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Trends and Evolution of Neuromarketing research in understanding consumer behavior: A Bibliometric Analysis

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ABSTRACT

This study performs a bibliometric analysis to delineate the patterns and progress of neuromarketing research from 2000 to 2023. The study finds significant themes, including "consumer behavior," "neuromarketing," and the integration of emerging technologies such as artificial intelligence and machine learning, through the analysis of papers indexed in Scopus. The results indicate robust international cooperation, especially among nations such as the United States, India, and Spain. The research underscores the transition from conventional methods to sophisticated neuroimaging techniques and accentuates the increasing significance of technology in comprehending consumer behavior. The analysis offers significant insights into the field's evolution; however, its reach is confined to Scopus-indexed articles. Future research could broaden this scope by incorporating industry-focused studies or qualitative content analyses. The results provide actionable insights for marketers and researchers seeking to implement neuromarketing methods to enhance marketing efforts.

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1. INTRODUCTION

In modern marketing research, comprehending consumer behavior has become a complex task that transcends self-report questionnaires and focus groups. As competitive pressures escalate, companies pursue more profound and intricate insights into consumer information processing, stimulus reactions, and purchasing decision-making. In this context, neuromarketing—utilizing neuroscience, psychology, and behavioral economics—has emerged as a potential domain. Neuromarketing fundamentally seeks to reveal hidden mechanisms, emotional reactions, and brain indicators that drive explicit consumer decisions. Recent bibliometric analyses indicate significant growth in the discipline over the past decade [1].

Traditionally, marketing research predominantly depended on self-reported metrics of attitude, intention, and recollection, wherein customers were queried about their thoughts, feelings, or intended actions. Despite their value, these approaches encounter intrinsic limitations: social desirability bias, insufficient introspection, and the incapacity to record real-time brain or physiological responses [2]. The advent of neuromarketing instruments—such as EEG (electroencephalography), eye tracking, facial coding, galvanic skin reaction, and functional magnetic resonance imaging—has enabled a more nuanced examination of attentional,

affective, and cognitive responses. For instance, eye-tracking can identify which components of a retail display attract attention, whereas EEG may indicate the moments when a consumer's brain activity reaches its zenith in involvement [3] [2].

Moreover, consumer behavior research has progressively recognized the influence of non-conscious processing, emotional arousal, and brain priming on decision-making. Consequently, neuromarketing is not merely a technological enhancement; it signifies a fundamental transformation in the understanding of the purchase choice, which is anchored in cerebral processes rather than solely in conscious reasoning. Researchers contend that the amalgamation of neuroscience and marketing facilitates a more profound understanding of how marketing stimuli (advertising, branding, packaging, price) influence customer responses at both explicit and implicit levels [4], [5].

The academic field of neuromarketing has experienced significant expansion and diversification. Several bibliometric analyses have delineated publishing trends, co-authorship networks, citation patterns, and thematic groupings within neuromarketing research. A recent analysis analyzing literature from 2000 to 2023 identified considerable increases in publications, indicating robust interest from both academia and industry [6]. This mapping illustrates not only an increase in volume but also a transition in subjects—from initial investigations (e.g., method establishment) to applications across many industries (e.g., retail, advertising, food selection) and nascent technologies (e.g., machine learning utilized on EEG data). This trend signifies that neuromarketing research is advancing, although also getting increasingly intricate and interdisciplinary [5].

The motivation for employing bibliometric methods in this domain is many. Bibliometrics enables the systematic quantification of research outputs, including publication counts, citation impact, author partnerships, nation contributions, and keyword co-occurrences [7]. Secondly, through the visualization of intellectual maps and clusters, researchers can discern prevailing themes, nascent frontiers, and knowledge deficiencies. This is especially advantageous for neuromarketing, as the area encompasses various disciplines (marketing, neuroscience, cognitive science, data analytics) and consequently gains from a meta-analysis of its framework [8]. A bibliometric analysis utilized techniques like Biblioshiny and CiteSpace to delineate the intellectual framework of neuromarketing research among Scopus-indexed papers [9]. , AI analytics) and the increasing interest in consumer neuroscience, a contemporary and thorough bibliometric analysis can offer an insightful overview of trends, developments, focal points, and opportunities within the neuromarketing-consumer behavior relationship.

