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Mapping the consumer mind: A bibliometric-LDA review of neuromarketing's past, present, and future in consumer behavior

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ABSTRACT

This review uses an integrated bibliometric-LDA analysis of 341 publications (2008–2025) to summarize two decades of neuromarketing research within the domain of consumer behavior. The bibliometric mapping shows an exponential increase in publications after 2015 with a thematic shift from fundamental cognitive neuroscience to the incorporation of machine learning and artificial intelligence for predictive consumer analytics. Latent Dirichlet Allocation is used to identify five dominant and cohesive research streams: (1) Eco-Neural Analytics which uses EEG to decipher subconscious drivers of sustainable consumption (2) The Visual Gaze which integrates eye-tracking and neural metrics in digital branding (3) Cognitive Foundations which synthesizes theoretical and review-based literature (4) Neural Intelligence which uses AI to predict consumer choice in real-time from brain signals and (5) Behavioral Neuro-Nexus which connects neuroscientific methods with traditional marketing research. The results show how an emerging multidisciplinary field is moving from laboratory observation to intelligent predictive and ecologically valid applications. By filling in important gaps in theoretical integration and practical application this structured taxonomy offers a unified framework to direct future studies at the intersection of consumer behavior neuroscience and intelligent marketing systems.

Introduction

Conventional marketing research focuses on behavioral and economic theories, including surveys, focus groups, and observational studies to obtain direct input from consumers regarding their purchasing decisions. Nonetheless, scientific research indicates that around 95 % of consumer decisions occur at a subconscious level. A notable discrepancy between stated preferences and actual behavior has compelled marketing researchers and practitioners to seek more objective measurements, coinciding with the advent of neuroscientific methodologies and instruments in consumer behavior research. The advent of neuromarketing, defined by the utilization of neuroscience instruments and techniques to gather data on attention, emotional reactions, facial recognition, and other factors in response to both dynamic and static stimuli, represents a significant progression in the objective evaluation of the brain's impact on consumer decision-making (Zeng & Lobo Marques, 2024). The historical methodological approaches of neuromarketing demonstrate considerable advancements in cognitive neuroscience and neuroimaging technologies. In the early 2000s, Knutson et al. (2007) and McClure et al. (2004) conducted pioneering fMRI studies on brand preference and perception, where the discipline has rapidly expanded to incorporate and integrate many forms of neuroimaging, biometric measurement instruments, and more sophisticated machine learning techniques for precise and validated signal classification and prediction .

Recently, neuromarketing research employs various methodologies, including neurometric techniques such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and functional near-infrared spectroscopy (fNIRS). Biometric metrics, including eye tracking, galvanic skin response (GSR), and heart rate variability, are utilized alongside psychometric evaluations to integrate data sources, enabling experimental analysis of consumer reactions to diverse static and dynamic stimuli (Agrawal et al., 2025). Consumer preferences emerge from the complex interaction of various neural systems: the

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Table 1
Summary of theoretical background and current state of neuromarketing literature.

Theoretical domain and key concepts	Core Findings	Key References
Dual-Process theory – System 1 vs System 2	Emotional responses dominate low-involvement purchases, beta PSD in frontal regions correlates with advertisement favourability, and dlPFC activation for complex decisions.	Kahneman & Tversky, 1979; Kenning & Plassmann, 2008; Gupta & Laishram, 2025
Subjective Valuation (vmPFC) – Hedonic-Symbolic integration, and the brand identity alignment in preference formation	vmPFC activates for preferred brands, and integrates hedonic benefits with consumer identity during selection.	Rangel et al., 2008; Plassmann et al., 2008; Reimann et al., 2011
Cognitive Load and Engagement – Inverted-U model of stimulus complexity and memory retention	Moderate cognitive load enhances memory, alpha desychrnoization and P300 amplitude indicate engagement, and frontal theta surges signal overload.	Kalaganis et al., 2025; Zhang et al., 2025; García-Madariaga et al., 2020
EEG – Spectral power analysis (Theta, Beta, Alpha bands), and ERP components (P300, N400, P2)	High temporal resolution, P300 indicates attention necessity, and deep learning achieves over 90 % accuracy in EEG-based preference prediction.	Klimesch, 1999; Stasi et al., 2022; Hakim et al., 2023
Neuroimaging (fMRI) – Blood oxygenation level mapping, and spatial resolution of brain activity	Medial orbitofrontal cortex indicates brand preference, anterior insula signals price fairness assessment, and nucleus accumbens denotes reward anticipation.	McClure et al., 2004; Sanfey et al., 2003; Knutson et al., 2007
Eye-tracking and Multi-modal integration – Triangulation of visual attention, emotional arousal, and cerebral engagement	Eye-tracking combined with EEG or GSR (Galvanic Skin Response) provides ecological validity, and brand familiarity drives prolonged fixations.	Alsharif & Isa, 2025; Lyu et al., 2025; Wedel & Pieters, 2008
AI and Machine Learning in Neuromarketing – CNN (convolutional neural networks) and LSTM (long-short term memory) for neural signal classification, and real-time predictive analytics	Artificial intelligence transforms neuromarketing from descriptive to predictive, and standardized protocols remain underdeveloped.	Shamshiri et al., 2019; Aldayel et al., 2020; Alsharif et al., 2025

limbic-reward system (ventromedial prefrontal cortex [vmPFC], nucleus accumbens, striatum) evaluates pleasure and establishes preferences; the dorsolateral prefrontal cortex (dlPFC) supports reasoning, value assessment, and impulse control; the anterior insula processes emotions and physical sensations; and other brain regions aid in memory retrieval, language comprehension, and social cognition (Bashar et al., 2024a).

