles, did not appear in the top 10 due to a combined total of only 60 citations.

This analysis reveals key trends in publication growth, influential authors, and the impact of citations on neuromarketing research.

Within this context, a significant analysis was also conducted to assess the influence of authors using Biblioshiny. As shown in Table 1, the outcomes presented that E-J. Lee had the maximum h-index of five despite having only four articles. On the other hand, although F. Babiloni had the most documents at eight, their h-index was four. This was followed by Boz H, who used four h-indexes and articles. Table 1 incorporates additional details for each author, including the m-index, g-index, and their initial publication year. These supplementary pieces of information provide further insights into the productivity and impact of the authors within the discipline.

Table 1. Author impact analysis

Element	h_index	g_index	m_index	TC	NP	PY_start
LEE EJ	5	5	0.5	98	5	2014
BABILONI F	4	8	0.5	78	8	2016
BOZ H	4	4	0.4	92	4	2014
CHERUBINO P	4	8	0.5	78	8	2016
MAGLIONE AG	4	4	0.5	71	4	2016
MODICA E	4	4	0.5	41	4	2016
ROSSI D	4	6	0.5	44	6	2016
TRETTEL A	4	8	0.5	78	8	2016
CARTOCCI G	3	4	0.375	36	4	2016
DAUGHERTY T	3	3	0.375	68	3	2016

An analysis using VOSviewer was conducted to examine the sources in the domain. This analysis identified eight journals that published at least five articles in the domain with a minimum of ten citations. Further analyses using Biblioshiny provided a deeper insight into sources and their impact. According to the source impact analysis, the *Journal of Business Research* emerged as the leader with the maximum h-index (6), seven articles, and 228 citations. It was trailed by the *European Journal of Marketing* and the *Journal of Advertising Research*, both with an h-index of 4, five documents, and 126 and

111 citations, respectively. The *Journal of Consumer Psychology* ranked fourth with an h-index of 4 and the highest total citations (841).

Table 2 provides supplementary information, including the g-index, m-index, and the year of initial publication for each journal. Furthermore, the investigation of locally cited sources revealed that the *Journal of Marketing Research* received the highest number of citations within the domain, with 287 local citations. *Neuroimage* ranked second with 240 local citations, followed by the *Journal of Consumer Research* with 232 local citations.

Table 2. Source-wise analysis

Element	h_index	g_index	m_index	TC	NP	PY_start
Journal of Business Research	6	7	0.75	228	7	2016
European Journal of Marketing	4	5	0.667	126	5	2018
Journal of Advertising Research	4	5	0.444	111	5	2015
Journal of Consumer Psychology	4	4	0.286	841	4	2010
Journal of Neuroscience, Psychology, And Economics	4	7	0.267	213	7	2009
Journal of Retailing and Consumer Services	4	4	0.571	100	4	2017
Springer Proceedings in Business and Economics	4	8	0.5	79	13	2016
Asia Pacific Journal of Marketing and Logistics	3	6	0.75	40	6	2020
Ethics and Neuromarketing: Implications for Market Research and Business Practice	3	5	0.375	35	12	2016
International Journal of Market Research	3	5	0.167	33	5	2006

Our subsequent analysis aimed to determine the leading countries in the field of neuromarketing (NM) based on citation count. The United States emerged as the top country with 1,302 citations, averaging 50.08 citations per year. The United Kingdom took second place with 405 citations, averaging 23.82 citations per article. France secured the third position with 277 total citations.

Keyword analyses

The theme "neuroscience," on the other hand, has very low supremacy, which indicates that it has few connections to other clusters in the field. The intensity of the connections holding the words in the cluster collectively is referred to as density (Callon et al., 1991). It signifies the theme's resilience and potential for growth within the field over time (Callon et al., 1991; Cobo et al., 2011). According to a thematic map study, "marketing" and "human" are the two themes with the highest density. This illustrates how strongly tethered and connected the terms in these clusters are. Since "neuroscience" and "product design" both have low densities, which indicates a reduced ability to sustain themselves and continued development over time, they may soon vanish from the NM domain.

We can sum up by pointing out that density denotes the "growth" of a theme, while centrality denotes the "importance" of the theme. Based on Figure 2, we can make additional observations that "marketing," "neuromarketing," and "sales" are considered core themes due to their significance and well-established presence (Cobo et al., 2011). Conversely, "neuroscience" falls within the quadrant of emerging or declining themes, as it displays both low centrality and low density, according to Cobo et al. (2011). These themes linked keywords can offer additional evidence of this. Keywords like "event-related potentials," "product-service systems," and "product and services" are present under "product design," indicating that this is a new issue in the field that requires more thought and enhancement. Decisively, it is evident that none of the clusters wholly fall within the fourth quadrant, underscoring a nuanced distribution across the thematic landscape. However, there are indications that

"fuzzy system" and "consumption behavior" partially reside in this quadrant. This suggests that these themes within neuromarketing hold significance in the NM domain but are still evolving and require additional attention from scholars in the field (Cobo et al., 2011).