Despite the expanding literature on neuromarketing and its role in elucidating consumer behavior, a disjointed and fragmented knowledge base persists, characterized by diverse methodologies, disciplinary underpinnings, nomenclature, and inconsistent thematic emphasis. Although some bibliometric studies have been undertaken, many either encompass restricted time periods or concentrate on certain sectors of the literature. Consequently, academics and practitioners encounter difficulties in acquiring a comprehensive, current overview of the evolution of neuromarketing research, the prevailing themes, the most significant nations or authors, and the potential developing research frontiers. In the absence of such a synthesis, efforts may be redundant, gaps may go unrecognized, and emerging researchers may find it challenging to situate their research within the dynamic context.

This study intends to provide an extensive bibliometric analysis of neuromarketing research within the framework of consumer behavior. The objectives are to chart the temporal progression of publications; to identify prominent authors, institutions, and countries; to elucidate co-authorship and co-citation networks; to ascertain dominant

thematic clusters and emerging keywords; and to underscore research gaps and future directions for both academic and practitioner audiences.

2. RESEARCH METHODS

This study utilizes bibliometric analysis to investigate the trends and devel opment of neuromarketing research within the framework of consumer behavior. Bibliometrics is a quantitative approach e mployed to examine the structure, de velopment, and influence of scientific literature through the analysis of publishing trends, citation frequencies, author collaborations, and keyword co-occurrences. The research commences by delineating an extensive dataset of neuromarketing publications sourced from the Scopus data base, recognized as one of the most substantial and credible repositories for academic inquiry [7]. The collection comprises articles, conference papers, review s, and books published from 2000 to 2023, offering a comprehensive account of the field's evolution. The search terms derive from a synthesis of keywords including "neuromarketing," "consumer behavior," "neuroscience," and associated terminology. A final compilation of pertinent documents is assembled for study after excluding irrelevant or non-peer-reviewed sources.

This study employs various bibliometric tools, such as VOSviewer and Biblioshiny, to visualize and analyze the d ataset. VOSviewer is utilized to generate network maps that depict co-authorship and co-citation relationships across authors, institutions, and nations [10]. This facilitates t he identification of major authors, institutions, and geographical clusters of research activity. Biblioshiny facilitates an in-depth examination of publication patterns, citation impact, and temporal term co-occurrence [11]. These instruments facilitate the identification of prevailing research themes, nascent ideas, and changes in the emphasis of neuromarketing studies. The research does a citation analysis to identify th e most impactful papers, authors, and jour nals in the field of neuromarketing literature [6].

The approach ultimately concentrates on identifying theme clusters in the research through keyword co-occurrence analysis. T his facilitates the recognition of notable trends and the progression of essential subjects in neuromarketing, including the utilization of advanced technologies such as EEG, eye-tracking, and fMRI, alongside the implementation of neuromarketing insights i n domains like advertising, branding, and consumer decision-making [9]. The paper examines the evolution of methodological techniques in the sector, focusing on the increasing use of machine learning and AI in the analysis of customer reactions. This study elucidates the chronological evolution of research themes, enhancing comprehension of neuromarketing's progression and offering insights into prospective research avenues.