Kahneman's dual-process theory distinguishes between rapid, intuitive thinking (System 1) and deliberate, effortful reasoning (System 2). This concept is supported by neurological studies that differentiate between limbic-driven, emotion-based automatic cognition and prefrontal-regulated cognition. Neuromarketing research has established this distinction by examining neural responses to marketing stimuli that elicit either instinctive emotional reactions, indicated by amygdala and insula activation, elevated galvanic skin response (GSR), and pupillary dilation, or intentional cognitive processing, denoted by dlPFC and posterior cingulate cortex activation, increased theta power, and diminished eye movement velocity.

Recent neuromarketing findings indicate that System 1 emotional responses often dominate customer decision-making, particularly in low-involvement purchases and rapid retail environments. For instance, studies utilizing EEG to monitor native advertising revealed a significant correlation between the cultivation of a favorable attitude towards advertising and the beta wave power spectral density (PSD) in the frontal region of the brain. This indicates that emotional involvement, rather than comprehension, is the key factor in the efficacy of advertising. In contrast, complex product categories and critical decisions need active activation of the dlPFC, evidenced by increased alpha and theta activity, indicating engagement in working memory and valuation processes (Zhang et al., 2022). This neurobiological evidence challenges traditional marketing theories based on rational data integration, hence supporting neuromarketing's core assertion: unconscious insights yield a more accurate prediction of consumer behavior than self-reported data.

The ventromedial prefrontal cortex (vmPFC) is crucial for subjective valuation. It associates hedonic benefits with symbolic significances and with products that align with the consumer's identity during selection (Plassmann et al., 2008). In neuromarketing fMRI studies, the vmPFC exhibits activation when subjects are presented with preferred familiar brands.

Complementing fMRI findings, EEG studies indicate that love advertisements (eliciting tension, affection, and reflection) generate smooth wave activity with a progressive increase, indicating activation in the medial prefrontal cortex. Excitement advertisements, conversely, elicit rapid dopamine responses in the left anterior region of the brain, manifested as elevated peaks and high-frequency waves. These different neural signals have different effects on advertising. Advertisements that are loving to create long-lasting connections with the audience that can last for years. On the other hand, exciting advertisements only create short-lived moments of interest and excitement. They don't build relationships over time, which makes it harder to keep a customer's attention for a long time.

Neuromarketing studies increasingly reveal that subjective cognitive demand; the mental effort required to interpret marketing stimuli; serves as a reliable indicator of customer engagement and recall . Eye-tracking in conjunction with EEG demonstrates that successful advertisement designs incorporate dynamic elements (animation, color contrast, spatial transitions) to moderately elevate cognitive load, hence enhancing memory retention without inducing overload (Zhang et al., 2025). Neural mechanisms include alpha band desynchronization (indicative of attentional engagement) and increased P300 amplitude (signifying thorough stimulus evaluation), achieving optimal performance at moderate complexity, when the brain functions efficiently rather than under stress. Excessive complexity can lead to cognitive overload, seen by frontal theta surges and diminished activation in the prefrontal cortex, resulting in a loss of interest. This quantifiable inverted-U relationship provides marketers with verifiable signs that transcend their subjective perceptions.

Functional magnetic resonance imaging (fMRI) measures cerebral blood oxygenation levels, reflecting localized blood flow in specific areas and providing accurate spatial resolution (3 mm) of extensive brain activity (Smidts et al., 2014). Fundamental neuromarketing research, especially studies utilizing fMRI, demonstrates that specific brain regions are associated with various consumer actions or preferences, as shown by the activity of the medial orbitofrontal cortex indicating brand preference (McClure et al., 2004). The activity of the anterior insula signifies the assessment of price fairness, while the activity of the nucleus accumbens denotes the expectation of product-cue rewards (Knutson et al., 2007).

EEG captures electrical potentials at the scalp that represent the synchronized activity of cortical neurons. It possesses an exceptional temporal resolution (about milliseconds) and is more economical (ranging from $1000 to $50,000 per system). Neuromarketing EEG studies predominantly examine spectral power fluctuations across frequency bands: theta (4–7 Hz, indicative of working memory and emotional processing), alpha (8–12 Hz, denoting attention and emotional valence), and beta (13–30 Hz, reflecting active processing

and motor planning).

EEG-derived event-related potentials (ERPs), which are time-locked averages of EEG responses to specific stimuli, have demonstrated components pertinent to marketing. The P300 waveform (300–400 ms post-stimulus) indicates the necessity of attention to the stimulus, the N400 (400 ms post-stimulus) signifies inconsistency with meaning or concept, and the P2 (200–250 ms post-stimulus) reflects early attentional allocation to the stimulus. Recent developments in neuromarketing utilize deep learning architectures, including convolutional neural networks (CNNs) and long short-term memory (LSTM) networks, to directly analyze consumer preferences from raw EEG signals, attaining classification accuracies surpassing 90 % in preference prediction models.