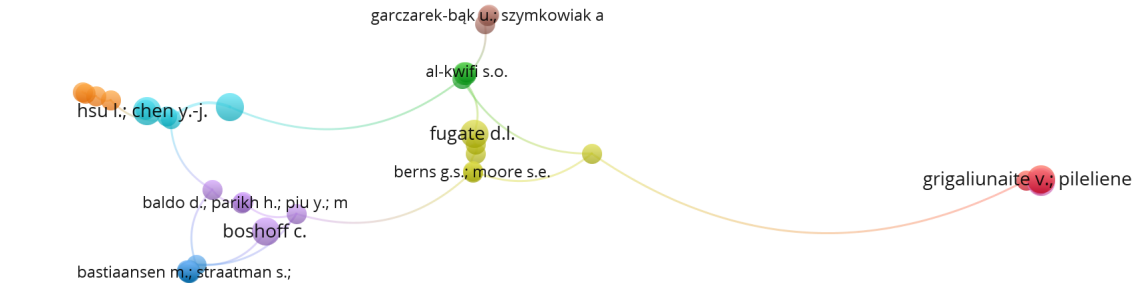

Figure 2. Thematic mapping of neuromarketing: density vs. centrality analysis (Source: Vosviewer)

Three-field plot analysis

Figure 3 illustrates the three-field plot, which presents the relationship among country, keywords, and journals. This visualization is inspired by the commonly used Sankey diagrams (Riehmann et al., 2005). The size of the boxes in the figure corresponds to the frequency of occurrences (Riehmann et al., 2005), indicating that the USA leads with the highest number of publications in the field. Furthermore, scholars from the USA exhibit a higher publishing activity in "neuromarketing," "EEG" "consumer neuroscience," "neuroscience," and "marketing." The primary interest of NM researchers in Italy and Turkey is also "neuromarketing," "emotion," "eye-tracking," and "EEG" while in the Netherlands, NM researchers' favorite theme is "consumer neuroscience." Brazilians are also publishing predominantly on "neuromarketing" and "neuroeconomics," the keywords "neuromarketing," "consumer neuroscience," "EEG," and "marketing" are also prevalent among Indians, whereas for Koreans, it is "purchase intention." Journal-wise, the keywords "NM," "eeg," and "consumer behavior" are well-accepted by the Springer Proceedings for Business and Economics, "NM" and "eye-tracking" are published in "Developments in marketing science: Proceedings of the academy of marketing science," whereas "consumer neuro-science" and "marketing research" is more prevalent in "Ethics and neuro-marketing: Implications for market research and business practice."

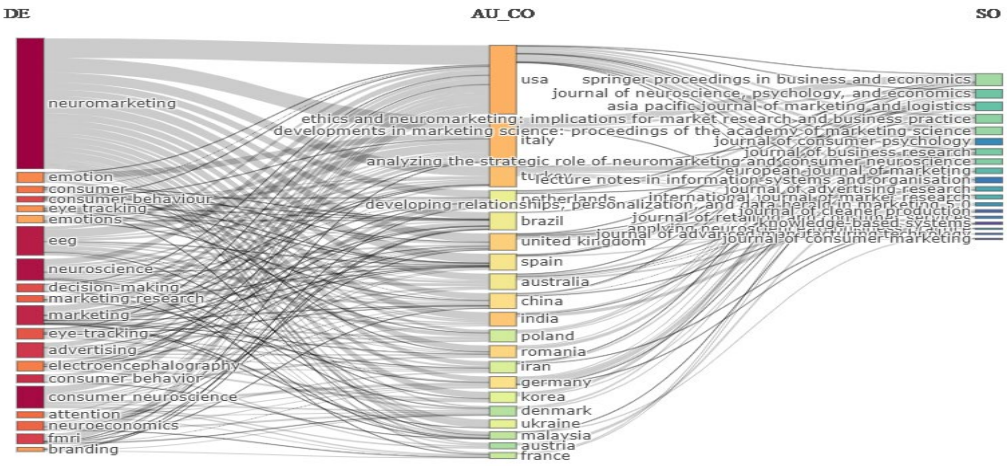

Figure 3. Three-field plot

Bibliographic coupling

To enhance our comprehension of the neuromarketing (NM) domain and its progressing themes, bibliometric coupling analysis was steered using VOSviewer. In this investigation, the unit was set as a "document" (van Eck & Waltman, 2014) using the fractional counting method. At least a citation limit of 30 was chosen, resulting in 44 documents, of which 40 were interconnected (Figure 4). As evident, seven clusters were found. The first cluster was labeled red, stating that nine documents had the theme "Integration of Neuroscience Techniques in Marketing." The next group, distinguished by green color, with seven articles with the theme of "Pervasive Cues in NM," third in blue having a subject of "Modalities in NM," fourth in yellow color with the "Boundaries and Frontiers of NM" theme, fifth with purple and "NM in practice" theme and sixth cluster presents "Inferences of NM data" theme depicted with aqua color and seventh cluster with "Novel metrics of NM" theme is depicted in orange color. (Appendix A presents a comprehensive compilation of papers organized by clusters and their corresponding main findings; Appendix B includes details of authors and tittle.)