3. RESULTS AND DISCUSSION

3.1 Network Visualization

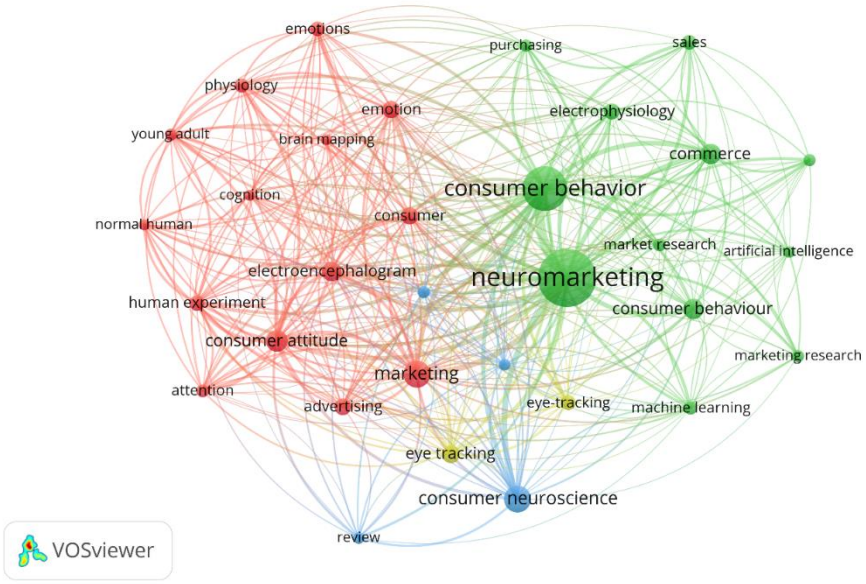

Figure 1. Network Visualization
Source: Data Analysis Result, 2025

The graphic depicts a bibliometric network map created with VOSviewer, illustrating the relationships among different phrases in the domain of neuromarketing r esearch. The map illustrates the connections and clusters among essential concepts, demonstrating the dynamic interdisciplinary character of neuromarketing as it merges with marketing and neuroscience. The network is categorized by color into distinct thematic clusters according to shared co-occurrence of the phrases.

The predominant cluster in the ne twork is depicted in green and encompasses key terms such as "consumer behavior," "neuromarketing," and "marketing research." This signifies that these concepts are profoundly interrelated and constitute the foundation of neuromarketing research. The green cluster signifies the increasing interest in comprehending customer behavior throu gh a neuroscience lens, highlighting the application of neuromarketing in market research and sales environments. Essential phrases in this cluster encompass "market research," "artificial intelligence," and "consumer behavior," highlighting the grow ing significance of AI in evaluating consumer reactions.

Next to the green cluster, we identify the red cluster, which emphasizes emotional responses and physiological dimensions of consumer behavior. Terminology such as "emotion," "emotions," and "electrophysiolo gy" prevails in this field, indicating a substantial corpus of study exploring the neurological and emotional foundations of consumer decision-making. The terms "consumer attitude" and "advertising" underscore the significance of emotional engagement in marketing methods designed to shape consumer perceptions of products and brands.

The blue part of the map features the terms "consumer neuroscience," "electroencephalogram," and "eye-tracking." This cluster emphasizes the techniques utilized in neuromarketing, including EEG and eye-tracking, which are progressively adopted to assess consumer responses in real-time. These strategies enable researchers to comprehend attentional mechanisms and emotional responses that are not consistently recorded by conventional self-report methods. The significance of "attention" and "human experiment" suggests that experimen tal research employing neuroimaging methods is essential for the advancement of neuromarketing as a field.

Finally, the yellow region of the map emphasizes the technological progress in n euromarketing, particularly the use of m

achine learning and other computational methodologies. Terms such as "machine learning," "review," and "eye tracking" signify an increasing dependence on sophisticated data analytics for the interpretation of intricate neurophysiological data. The presence of phrases such as "market research" and "sales" in this cluster reflects the growing significance of these technologies in enhancing marketing strategies and forecasting customer behavior via extensive data analysis.

The map offers a thorough overview of the interrelations among concepts in neuromarketing, highlighting the methodological variety and the extent of interdisciplinary involvement in the subject. It highlights the transformation of ne uromarketing from a specialized study domain to a fundamental component in comprehending and forecasting consumer behavior, with substantial implications for advertising, market research, and business strategy.