Neuromarketing research combines eye-tracking with concurrent electroencephalography (EEG) and galvanic skin response (GSR) evaluations to triangulate visual attention patterns, emotional arousal, and cerebral engagement as depicted in following Table 1. This results in complex insights into consumer responses (Alsharif & Isa, 2025). Employed eye-tracking to evaluate visual attention to football stadium naming rights sponsorships, demonstrating that Coca-Cola brand overlays elicited prolonged fixations and reduced saccadic latencies in both European and Chinese youth groups, compared to equally prominent technology brands. This disparity arose from Coca-Cola's extensive history of sponsoring sporting events. Eye-tracking offers numerous advantages, including its non-invasive nature, affordability (with systems priced below $5000), compatibility with other modalities, capacity for objective attention measurement, superior temporal resolution (exceeding 100 Hz), and greater ecological validity compared to fMRI, rendering it highly beneficial for marketing purposes.

Despite much neuromarketing research over the past two decades, significant gaps persist in both scientific understanding and practical application. A bibliometric analysis of 96 neuromarketing publications from 2005 to 2024 indicates a concentration on advertising, products, brands, pricing, websites, and associated subjects, marked by limited theoretical integration and inadequate investigation of the synergistic influences of emotional and cognitive factors on consumer behavior across various cultural contexts (Zeng & Lobo Marques, 2024).

Several prior systematic and bibliometric studies have attempted to map the neuromarketing landscape, though each exhibits notable limitations. Alsharif et al. (2021) conducted a bibliometric analysis of neuromarketing publication from 2015 to 2020 which restricted their scope to five years and did not employ topic modeling, resulting in descriptive rather than thematic synthesis. Cherubino et al. (2019) reviewed the effectiveness of neuromarketing techniques but focused narrowly on methodology without integrating emerging artificial intelligence and machine learning applications. Lee et al. (2007) conceptualized a framework for neuromarketing; however, their work predates the field's computational turn and does not account for the potential growth in EEG-based and deep learning approaches. Most recently, Alsharif et al. (2025) examined the synergy between artificial intelligence and neuromarketing, concentrating on narrative synthesis rather than data driven bibliometric-LDA approach. Critics argue that the development of marketing practice and theory is insufficient compared to the ongoing progress in neuroscience and the neurological processes influencing consumer decision-making (Hackett & Foxall, 2017).

The incorporation of artificial intelligence (AI) and machine learning (ML) for real-time neuro-data analysis represents a nascent domain; nevertheless, standardized protocols for experimental design, data collection, and analysis remain inadequately established due to numerous challenges, including restricted frequency and the substantial expenses linked to neuroscientific instruments for extensive and longitudinal studies (Alsharif et al., 2025). This study aims to address three critical shortcomings in neuromarketing literature: the lack of a comprehensive theoretical integration of neuroscience discoveries with consumer behavior theories, the gap between the accuracy of neuroscientific methods and their practical marketing implementations, and the need for multifaceted methodological approaches that account for the interaction between conscious and unconscious neural processes.

The present study addresses these shortcomings by combining bibliometric mapping with LDA topic modeling across a broader temporal window (2008–2025) and a large corpus (341 publications), thereby providing a more comprehensive, reproducible, and thematically nuanced analysis, revealing publication trajectories, influential authors, thematic clusters, and emergent research fronts that narrative reviews alone cannot capture (Donthu et al., 2021; Zupic & Čater, 2015). Integrating Latent Dirichlet Allocation (LDA) topic modeling moves beyond surface-level keyword analysis to uncover latent thematic structures within the corpus, enabling the identification of dominant intellectual streams and under-explored intersections (Blei et al., 2003), where the rapid proliferation of studies demands a structured synthesis to guide future inquiries in this multidisciplinary field as neuromarketing spanning marketing, neuroscience, psychology, computer science and artificial intelligence.

The review therefore offers three key contributions. First, it provides a comprehensive intellectual map of neuromarketing research from 2008 to 2025. Second, through LDA-derived thematic analysis, it presents a five-pillar taxonomy through Eco-Neural analytics, visual gaze, cognitive foundations, neural intelligence, and behavioral neuro-nexus, that organizes the fragmented literature into a coherent framework and highlights underexplored research frontiers. Third, by explicitly mapping the intersection of artificial intelligence, machine learning, and neuroscience within consumer behavior research, the study provides a forward-looking roadmap that addresses both theoretical integration and practical application gaps equipping researchers and practitioners with actionable directions fro advancing the field.

Research objective and contribution

In response to the identified gaps namely, the lack of theoretical integration, the translational gap between neuroscience and practice and the need for multifaceted methodologies this study has the following primary objective: To map the intellectual structure and thematic evolution of neuromarketing research specifically as it applies to the understanding and prediction of consumer behavior. To achieve this, we employ an integrated bibliometric and Latent Dirichlet Allocation (LDA) analysis. This approach allows us to:

1 *Quantitatively analyze the growth, key contributors, and influential works in consumer-focused neuromarketing.*
2 *Identify and characterize the dominant, latent research themes that have shaped this sub-field.*
3 *Synthesize these findings into a unified framework that bridges neuroscientific theory with consumer behavior applications, providing clear pathways for future research.*

By maintaining this explicit focus on consumer behavior, we ensure our search strategy, analytical lens and concluding implications are targeted and coherent.

Methodology

This study employs a multi-methodological approach for evaluating the current state and forecasting future research trajectories of applications in consumer behavior and decision-making as shown in Table 2. The research design integrates bibliometric mapping and the Latent Dirichlet Allocation (LDA) topic modelling framework. This dual method allows for a macro-level understanding of publication trends alongside a micro-level thematic synthesis of underlying theoretical and operational landscape.