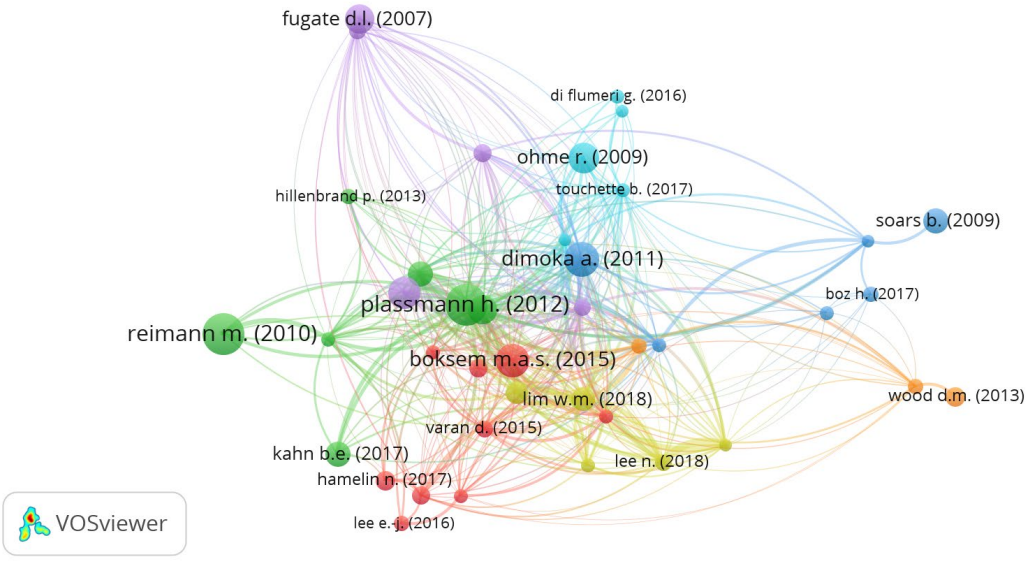

Figure 4. Bibliographic coupling of 40 articles

FUTURE RESEARCH DIRECTIONS

The primary objective of this study was to put forth a set of recommendations for upcoming researchers in the field of NM. For each cluster, we have outlined distinct areas for future research.

CLUSTER 1: INTEGRATION OF NEUROSCIENCE TECHNIQUES IN MARKETING

Future research should focus on how neuroscience can deepen our understanding of consumer behavior beyond the scope of traditional marketing theories. Key research directions include:

- **Contribution of Neuroscience to New Marketing Theories**: How can neuroscience contribute to the development of new theories that existing marketing frameworks do not address? Studies could explore the application of techniques like fMRI and EEG to test alternative hypotheses about consumer behavior and decision-making (Müller-Putz et al., 2021; Pranjal & Lakhawat, 2022).
- **Comparative Neuromarketing Studies**: How do different neuroscience tools, such as fMRI, EEG, and eye-tracking, compare in terms of reliability and insight when applied to neuromarketing? Comparative studies could help identify the most effective methodologies for understanding consumer behavior (Ahmed et al., 2022; Hsu & Cheng., 2018; Nancarrow et al., 2010; Zhang et al., 2022).

CLUSTER 2: PERVASIVE CUES IN NM

Research in this cluster should examine how sensory cues influence consumer decision-making and how these cues can be optimized for better marketing outcomes. Key areas for future exploration include:

- **Optimizing Sensory Cue Integration**: How does the combination of visual, auditory, and olfactory cues impact consumer engagement and emotional responses? Experimental studies should explore different sensory cue combinations to measure their effects on memory, perception, and consumer behavior (Zhang et al., 2022). Exploring the optimal combinations of sensory cues to create immersive and persuasive marketing experiences would be a research priority. This is also mentioned as a research priority as 2.4 in MSI (2022)– how can the use of technology improve or detract from customer experience (MSI, 2022)?
- **Individual Differences and Persuasion Cues**: How do individual characteristics, such as personality traits and cognitive styles, moderate the effectiveness of sensory cues? Future studies could explore how personal attributes affect how consumers respond to multisensory marketing messages (Isabella et al., 2015; Ntapiapis & Özkardeşler, 2020).
- **Ethical Boundaries of Persuasion**: What are the ethical limits of using pervasive sensory cues in advertising? Research should explore the long-term effects of sensory-based persuasion techniques and their impact on consumer autonomy in digital environments (Randolph & Pierquet, 2015), like social media and augmented reality (Byrne et al., 2022).

CLUSTER 3: MODALITIES IN NM

This cluster focuses on the different modalities used in neuromarketing, such as brain imaging and physiological response measurements. Future research should investigate:

- **Cross-Modal Interactions**: How do stimuli from one sensory modality (e.g., visual) influence responses in another (e.g., auditory) (Daugherty et al., 2016; Kalkova et al., 2023; N. Lee et al., 2017; López, 2020; Quiñones, 2022; Soars, 2009)? Studies could explore how visual cues impact auditory judgments during product evaluations (Hilken et al., 2022; Michael et al., 2019; Reimann et al., 2012).

- **Multimodal Neuromarketing**: Can combining multiple modalities (visual, auditory, tactile) offer a more comprehensive understanding of consumer preferences than studying them individually? Research could involve designing multimodal experiments to assess how different sensory inputs influence decision-making (Garczarek-Bąk et al., 2021).