3.2 Overlay Visualization

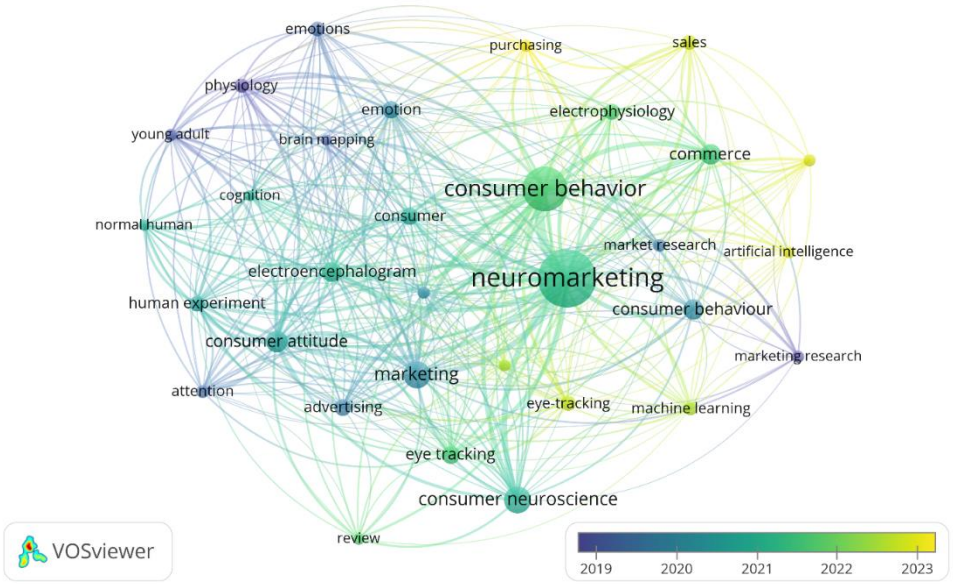

Figure 2. Overlay Visualization

Source: Data Analysis Result, 2025

The graphic illustrates a bibliometric network map produced by VOSviewer, emp hasizing the historical progression of neuromarketing research from 2019 to 2023. The nodes are distinguished by color according to publication year, with a gradient indicating the temporal range from blue (2019) to yellow (2023). The fundamental principles of "neuromarketing" and "consumer behavior" persistently demonstrate their significance throughout time in the sector. Recent trends indicate a rising convergence of neuromarketing, consumer behavior, and emerging techno logies, including artificial intelligence and machine learning, underscoring the expanding significance of these technologies in neuromarketing research.

The map indicates a change in the di stribution of study topics over time. In the initial years (2019-2020), research concentrated mostly on foundational domains such as "consumer attitude," "advertising," and "marketing." The regions depicted in darker blue correspond to recognized neuromarketing techniques, including EEG, eye-tracking, and electrophysiology. From 2021 to 2023, the study focus has broadened to encompass advanced methodologies, particu larly "machine learning," "artificial int

elligence," and their use in elucidating "consumer neuroscience."This transformation is seen in the progressive change from blue to green and yellow hues surrounding terms such as "eye-tracking" and "market research" signifying an increase in their academic focus and research utilization.

Moreover, the overlay map d emonstrates that phrases such as "purchasing," "sales," and "commerce" have attained greater popularity in recent years. This advancement corresponds with the increasing interest in the commercial use of neuromarketing methodologies. Terminology such as "market research" and "consumer behavior" has broadened its interc onnections, highlighting the growing interdisciplinary character of neurom arketing, where marketing tactics, behavioral science, and neurotechnologies converge. Thi s overall transition signifies a developing discipline, emphasizing the use of neuromar keting insights in practical business scenarios, alongside an expanding corpus of research investigating how neuroscience might enhanc e consumer purchasing behavior and mar keting tactics.

3.3 Citation Analysis

Neuromarketing has garnered consid erable academic interest in recent decades as scholars investigate the convergence of ne urobiology and consumer behavior. This nascent field employs neurophysiological methods, including EEG, fMRI, and eye-tracking, to assess and evaluate consumer reactions to marketing stimuli. Comprehen ding the brain's processing of information concerning customer decisions, preferences, and attitudes has resulted in a more profound understanding of how marketing methods might affect purchase behavior. The subse quent table presents a compilation of significant studies in neuromarketing, e ncompassing pivotal papers that have shaped the discipline.

Table 1. Top Cited Research

Citations	Authors and year	Title
529	Lee, N., Broderick, A.J., Chamberlain, L.	What is 'neuromarketing'? A discussion and agenda for future research
367	Morin, C.	Neuromarketing: The New Science of Consumer Behavior
214	Yadava, M., Kumar, P., Saini, R., Roy, P.P., Prosad Dogra, D.	Analysis of EEG signals and its application to neuromarketing
192	Fugate, D.L.	Neuromarketing: A layman's look at neuroscience and its potential application to marketing practice
191	Zurawicki, L.	Neuromarketing: Exploring the brain of the consumer
168	Fisher, C.E., Chin, L., Klitzman, R.	Defining neuromarketing: Practices and professional challenges
149	Stanton, S.J., Sinnott-Armstrong, W., Huettel, S.A.	Neuromarketing: Ethical Implications of its Use and Potential Misuse
147	Aldayel, M., Ykhlef, M., Al-Nafjan, A.	Deep learning for EEG-based preference classification in neuromarketing
141	Golnar-Nik, P., Farashi, S., Safari, M.-S.	The application of EEG power for the prediction and interpretation of consumer decision-making: A neuromarketing study
139	Cherubino, P., Martinez-Levy, A.C., Caratù, M., ... Mancini, M., Trettel, A.	Consumer behaviour through the eyes of neurophysiological measures: State-of-the-art and future trends