Search strategy and screening protocol

This review adopted the PRISMA 2020 (Preferred Reporting Items

Table 2
The systematic research methodology process.

Step	Purpose	Tools	Key Activity	Outcome
1. Data Extraction	Identify relevant neuromarketing literature applied to consumer behavior.	Scopus	Boolean search and metadata download	Initial dataset of 573 documents
2. Data Cleaning	Ensure high-relevance and quality	Excel / Manual	Removal of non-English/technical-only papers	Refined dataset of 341 documents
3. Bibliometric Analysis	Map scientific productivity and trends	Biblioshiny (R)	Analysis of citations, authors, and journals	Snapshot of research productivity and influence
4. LDA based Topic Modelling Analysis	Identification of dominant topics/ themes and subthemes	Python / Excel	Topics extraction using LDA method to establish the core topics in the neuromarketing and consumer behaviour.	Identification of research topics and structured future directions

Source: Authors' conception (2026).

for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and replicability (Pesovski et al., 2022). The literature search was executed on November 25, 2025, using the Scopus database. Scopus was selected due to its extensive coverage of peer-reviewed journals and its recognized strength in indexing interdisciplinary research spanning social sciences, management and technology, which is central to the neuromarketing field (Wasiq et al., 2024).

Search string

The following Boolean string was applied to the TITLE-ABS-KEY fields of the scopus search engine to capture literature at the intersection of neuromarketing techniques and core consumer behavior constructs:

("neuromarketing" OR "consumer neuroscience" OR "neuro-marketing" OR "EEG" OR "fMRI" OR "eye tracking" OR "biometrics" OR "neurophysiological" OR "implicit measures" OR "brain imaging") AND ("consumer behavior" OR "consumer behaviour" OR "purchase intention" OR "brand engagement" OR "customer experience" OR "advertising" OR "decision making")

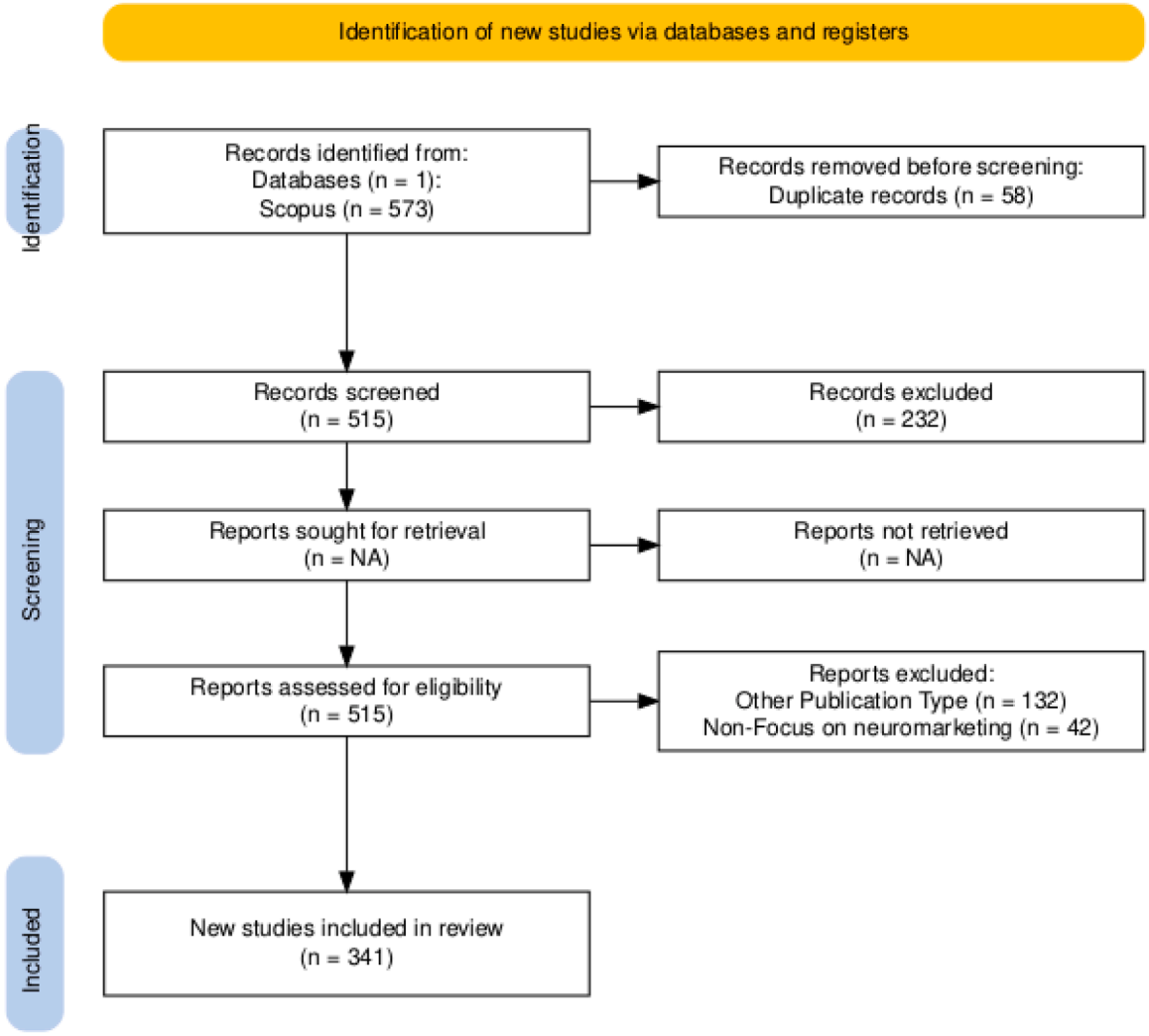

Fig. 1. PRISMA 2020 flow diagram for the identification, screening, and inclusion of studies in the bibliometric-LDA review.
Source: Authors' conception (2026).