Cluster 4: Boundaries and Frontiers of NM

This cluster examines the ethical considerations and subconscious influences that shape consumer behavior. Future research could explore:

- **Implicit Consumer Decision-Making**: How do subconscious processes affect consumer choices? Research could explore how marketers can ethically leverage implicit, non-conscious influences to shape consumer preferences (Azman et al., 2019).
- **Neurophysiology in Online Consumer Behaviour**: How does consumer neurophysiology differ in online environments compared to traditional retail settings? Studies could examine the emotional and cognitive responses to digital interfaces in e-commerce and mobile apps (Caratù, 2022; Riley & Randolph, 2021; Shaari et al., 2019).
- **Neurofeedback in Marketing**: Can real-time neurofeedback enhance consumer engagement and decision-making? Future studies could test the use of live brain data in personalized advertising and explore how marketers can tailor content based on real-time brain activity (Halkin, 2018).
- **Transdisciplinary Approach and Ethics in Neuromarketing**: How can the integration of neuroscience, psychology, and marketing create more comprehensive insights into consumer behavior? Can this transdisciplinary approach lead to the development of ethical, evidence-based marketing strategies that respect consumer autonomy and build trust?(Krajčovič & Darázs, 2021; Matthews, 2015)

Cluster 5: NM in Practice

This cluster looks at translating neuromarketing insights into practical marketing strategies. Future research could explore:

- **Neuromarketing in Product and Service Design**: How can neuromarketing insights guide product design and advertising strategies? Studies could focus on how neural responses to product prototypes influence design decisions and consumer acceptance (Lugli et al., 2013).
- **Evaluating Neuromarketing Effectiveness**: How effective are neuromarketing techniques in driving consumer engagement and loyalty? Research could investigate the return on investment (ROI) of neuromarketing strategies in terms of sales, brand recognition, and consumer retention (Alsharif et al., 2022; Baldo et al., 2015; Matukin & Ohme, 2016).

Cluster 6: Inferences of NM Data

Interpreting neuromarketing data accurately remains a challenge. Future research could address:

- **Impact of Demographics on Data Interpretation**: How do factors like age, gender, and personality traits influence how consumers react to neuromarketing stimuli? Research should explore how these demographic variables affect the interpretation of brain activity and physiological responses (Priilaid & Horwitz, 2016).
- **Integrating Neuromarketing with Other Data Sources**: How can neuromarketing data be combined with behavioral and demographic data to create a holistic understanding of consumer behavior? Studies could focus on integrating neuromarketing with traditional marketing research methods to provide deeper insights (Pileliene & Grigaliunaite, 2017).

- **Cross-Validation and Replication**: How can researchers ensure the reliability and generalizability of neuromarketing findings? Future studies should emphasize cross-validation and replication to ensure the robustness of neuromarketing insights (Priilaid & Horwitz, 2016).

CLUSTER 7: NOVEL METRICS OF NM

This cluster focuses on the development of new tools and metrics for measuring consumer responses. Future research could explore:

- **Refining Neuroimaging Techniques**: What emerging neuroimaging technologies, like near-infrared spectroscopy (NIRS) or portable EEG, could improve the accuracy of neuromarketing measurements? Research could investigate the potential of these technologies to provide more precise data on consumer engagement (Heinonen, 2018).
- **Developing New Metrics for Consumer Neuroscience**: How can novel metrics be designed to assess neural activity in real-time during consumer interactions? Future research could focus on developing metrics that combine multiple neurological signals (e.g., EEG, eye-tracking) to assess consumer engagement during online shopping or brand interactions (Daugherty et al., 2016).

RESEARCH CONTRIBUTIONS

This study aimed to conduct a comprehensive bibliometric analysis to map the intellectual landscape in neuromarketing systematically. It also sought to pinpoint potential areas for future investigation, guiding researchers in this field. The analysis identifies seven distinct clusters, providing clear directions to enhance research comprehensiveness. Notably, the "Integration of Neuroscience Techniques in Marketing" cluster offers valuable insights for marketers, deepening understanding of consumer behavior and marketing strategy effectiveness. For instance, brands like Campbell's Soup have utilized neuroscience tools, such as EEG and emotional response analysis, to optimize packaging designs by identifying elements that resonate positively with consumers, thereby enhancing the product's market appeal.

Besides, the study makes another significant contribution by identifying research gaps and suggesting potential research directions for all seven themes. This comprises numerous aspects, including exploring various neuroscience methods to understand how the brain processes information, emotions, and motivations, aiding marketers in crafting more effective campaigns. For example, Coca-Cola has employed neuromarketing techniques, such as brainwave monitoring, to analyze emotional responses to advertisements, allowing the company to refine its messaging for stronger consumer impact and brand connection.

Second, understanding varied persuasive cues amid different perspectives and revealing customer segmentation schemes by leveraging subconscious or implicit brain processing to influence consumer perceptions and behaviors. Starbucks effectively uses the aroma of freshly brewed coffee, a subconscious olfactory cue, to create a welcoming environment that strengthens customer loyalty and enhances the overall brand experience.

Third, understanding modalities in NM to measure and interpret the neural and physiological responses. This elaborates that an effective marketing strategy may use eye-tracking, EEG, and fMRI techniques to gain insights into how consumers react to marketing stimuli. For example, a car brand may use eye-tracking technology to analyze how customers are visually interacting with car interiors and may accordingly optimize designs for enhanced user satisfaction and engagement.

Fourth, to comprehend the limitations and emerging areas of study within the field (for researchers and practitioners) to navigate and advance the field of neuromarketing effectively. For example, while techniques like fMRI offer valuable insights into consumer decision-making, they come with challenges, such as high costs and limited real-world applicability. Addressing these limitations has led to

emerging areas like mobile EEG devices, which provide more practical and scalable solutions for studying consumer behavior in natural environments.