Source: Scopus, 2025

The table above emphasizes foundational works and extensively cited papers in the field of neuro marketing. The researchers and their investigations have greatly enhanced the com prehension of consumer behavior via

neuroscientific techniques [12]. Provided a seminal discourse on the notion of neuromarketing, delineating its possibilities and proposing avenues for subsequent research. [13]. Research serves as a fundamental reference, elucidating the evol ution of neuromarketing and its influence on marketing practices. Recent works, like [14] and [15]. have investigated the application of advanced deep learning techniques with EEG signals to identify customer preferences and f orecast decision-making processes. These research demonstrate the advancing sophistic ation of neuromarketing methodologies, ama lgamating artificial intelligence and machine learning with conventional neuroimaging instruments. The steady increase in citations and the variety of research subjects, from ethical considerations [16] to the utilization of neurophysiological metrics [17], exemplify the expanding scope and potential applica tions of neuromarketing in comprehending and shaping consumer behavior.

3.4 Density Visualization

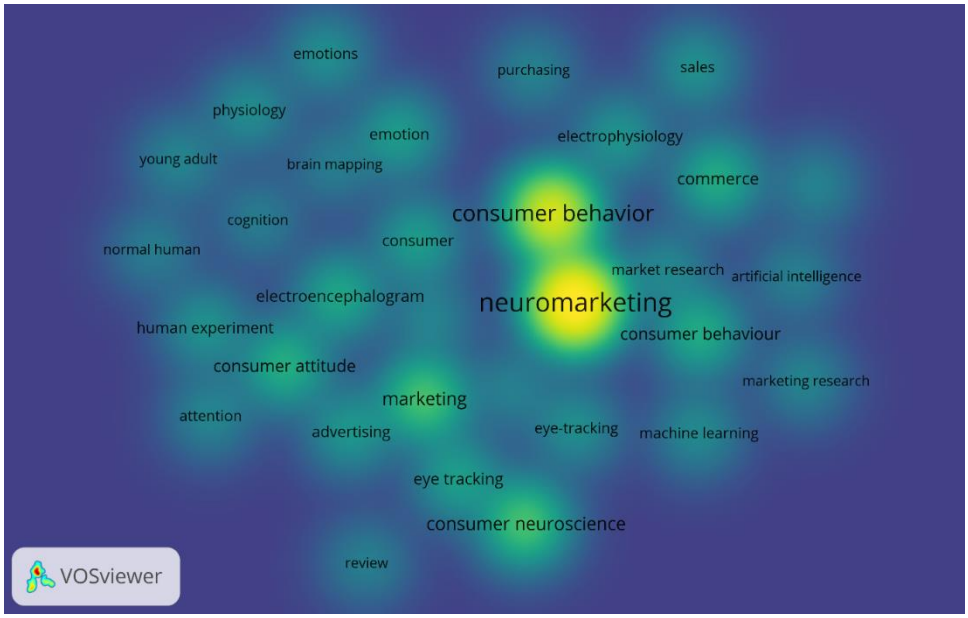

Figure 3. Density Visualization

Source: Data Analysis Result, 2025

The figure above presents a density map produced using VOSviewer, illustrating the concentration of phrases pertinent to neuromarketing research. The regions shown in yellow and green denote the highest density, signifying the most commonly occurring phrases within the literature. At the map's center, "neuromarketing" and " consumer behavior" are the predominant terms, indicating the field's primary emphas is. The closeness of other significant phrases like "consumer behavior," "marketing," and "consumer neuroscience" highlights the interrelation of these topics. The primary focus indicates that neuromarketing has devel oped into an essential framework for comprehending consumer behavior through neuroscientific perspectives, particularly in its application to marketing techniques. The map additionally emphasizes burgeoning areas of interest, like "artificial intelligence," "machine learning," and "eye-tracking," which are progressively being incorporated into neuromarketing research. These phrases are located in areas of intermediate density, signifying an expanding corpus of study that investigates advanced technology for analyzing consumer responses. Terms such as "advertising," "consumer attitude," and "electrophysiology" denote conventional neuromarketing techniques, whereas the inclusion of "sales," "purchasing," and "commerce" indicates a transition towards the pragmatic, commercial utilization of neu