While this string includes general marketing terms (e.g., "marketing", "advertising"), it is designed to capture the application of neuromarketing techniques to core consumer behavior constructs such as "consumer behavior", "purchase intention", "brand engagement" and "customer experience." The broad marketing terms ensure we capture interdisciplinary work published in marketing journals, while the neuromarketing and consumer behavior terms focus the corpus on our specific objective

Inclusion and exclusion criteria

To ensure the relevance and quality of the dataset, the following criteria were applied:

- **Inclusion Criteria:** (1) Peer-reviewed journal articles or conference proceedings (2) Primary focus on applying neuromarketing techniques (e.g., EEG, fMRI, eye-tracking) to study consumer behavior, decision-making or related psychological processes (3) Published between January 2008 and November 2025 (4) Written in English.
- **Exclusion Criteria:** (1) Publications where neuromarketing methods were not the primary research tool (e.g., purely survey-based studies) (2) Technical papers focused solely on hardware/algorithm development without a clear consumer research application (3) Non-primary literature (editorials, notes, errata, book reviews).

Screening procedure

The screening process followed the PRISMA 2020 flow diagram (Fig. 1). The initial search yielded 573 records. After removing 58 duplicate documents, 515 records underwent title and abstract screening. Of these, 132 were excluded for not meeting the inclusion criteria (e.g., off-topic, other publication type). The remaining 383 full-text documents were assessed for eligibility. A further 42 were excluded primarily for lacking a substantive focus on consumer behavior (e.g., clinical neuroscience studies). Thus, the final dataset for analysis consisted of 341 publications.

Analytical procedures

The data was extracted from the Scopus database using the specified Boolean keyword combinations. Scopus was selected due to its extensive coverage of peer-reviewed journals and robustness in social science research (Bashar et al., 2024b). The search returned 573 articles published between 2008 and November 25, 2025. After applying the screening protocol, the final dataset consisted of 341 publications meeting all inclusion criteria.

Bibliometric analysis

Bibliometric analysis was conducted using the Bibliometrix R-package and its Biblioshiny interface. This tool facilitates the quantitative analysis of large bibliographic datasets. We analyzed metrics including annual publication trends, most prolific authors and institutions, citation networks, and keyword co-occurrence to map the field's productivity and intellectual structure (Rabbani et al., 2022).

LDA based topic modelling

To uncover the latent thematic structure within the corpus, we employed LDA topic modeling, an unsupervised probabilistic model. LDA treats each document as a mixture of topics and each topic as a distribution over words (Wasiq et al., 2023). The analysis was performed on the titles, abstracts, and keywords of the 341 publications. The optimal number of topics (k=5) was determined by maximizing the coherence score. This data-driven approach minimizes subjective bias in theme identification and reveals the dominant research streams within consumer-focused neuromarkaking literature.

Table 3
Descriptive characteristics of bibliometric dataset.

Description	Results
Timespan	2008:2025
Sources (Journals, Books, etc)	170
Documents	341
Document Average Age	4.88
Average citations per doc	17.44
References	2344
Keywords Plus (ID)	1276
Author's Keywords (DE)	775
Authors	1000
Authors of single-authored docs	22
Single-authored docs	25
Co-Authors per Doc	3.78
International co-authorships %	29.62
Article	191
Book Chapter	47
Conference Paper	74
Review	29

Source: Authors' analysis based on Scopus data (2026).

Analysis and results

Before presenting our findings, it is important to contextualize this study within existing systematic reviews of neuromarketing. Previous bibliometric analyses have made valuable contributions to mapping the field. For instance, Alsharif et al. (2021) conducted a bibliometric review covering 2016–2020 that has identified key journals and trending keywords but focusing on a limited five-year timeframe. Similarly, a review by (Lobo Marques et al., 2025) analyzed 96 publications but was constrained by a relatively small sample size, potentially missing emerging thematic nuances. A common shortcoming across these studies is their reliance on bibliometric mapping alone, which excels at identifying productivity metrics (authors, journals, citations) but often falls short of uncovering the latent thematic structure and intellectual relationships within the literature (Wasiq et al., 2023). This study addresses these gaps by integrating bibliometric analysis with Latent Dirichlet Allocation (LDA) topic modeling. While bibliometrics reveals the "where" and "who" of research, LDA uncovers the "what" the underlying, coherent research streams that may not be apparent through co-citation or keyword analysis alone (Blei et al., 2003). This integrated approach provides both a macro-level view of the field's evolution and a micro-level, data-driven synthesis of its core intellectual themes, offering a more comprehensive framework than previous reviews.

Bibliometric analysis

Data characteristics

Table 3 presents the descriptive characteristics of the final analytical corpus of 341 publications on neuromarketing in consumer behavior, consistent with established bibliometric reporting standards.