Fifth, consider the key areas where NM may be applied, such as advertising, product development, and retail strategies. Brands may use heatmaps generated through neuromarketing techniques to optimize store layouts, directing customer flow toward high-margin products.

Sixth, it helps make interpretations and conclusions based on the neural and physiological responses analysis. For example, biometric data such as heart rate and skin conductance can be used to assess consumer reactions to new product designs during testing phases. This approach helps gauge emotional engagement, enabling refinements that ensure products align with both functional needs and emotional resonance. Last, to explore and develop novel metrics like eye-tracking, EEG, facial coding, and galvanic skin response (GSR) to capture and analyze consumer responses in innovative ways.

The third subsidy of the research is the detection of leading research and data methods for neuromarketing in typical, as well as for each cluster specifically. Among the 40 papers employed for bibliometric analysis, 20 are conceptual, and equally, 20 are empirical, indicating a balanced research landscape in the field. It indicates the presence of a robust research environment in the NM field, where theoretical advancements are grounded in empirical evidence and empirical findings are informed by strong theoretical foundations. In the overall research on NM, a variety of data types have been utilized, including reviews (20 articles), surveys (2 articles), and experiments (12 articles). These findings suggest that researchers in the field have adopted diverse data-gathering and analysis approaches, contributing to a comprehensive understanding of the topic. Out of the numerous papers analyzed, only two have presented a multidisciplinary approach, indicating a need to expand the application of interdisciplinary approaches in the field of NM. Our research contributes by utilizing Biblioshiny, a novel tool that, based on our current understanding and wisdom, has not been previously used for bibliometric analysis research in marketing. With its user-friendly interface and ease of use, this software holds promise as a valuable tool for researchers engaged in bibliometric analysis in the future.

Conclusion and Limitations

The primary goal of the study is to gain insights into the evolving nature of neuromarketing (NM) and suggest potential avenues for future research. The identification of emerging themes in NM from this study can assist researchers in planning future investigations within this field. It is important to acknowledge that, like numerous other studies, this research has few limitations. The bibliometric analysis relies solely on data from Scopus, potentially excluding publications from other databases and introducing biases. Future studies could consider incorporating various databases to mitigate the bias. Due to the novelty of NM as a research area, with only a limited number of papers available before 2008, further studies are needed to comprehend the growing nature of the subject. Given that NM is a rapidly evolving field, longitudinal studies would also be beneficial in analyzing how NM concepts and applications have changed and how they are likely to progress in the coming years. The study primarily relies on quantitative bibliometric analysis, potentially overlooking qualitative aspects like practical applications and ethical concerns of NM. Future research should incorporate qualitative methods, such as interviews or case studies, to explore real-world applications and consumer behavior. Additionally, addressing biases from overrepresentation in specific regions or industries would create a more diverse and accurate view of the neuromarketing landscape. Regardless of these limitations, this review offers a comprehensive overview of the subject and serves as a solid foundation for scholars interested in delving deeper into this topic.

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APPENDIX A: CLUSTER-WISE COMPILATION OF PAPERS

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
1	1	Empirical research: experiment	The research explored using brain event-related potentials (ERPs) to gauge emotional reactions to tourist destination marketing via movies. Participants viewed Bruges and Kyoto images, with one group seeing a positive Bruges movie clip. The "In Bruges" group showed early emotional responses to Bruges, suggesting EEG-based neuromarketing's effectiveness in destination marketing.	59	20	7
	2	Empirical research	The study compared EEG measures to conventional methods in predicting marketing success. Participants watched movie trailers, and EEG data was collected. Findings indicated EEG provided added insight into preferences beyond stated choices alone. It suggests EEG can serve as neural markers for commercial success, enhancing choice behavior prediction models and offering tangible evidence of EEG's link to real-world outcomes.	183	20	28
	3	Exploratory research	The article discusses applying consumer neuroscience methodologies, usually hypothesis-driven, in scientific fields. It cites a dEEG study as an example, aiming to generate new theories. This approach could revolutionize marketing research, bridging academia and practice, and potentially shifting paradigms in both fields.	36	25	17
	4	Empirical experiment	The study utilized GfK-EMO Scan, a facial expression recognition software, to assess the effects of emotional advertising on safe driving attitudes. High emotional ads resulted in significantly stronger and lasting positive attitudes compared to low emotional ones. This underscores the vital role of emotional advertising in shaping safe driving perceptions.	66	8	5
	5	Conceptual	This article offers practical guidance to managers regarding the utilization of these tools for validating existing insights and generating novel insights. It emphasizes that conventional and brain-based approaches should be seen as complements, not alternatives, in recognizing customers.	55	27	13
	6	Empirical experiment	The study found traditional methods ineffective in identifying green consumers. Using brainwave analysis, they found elevated frontal theta activations among green consumers exposed to eco-friendly product messages. This suggests frontal theta as a neural marker of cognitive engagement, outweighing the impact of price information on their processing.	32	20	9