romarketing insights in the market. This density map effectively illustrates the ev olution of the field, emphasizing the convergence of neuroscience, technology, and practical marketing applications.

3.5 Co-Authorship Network

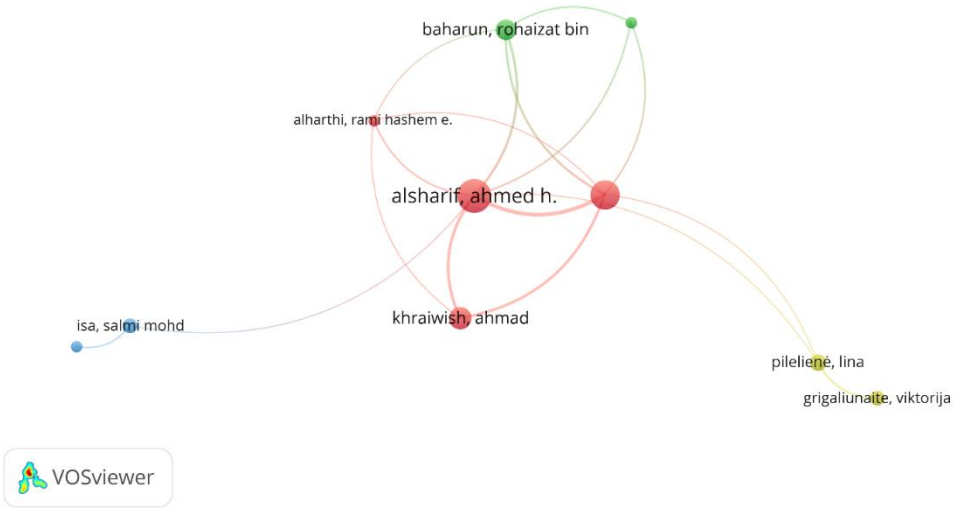

Figure 4. Author Visualization
Source: Data Analysis Result, 2025

The illustration depicts a co-authorship network diagram rendered with VOSviewer. The nodes on the map represent writers who have collaborated on research, with the size of each node reflecting the freque ncy or quantity of partnerships. The connections between the nodes signify co-authorship relationships, while the hue of the connections denotes the intensity of th ose associations, with warmer hues (such as red) signifying more frequent collaborations. The map prominently features Ahmed H. Alsharif, who is linked to numerous authors, indicating a pattern of regular collaboration. Authors Rami Hashem Alharthi and Ahmad Khraiwish are intimately associated with Alsharif, evidenced by numerous collabo rative research outputs, as indicated by the prominent red linkages. Conversely, Rohazat Bin Baharun emerges as a more contemporary associate, as evidenced by their green node and lighter links to Alsharif and others. Furthermore, authors such as Isa Salmi Mohd, Viktorija Grigaliunaite, and Lina Pilelienė exhibit limited collaborations, as indicated by their smaller nodes and weaker affiliations with the primary author group. This network underscores the collaborative research environment, accentuating Alsharif's pivotal role within this cohort of authors.