The dataset comprises publications between 2008 and 2025 and has a total of 341 documents taken from 170 sources including books and conference papers. The average age of the documents is approximately 4.88 years, and they also have a median of approximately 17.44 citations. There are 2344 references, 1276 Keywords Plus, and 775 author keywords with many topics covered. There are 1000 authors with 25 papers that only contain one author (authored by 22 different authors), with an average number of 3.78 co-authors for each document. International co-authors account for about 29.62 % of co-authorships. The document types are well balanced, consisting of 191 articles, 47 book chapters, 74 papers presented at conferences, and 29 review articles. Overall, it reflects rapid growth and inter-disciplinary studies in neuromarketing, which will pave the way for trend analysis.

Annual publications and citations trends

Fig. 2 illustrates the annual publication output and corresponding

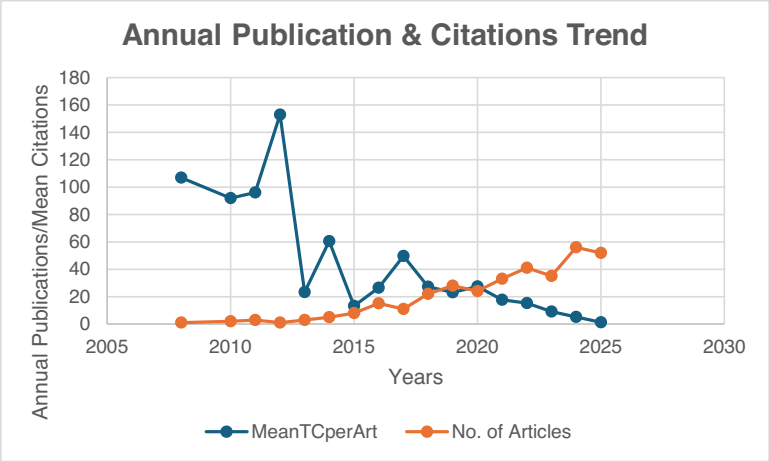

Fig. 2. Annual publication and citations trend.
Source: Authors' analysis based on Scopus data (2026)

Table 4
Prominent authors by productivity and impact metrics.

Based on no. of paper		Based on h-index		Based on Total Citations	
Author	No. of Papers	Author	h-index	Author	Citations
Alsharif Ahmed H.	8	Alsharif Ahmed H.	7	Huettel Scott A.	307
Berčík Jakub	8	Salleh Nor Zafir Md	6	Dogra Debi Prosad	286
Anwar Syed Ferhat	8	Berčík Jakub	5	Kumar Pradeep	286
Mamun Khondaker A.	8	Anwar Syed Ferhat	4	Roy Partha Pratim	286
Mashrur Fazla Rabbi	8	Mamun Khondaker A.	4	Davis Fred D.	252
Miya Mohammad Tohidul Islam	8	Mashrur Fazla Rabbi	4	Dimoka Angelika	252
Rahman Khandoker Mahmudur	8	Miya Mohammad Tohidul Islam	4	Pavlou Paul A.	252
Sarker Farhana	8	Rahman Khandoker Mahmudur	4	Alsharif Ahmed H.	231
Vaidyanathan Ravi	8	Sarker Farhana	4	Babiloni Fabio	227
Salleh Nor Zafir Md	6	Vaidyanathan Ravi	4	Saini Rajkumar	220

Note: The h-index is calculated based on publications within the analyzed corpus.
Source: Authors' analysis based on Scopus data (2026).

average citation trends from 2008 to 2025. The trend shows a pronounced increase in publication volume post-2015, accelerating significantly after 2020, which aligns with the broader adoption of accessible neuro-tools like consumer-grade EEG and eye-trackers (Cherubino et al., 2019). Early publications (pre-2015) garnered higher average citations, indicative of foundational, high impact works that established the field (e.g., Knutson et al., 2007; Plassmann et al., 2008). The subsequent decline in average citations per paper, despite rising output, is characteristic of a maturing field where knowledge dissemination expands across a larger body of literature (Zeng & Lobo Marques, 2024).

The most prolific authors

The most prolific authors in neuromarketing and consumer behavior, as measured by three criteria: the number of published papers, the h-index, and the total number of citations, are listed in Table 4. Regarding the number of papers published, the top three are Alsharif Ahmed H., Berčík Jakub, and Anwar Syed Ferhat with 8 papers each. They are followed by other prolific authors such as Mamun Khondaker A., Mashrur Fazla Rabbi, and Miya Mohammad Tohidul Islam also with 8 papers each. The presence of this group indicates that there is regularly publishing research in the field of neuromarketing. From the h-index, which provides an overview of both productiveness and citation rates, Alsharif Ahmed H. has the highest h-index of 7, followed by Salleh Nor Zafir Md ($h = 6$) and Berčík Jakub ($h = 5$). There are multiple authors who have an equal h-index of 4, namely Anwar Syed Ferhat, Mamun Khondaker A., Mashrur Fazla Rabbi, and Miya Mohammad Tohidul Islam. In total citation counts, Huettel Scott A. is the leader with a total of 307 citations. The next leaders include Dogra Debi Prosad, Kumar Pradeep, and Roy Partha Pratim with a total of 286 citations each. Other leaders may include Davis Fred D., Dimoka Angelika, and Pavlou Paul A. with a total of 252 citations.

Experts such as Babiloni Fabio and Saini Rajkumar also feature prominently with more than 220 citations for each of them. These figures indicate the level of engagement with the research by some individuals and the number of citations being generated in the field. In general, it is apparent from this analysis that there are evidence of high research output and an increase in citation influence regarding neuromarketing studies. It indicates that new scholars and prominent experts are contributing to how the concepts of consumer behavior, neuropsychological measures, and marketing on digital platforms are perceived.