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
	7	Empirical experiment	The paper investigates how CSR initiatives enhance customer equity by reducing price sensitivity and increasing willingness to pay (WTP) through empathy. Study 1, using behavioral and neuromarketing methods, revealed higher theta-band activity in the anterior cingulate cortex (ACC) correlating with increased WTP and positive reactions to pro-social marketing messages, suggesting empathy's pivotal role.	42	4	5
	8	Empirical survey	The study introduces a novel approach to gauge emotional responses to TV commercials using neuromarketing. Combining visual self-reporting scales with fMRI identifies brain responses to emotions at the gyrus level. Researchers stress evaluating advertising by assessing appeal, engagement, and empowerment dimensions of emotion for effective marketing strategies.	34	22	9
	9	Empirical quantitative comparison	The article highlights challenges buyers encounter in selecting neuromarketing techniques for predicting advertising efficacy, given the industry's unclear methodological distinctions among vendors. Analyzing trial results, the authors concluded no universal certainty exists, as diverse approaches yield varied interpretations. They stress transparency and provide a framework for buyers to assess vendors' measures' validity.	49	27	18
2	1	Empirical survey	The article delves into how brand names shape consumer judgments and buying choices.	39	9	4
	2	Conceptual	The article examines how visual design influences consumer reactions to online shopping, particularly as its prevalence grows.	109	8	10
	3	Conceptual	The article examines neuroscience's integration into consumer psychology, extending beyond neuromarketing.			
	4	Empirical experiment	This study links effective product involvement with neural-level aesthetic experiences, offering valuable insights for aesthetics research and product design.	290	7	12
	5	Empirical experiment	Two experiments examined neurophysiological activation, response latency, and brand choice between new and familiar brands.	33	28	23
	6	Conceptual	The article underscores effective segmentation's importance in marketing and advocates for integrating neuroscience with traditional data to deepen understanding of consumer behavior.	108	28	39

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
	7	Conceptual	The article challenges stereotypes in neuromarketing, revealing how mental accounting and planning illusions influence consumer choices differently from marketers' assumptions. It underscores the importance of understanding consumers' decision-making processes, with brain and biometric studies offering novel insights. Conducted by Springer-Verlag Berlin Heidelberg in 2010.	140	32	61
3	1	Empirical experiment	This study examines tourists' understanding of prices, which is crucial for tourism businesses' revenues and profits. Customers' value assessment is influenced by price, emphasizing the importance of understanding tourists' perceptions. Using neuromarketing examples, the study explores how tourists perceive prices in holiday advertisements, considering design, positioning, and content. Its goal is to provide insights into pricing perceptions in the tourism industry.	44	8	2
	2	Conceptual	The paper introduces "NeuroIS" and suggests merging cognitive neuroscience into information systems (IS) research. It outlines seven opportunities for IS researchers to gain insights, like localizing neural correlates of IS constructs. It cites an fMRI study on e-commerce adoption and concludes with the potential for enhancing IS research with cognitive neuroscience theories and imaging tools.	198	27	25
	3	Conceptual	This study introduces psychoneurobiochemistry to investigate consumer/tourist behavior's impact on tourism marketing. It explores psychological, neurological, biological, and chemical findings, focusing on neurotransmitters like serotonin and dopamine, the melatonin hormone, and emotions. By integrating these factors, it proposes a multidisciplinary approach to understand their implications for tourism marketing.	30	10	14
	4	Conceptual	The paper examines the interplay of public policy and marketing regarding consumer privacy, focusing on conflicts between advertisers and consumer needs. It explores privacy concerns, regulatory frameworks like the FTC's, and domains such as direct mail, the Internet, and neuromarketing. Advocating for consistent guidelines, it aims to empower consumer self-protection through self-regulation and legislation in product and informational exchanges.	36	9	2
	5	Conceptual	The paper examines how sensory stimuli improve retail environments and drive sales, discussing neuro-imaging and virtual reality for cost-effective optimization. It emphasizes sustainable, sensory approaches, advocating for understanding shopper needs beyond displays to enhance spending. Relevant to all retail operators.	107	1	2

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
	6	Empirical experiment	The study applies fNIRS in neuromarketing, developing a purchasing behavior model based on fNIRS measurements. Positive decisions correlate with increased neural activity in fronto-polar regions, which is involved in subjective value computation. fNIRS is an effective biomarker, enhancing understanding of purchasing drives in marketing research. It identifies individual differences in consumer behavior, achieving an 85% decoding accuracy.	35	28	18
4	1	Conceptual	The authors offer a comprehensive review of the past decade's neuromarketing research and a visual representation of its typical process. They critique insufficient attention to three aspects: event-based designs, underutilized alternative modalities, and excessive reliance on reverse inference. Addressing these can enhance neuromarketing's introspective nature, positively advancing marketing knowledge, practices, and public perception.	31	25	26
	2	Conceptual	This research evaluates if current neuromarketing literature supports field expansion and aids newcomers in conducting high-quality research. Analyzing 131 papers, findings reveal growing interest but highlight fragmented literature and lack of clear quality guidelines. The authors propose a future agenda to imbue neuromarketing with a stronger scientific purpose, fostering its establishment as a more cohesive field within marketing.	52	30	42
	3	Conceptual	This article conducts a systematic review and thematic analysis of neuromarketing's concept, methods, ethics, and contributions to marketing science. It addresses fundamental questions and identifies opportunities for research expansion, aiming to unleash neuromarketing's potential in advancing marketing theory and practice.	102	33	67
	4	Empirical experiment	This article explores the value of mobile fNIRS in marketing research. It assesses its feasibility in two experiments on brands and labels, measuring prefrontal cortex activity. The study concludes that fNIRS can detect brand-related and label-related prefrontal cortex activation, potentially expanding neuroimaging's usage beyond the lab, thus reducing costs.	38	25	14