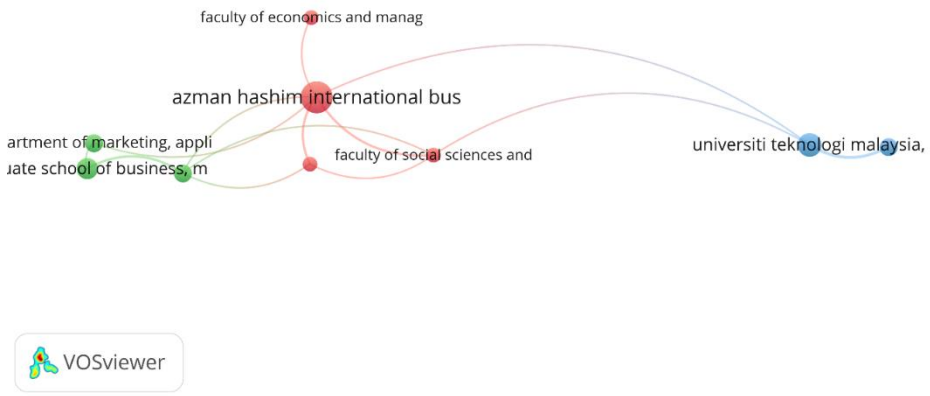

Figure 5. Affiliation Visualization
Source: Data Analysis Result, 2025

The figure illustrates a co-affiliation network map created with VOSviewer, where the nodes signify different academic institutions and departments, while the connections between them denote sha red affiliations or partnerships. The primary entity is Azman Hashim International Business, presumably a department or research unit, which maintains robust conn ections with many other institutions, including the Faculty of Economics and Management and the Faculty of Social Sciences and Humanities. The red nodes indicate that these departments are significa ntly engaged with Azman Hashim International Business, suggesting regular partnerships or common research outputs.

On the opposite side of the map, the Universiti Teknologi Malaysia node is linked to other departments, albeit with weaker connections indicated in blue, implying infrequent or limited partnerships. The green nodes, including the Department of Mar keting and Graduate School of Business, exemplify the extensive network of linkages, with certain institutions intimately associated with others, indicating a collaborative academic atmosphere. The differing node siz es signify the level of centrality or significance of each institution inside the network. The map illustrates a network of academic connect ions across universities, with Azman Hashim International Business at the core, interacting with several faculties and research units throughout the region.

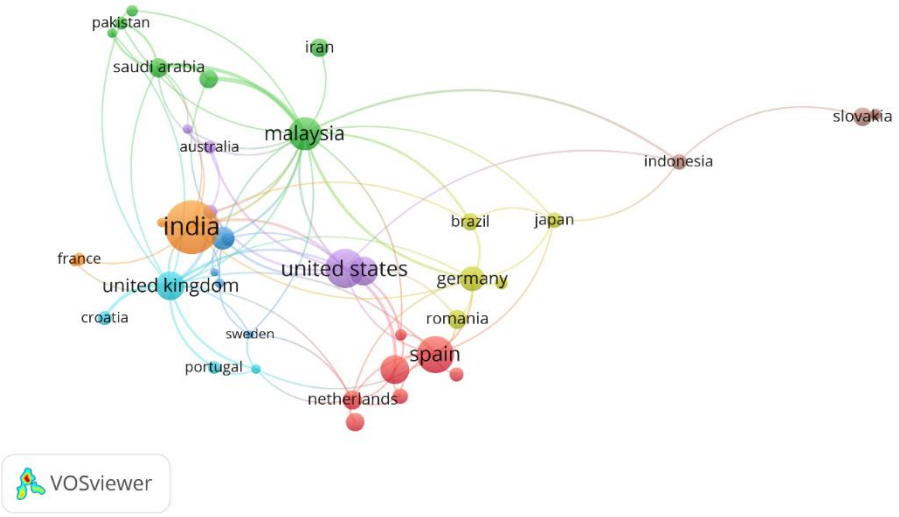

Figure 6. Country Visualization
Source: Data Analysis Result, 2025

The graphic depicts a co-authorship network map representing the countries engaged in neuromarketing research. Each n ode signifies a country, while the links illus trate collaborative relationships or shared research outcomes. The nodes are color-coded, with each hue denoting a distinct cluster of countries that are significantly interconnected. India (orange) occupies a central position inside one cluster, indicating that a substantial amount of the research is either conducted by Indian scholars or sign ificantly includes partnerships with Indian institutions. Likewise, Malaysia (green) emerges as a pivotal node, signifying robust connections to other nations in Asia and b eyond, underscoring its prominence in the domain of neuromarketing. The United States (purple), United Kingdom (blue), and Spain (red) constitute a significant cluster, undersc oring the international scope of neuromarketing research. Spain, with its numerous connections to other European countries such as Portugal and Germany, serves as a pivotal node in this network, indicating a significant degree of research acti vity within the European framework. Countries in the periphery, such as Slovakia, Croatia, and France, exhibit diminished connectivity, as seen by their smaller dimensions and weaker affiliations. The map illustrates a robust global network, including important research centers in Asia, Europe, and North America, which underscores the international collaboration propelling the advancement of neuromarketing as a discipline.