Most prominent documents

Table 5 highlights the most influential documents in neuromarketing and consumer behavior, according to total citations and average citations per year (TC/Year). These works are core and have contributed greatly to the development of the area. The most cited paper is Dimoka, A., "Research commentary—NeuroIS: The potential of cognitive neuroscience for information systems research," published in Information Systems Research, with 252 citations and 15.75 citations each year. The paper links neuroscience and information systems research and laid very important foundations for such interdisciplinary research.

Secondly, there was a highly cited technical paper by Yadava, M. in Multimedia Tools and Applications regarding EEG signal analysis in neuromarketing with 220 citations and an average of 22 per year, which reflected its relevance to research in applied neural signals. Fisher, CE. authored "Defining neuromarketing: Practices and professional challenges" in Harvard Review of Psychiatry. This work is cited by 169 other documents and is a very important source on ethical issues. Stanton, SJ. also considered the ethical implications of neuromarketing in his work

Table 5
Most influential documents.

Paper	Title of the Paper	Journal	Year	Total Citations	TC per Year
Dimoka, A	Research commentary—NeuroIS: The potential of cognitive neuroscience for information systems research	Information Systems Research	2011	252	15.75
Yadava, M	Analysis of EEG signals and its application to neuromarketing	Multimedia Tools and Applications	2017	220	22.00
Fisher, CE	Defining neuromarketing: Practices and professional challenges	Harvard review of psychiatry	2010	169	9.94
Stanton, Sj	Neuromarketing: Ethical implications of its use and potential misuse	Journal of business ethics	2017	154	15.40
Venkatraman, V	New scanner data for brand marketers: How neuroscience can help better understand differences in brand preferences	Journal of Consumer Psychology	2012	153	10.20
Aldayel, M	Deep learning for EEG-based preference classification in neuromarketing	Applied Sciences	2020	149	21.29
Golnar-Nik, P	The application of EEG power for the prediction and interpretation of consumer decision-making: A neuromarketing study	Physiology & behavior	2019	144	18.00
Lin, MH	Applying EEG in consumer neuroscience	European Journal of Marketing	2018	141	15.67
Muñoz-Leiva, F	Measuring advertising effectiveness in Travel 2.0 websites through eye-tracking technology	Physiology & behavior	2019	122	15.25
Vecchiato, G	Neurophysiological tools to investigate consumer's gender differences during the observation of TV commercials	Computational and mathematical methods in medicine	2014	116	8.92

Source: Authors' analysis based on Scopus data (2026)

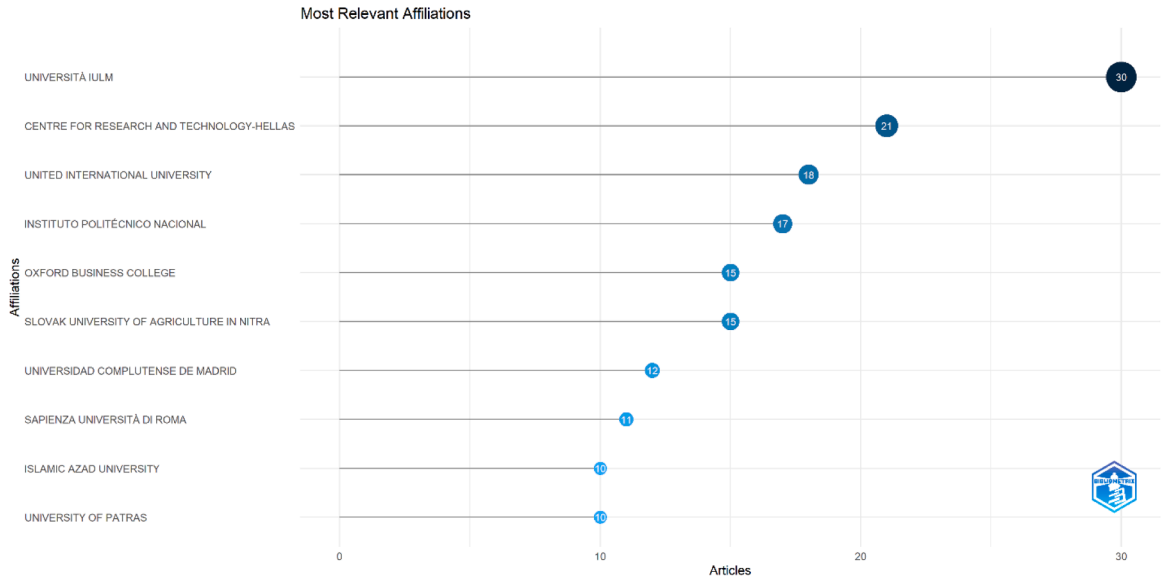

Fig. 3. Most Prominent Affiliations.
Source: Authors' analysis using Bibliometrix R-package (2026).

in the Journal of Business Ethics. This work is cited by 154 other documents.

Among the empirical papers, Venkatraman, V. analyzed the application of neuroscience knowledge regarding brand preference, utilizing scanner data, and was published in Journal of Consumer Psychology, garnering 153 citations. Aldayel, M. applied deep learning algorithms to classify brand preference through EEG, and was published in Applied Sciences, garnering 149 citations and a rate of 21.29 per year, indicating increasing use of AI in neuromarketing research. Also of interest is the study by Golnar-Nik, P., regarding EEG power and decision-making, which appears in the journal Physiology and Behavior and has been cited 144 times, with 18 annual citations, ranking it among the strongest studies in literature from the methodology viewpoint.