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
	5	Conceptual	The article addresses ethical concerns in neuromarketing, arguing that prominent worries about consumer autonomy, privacy, and control are not significant given current practices. However, it highlights potential ethical issues arising from proprietary and opaque research practices. The authors propose steps to mitigate risks and protect consumers, emphasizing neuromarketing's potential positive impact on society, which is often overlooked in ethical discussions.	82	25	30
5	1	Empirical experiment	The paper examines using fMRI to forecast cultural popularity. Brain responses of adolescents listening to unfamiliar music were correlated with song sales over three years. A significant correlation between ventral striatum activity and units sold suggests neural responses can predict cultural popularity.	177	27	15
	2	Exploratory research	The article evaluates neuromarketing perceptions among marketing academics, neurologists, and marketing specialists. All agree neuromarketing isn't manipulative, noting interest, knowledge, awareness, and ethics as key aspects. Neurologists and marketing experts view neuromarketing more favorably than marketing academics.	58	24	17
	3	Conceptual	This research provides a layman's introduction to neuromarketing, covering its origins, process, anecdotal findings, and future research directions. It proposes that integrating neural activity images with traditional marketing tools could enhance effectiveness. Neuromarketing holds the potential to fundamentally reshape product design, promotion, pricing, and packaging.	142	22	17
	4	Conceptual	The paper presents a contemporary approach to consumer decision-making by measuring real-time neural activity in response to marketing stimuli. This methodology offers direct correlations, potentially enhancing service marketers' efficiency, especially with intangible services. Acknowledging limitations in specific examples encourages service marketers to adopt evolving techniques for improved understanding.	47	24	17

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
	5	Conceptual	The research discusses how companies and organizations are turning to neuroscience to understand and change people's behavior. It highlights three key areas: neuroergonomics, neuromarketing, and neurogastronomy. It explains that neuroscience-inspired approaches can offer insights that traditional behavioral methods cannot. However, there are practical issues in association with commercial neuromarketing research, including cost, ethics, and limited ecological validity. Overall, the article emphasizes the potential of neuroscience-inspired approaches to provide valuable insights into human behavior.	46	28	47
6	1	Empirical experiment	The article proposes a new approach to forecasting product performance based on brain data, as self-report and focus group methods are unreliable. A case study on a European shoe store chain revealed that brain scan prediction accuracy reached 80%, compared to 12.1% using self-report methods. Using the new approach, simulations based on sales data indicated an increase in profit by 36.4%, greatly improving brand image & value for organizations, consumers, and shareholders. The article highlights the significance of pre-market forecasting popular in the footwear retailing industry.	31	7	3
	2	Empirical experiment	This study aimed to show that the brain's approach/withdrawal (AW) index, which is closely linked with pleasantness, can be used to determine the pleasantness or no-pleasantness of olfactory stimuli. EEG signals were recorded from 24 healthy and non-smoking participants during the perception of ten different smells, and the AW indexes were compared with the participants' numeric appreciation scores for each odor. The results suggest that EEG signals can be used to assess the pleasantness of odorous substances, which could have applications in marketing research.	36	5	2
	3	Empirical experiment	The article shows how neurophysiology can be beneficial for marketing. In a research case, the authors analyzed two versions of a TV ad for a skincare product and found that a single gesture made a significant difference in consumer reactions. By using electroencephalography, electromyography, and skin conductance, they were able to detect neurophysiological differences even when the variance was not deliberately noticed. The researchers suggest that neurophysiological measures will soon be sourced as a complementary method in traditional marketing research.	156	12	11

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
	4	Empirical experiment	This experiment aimed to explore the neural system of apparel product attractiveness and comparison of consumers' brain responses with self-reported replies. The study discovered a notable distinction in frontal asymmetry between attractive and unattractive apparel products, aligning with Davidson's theory. The authors propose that frontal asymmetry scores can serve as an effective measure for assessing consumers' unconscious responses to the attractiveness of apparel products.	35	32	19
	5	Conceptual	This paper discusses the potential for using neuroscientific methods in the service field and provides a roadmap for incorporating neuro-tools into service research. The authors highlight the limited usage of neuro-tools in the service field despite their potential to advance service research. They specify a summary of the most significant neuro-tools and their theoretical and empirical value and discuss promising areas for neuroscientific input in service research, such as service experience and servicescape. The objective of this paper is to promote the adoption of neuro-tools among service researchers and demonstrate their complementary nature alongside traditional research methods. Additionally, it aims to assist reviewers and editors in evaluating the quality of neuro-studies in the service field more effectively.	31	26	34
7	1	Conceptual	This paper discusses the use of neuroscience in business and management practices, specifically focusing on neuromarketing, which applies brain imaging or measurement technology to understanding consumer responses for marketing. The authors argue that neuromarketing technologies can expose and portray a specific sort of consumer, highlighting a contrast between what consumers say they prefer and what is shown through the application of these technologies. This contrast structure shapes assessments of neuromarketing's effectiveness and the associated accountability relations.	45	20	8
	2	Conceptual	This research delves into neuromarketing, merging neuroscience, neuroeconomics, and marketing to enhance strategies and boost sales. Despite its potential, concerns over ethical issues like privacy invasion and consumer manipulation have sparked public protests. The paper assesses neurotechnology's current capabilities and limitations, addressing ethical concerns and advocating for open dialogue, adherence to ethical principles, and regulatory oversight to safeguard against harm and protect consumer rights and privacy.	41	22	22