Discussion

Practical Implications

The findings from this study have significant practical implications for both academics and industry professionals working in neuromarketing and related fields. By mapping the evolution and current state of neuromarketing research, this study provides key insights for marketing practitio ners seeking to better understand consumer behavior through neuroscientific techniques. The identification of dominant themes such as consumer behavior, artificial intelligence, and neuroimaging techniques highlights areas where businesses can leverage emerging technologies to optimize marketing strategies. For example, insights from studies involving eye-tracking and EEG could be applied to refine advertising and branding techniques, enhancing consumer engagement and conv ersion rates. Furthermore, the study provides an understanding of the collaborative networks across various regions, helping fir ms identify key academic partners and

potential research collaborations that can foster innovation in the application of neuromarketing in real-world business c ontexts.

Theoretical Contribution

This study contributes to the theoret ical understanding of neuromarketing by providing a comprehensive overview of the evolution of research in the field, as well as highlighting emerging trends, methods, and interdisciplinary connections. By ut ilizing a bibliometric approach, the study not only traces the historical development of neuromarketing but also uncovers the shifting focus from foundational neuroscience methods to the integration of new technolog ies such as artificial intelligence and machine learning. This broadens the theoretical framework of neuromarketing by demonstrating how neuroscience, technology, and marketing theory intersect to inform consumer behavior models. The identification of key research themes and methodologies offers scholars a foundation for future research and theory development, particularly in areas where neuromarketing intersects with behavioral economics, consumer psychology, and data analytics. Limitations Despite its contributions, this study has several limitations. First, the bibliometric analysis is limited to publications indexed in the Scopus database, which may not capture all relevant literature, particularly articles published in less widely indexed journals or conference proceedings. This may introduce bias, as emerging research in certain regions or niche areas of neuromarketing mi ght not be fully represented. Second, while the study maps the temporal evolution and collaborative networks within neuromarketing, it does not provide in-depth qualitative analysis of the content or the specif ic methodologies employed in the studies. Future research could extend this by conducting a content analysis of the studies to examine in more detail the methodological advancements and how different research methods impact the outcomes and applications in neuromarketing. Lastly, this study focuses primarily on academic publications, and it would benefit from inclu ding insights from industry reports or practitioner-driven research, which could provide a more balanced view of the field's pr actical applications.

4. CONCLUSION

This paper presents a thorough biblio metric analysis of neuromarketing, emphasizing its development, principal issues, and international collaboration trends from 2000 to 2023. By delineating the network of research papers, it elucidates the centrality of fundamental ideas such as "neuromark eting," "consumer behavior," and "marketing research," which constitute the bedrock of the discipline. The escalating incorporation of modern technology, including artificial intell igence, machine learning, and neuroimaging methods such as EEG and eye-tracking, signif ies the advancing complexity of neuroma rketing research. These advances are swiftly transforming how firms comprehend and interact with customer behavior, highlighting the necessity for marketers to adjust to these emerging technologies to remain competitive in an increasingly data-centric industry. The study illustrates the international scope of neuromarketing research, highlighting robust collaboration connections among countries including the United States, India, and Spain. This global network emphasizes the signific ance of transnational academic partnerships, which enrich the scope and depth of research in neuromarketing and aid in the formulation of more holistic, culturally pertinent marketing tactics. Nonetheless, the analysis indicates that certain regions and nations exhibit diminished representation, implying potential for expansion in these domains.

This study enhances awareness of the area; yet, its dependence on Scopus-indexed publications constrains its reach, as significant works in niche journals or new research may be inadequately represented. Subsequent research may build upon this study by integrating non-indexed sources or by performing qualitative studies to examine the methodology and theoretical frameworks more comprehensively. Additionally,

industry-centric research might be incorporated to enhance comprehension of the practical application of academic ideas. This study establishes a basis for further investigation into the convergence of neuroscience, marketing, and consumer beh avior, offering significant insights for b oth scholars and practitioners seeking to utilize neuromarketing in practical contexts.

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