Cluster No.	S.No.	Article type	Synopsis of the main idea	Citations	Links	Total link strength
	3	Conceptual	This study examines "brandscapes" in neoliberal capitalism, amalgamating marketing, urbanism, technology, and surveillance. Brandscapes imbue consumers with experiential qualities, shaping desires and interconnections through sophisticated marketing. Consumers serve as constant data sources, exploited yet captivated. Brandscapes also act as heavily monitored security domains, promoting safety and risk-free living yet facing challenges from alternative security and computing visions.	63	1	2

APPENDIX B: CLUSTER WISE DETAILS OF AUTHORS AND TITLE

Cluster No.	S.No.	Author	Title
1	1	(Bastiaansen et al., 2018)	My destination in your brain: A novel neuromarketing approach for evaluating the effectiveness of destination marketing
	2	(Boksem & Smidts, 2015)	Brain responses to movie trailers predict individual preferences for movies and their population-wide commercial success
	3	(Daugherty et al., 2016)	Research in reverse: Ad testing using an inductive consumer neuroscience approach
	4	(Hamelin et al., 2017)	Emotion and advertising effectiveness: A novel facial expression analysis approach
	5	(M. Hsu, 2017)	Neuromarketing: Inside the Mind of the Consumer
	6	(E.-J. Lee et al., 2014)	The Spell of Green: Can Frontal EEG Activations Identify Green Consumers?
	7	(E.-J. Lee, 2016)	Empathy can increase customer equity related to pro-social brands
	8	(Shen & Morris, 2016)	Decoding neural responses to emotion in television commercials: An integrative study of self-reporting and fMRI measures
	9	(Varan et al., 2015)	How reliable are neuromarketers' measures of advertising effectiveness: Data from ongoing research holds no common truth among vendors
2	1	(Hillenbrand et al., 2013)	Better branding: Brand names can influence consumer choice
	2	(Kahn, 2017)	Using Visual Design to Improve Customer Perceptions of Online Assortments
	3	(Plassmann et al., 2012)	Branding the brain: A critical review and outlook
	4	(Reimann et al., 2010)	Aesthetic package design: A behavioral, neural, and psychological investigation
	5	(Reimann et al., 2012)	Novel versus familiar brands: An analysis of neurophysiology, response latency, and choice
	6	(Venkatraman et al., 2012)	New scanner data for brand marketers: How neuroscience can help better understand differences in brand preferences
	7	(Zurawicki, 2010)	Neuromarketing: Exploring the brain of the consumer
3	1	(Boz et al., 2017)	Neuromarketing aspect of tourısm pricing psychology
	2	(Dimoka et al., 2011)	NeuroIS: The potential of cognitive neuroscience for information systems research
	3	(Koc & Boz, 2014)	Psychoneurobiochemistry of tourism marketing
	4	(Rapp et al., 2009)	Advertising and consumer privacy: Old practices and new challenges
	5	(Soars, 2009)	Driving sales through shoppers' sense of sound, sight, smell and touch
	6	(Çakir et al., 2018)	An investigation of the neural correlates of purchase behavior through fNIRS

4	1	(N. Lee et al., 2017)	This is your brain on neuromarketing: reflections on a decade of research
	2	(N. Lee et al., 2018)	Welcome to the jungle! The neuromarketing literature through the eyes of a newcomer
	3	(Lim, 2018)	Demystifying neuromarketing
	4	(Meyerding & Mehlhose, 2020)	Can neuromarketing add value to the traditional marketing research? An exemplary experiment with functional near-infrared spectroscopy (fNIRS)
	5	(Stanton et al., 2017)	Neuromarketing: Ethical Implications of its Use and Potential Misuse
5	1	(Berns & Moore, 2012)	A neural predictor of cultural popularity
	2	(Eser et al., 2011)	Perceptions of marketing academics, neurologists, and marketing professionals about neuromarketing
	3	(Fugate, 2007)	Neuromarketing: A layman's look at neuroscience and its potential application to marketing practice
	4	(Fugate, 2008)	Marketing services more effectively with neuromarketing research: A look into the future
	5	(Spence, 2019)	Neuroscience-Inspired Design: From Academic Neuromarketing to Commercially Relevant Research
6	1	(Baldo et al., 2015)	Brain Waves Predict Success of New Fashion Products: A Practical Application for the Footwear Retailing Industry
	2	(Di Flumeri et al., 2016)	EEG Frontal Asymmetry Related to Pleasantness of Olfactory Stimuli in Young Subjects
	3	(Ohme et al., 2009)	Analysis of Neurophysiological Reactions to Advertising Stimuli by Means of EEG and Galvanic Skin Response Measures
	4	(Touchette & Lee, 2017)	Measuring Neural Responses to Apparel Product Attractiveness: An Application of Frontal Asymmetry Theory
	5	(Verhulst et al., 2019)	Neuroscience in service research: an overview and discussion of its possibilities
7	1	(Schneider & Woolgar, 2012)	Technologies of ironic revelation: Enacting consumers in neuromarkets
	2	(Ulman et al., 2015)	Ethical Issues in Neuromarketing: “I Consume, Therefore I am!”
	3	(Wood & Ball, 2013)	Brandscapes of control? Surveillance, marketing and the co-construction of subjectivity and space in neo-liberal capitalism

AUTHORS

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