Other highly cited papers include Lin, MH. on EEG in consumer neuroscience (141 citations, 15.67 per year), Muñoz-Leiva, F. who assessed the effectiveness of ads using eye-tracking (122 citations, 15.25 per year), and Vecchiato, G. who investigated neurophysiological differences in the perception of ads between These research papers include various techniques such as EEG, fMRI, Deep Learning, Eye Tracking, and they tackle both theoretical and application-oriented aspects. They represent progress, issues and interdisciplinary research, which comprise the main body of developments in this field.

Most relevant affiliations

In Fig. 3, the major affiliations that fuel the study of neuromarketing and consumer behavior are highlighted. This is done by showing the institutions that have published the greatest number of articles on the subject. The first is Università LUM, having published 30 articles.

Centre for Research and Technology-Hellas is in second position with 21 articles, indicating its strong contribution to interdisciplinary research activities that involve neuroscience, technology, and consumer research. United International University is next with 18 articles, indicating a strong interest in neuromarketing research. Instituto Politecnico Nacional is in fourth position with 17 articles, indicating the strong contribution made by technical institutions in the development of marketing research using neuroscience.

Institutions such as Oxford Business College and Slovak University of Agriculture in Nitra published 15 articles each, which illustrates an increased level of interest in neuromarketing research in business and management and social sciences fields. Universidad Complutense de Madrid published 12 articles in this field, and Sapienza Università di Roma published 11 articles.

Fig. 4. The Word Cloud.
Source: Authors' analysis using Bibliometrix R-package (2026).

Also, Islamic Azad University and University of Patras with a total of 10 publications each contribute significantly to diversification and internationalization in neuromarketing studies.

Word cloud

The word cloud is prepared for the most prominent keywords in the research domain of neuromarketing & CB and presented in Fig. 4. The key words that appear most frequently are related to electroencephalography (EEG) and appear prominently in the center of the visualization. The key words are strongly linked to neuromarketing and decision-making, implying that it is important to understand consumer decision-making by monitoring their brain activity. The visualization reveals that tools such as EEG are widely used to analyze consumer processing of information to make purchasing decisions.

Consumer behavior is another common term that highlights the behavioral and psychological emphasis of the research. Other close words are consumer attitude, motivation, and advertising, each of which reveals a multi-level perspective on the influence of marketing communications on thought and feelings.

Demographic variables such as adult, young adult, female, and male are evident in this graph, showing that much research is conducted on people in terms of their age and gender. This aims to provide targeted marketing concepts based on brain data from different groups.

Other examples of terms include eye tracking, brain, emotion, attention, and neuroscience, which reflect the combination of psychology, physiology, and cognitive science. Descriptions of the technology include machine learning, deep learning, biomedical signal processing, and brain-computer interface, which indicate increased research involving complex computer algorithms.

Words such as commerce, sales, and forecasting reflect an applied focus where the goal is to apply findings for the purpose of improved business outcomes. The use of consumer neuroscience, functional magnetic resonance imaging, or even neurophysiology reflects the application of biology-based methodologies.

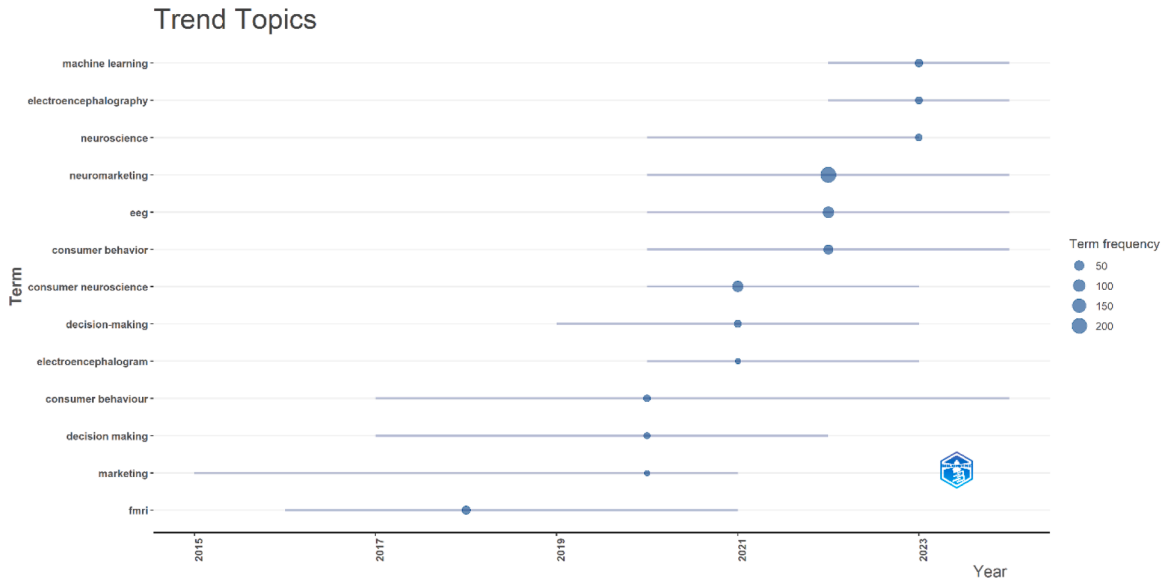

Fig. 5. The Trending Topics.
Source: Authors' Trending Topic analysis (2026).

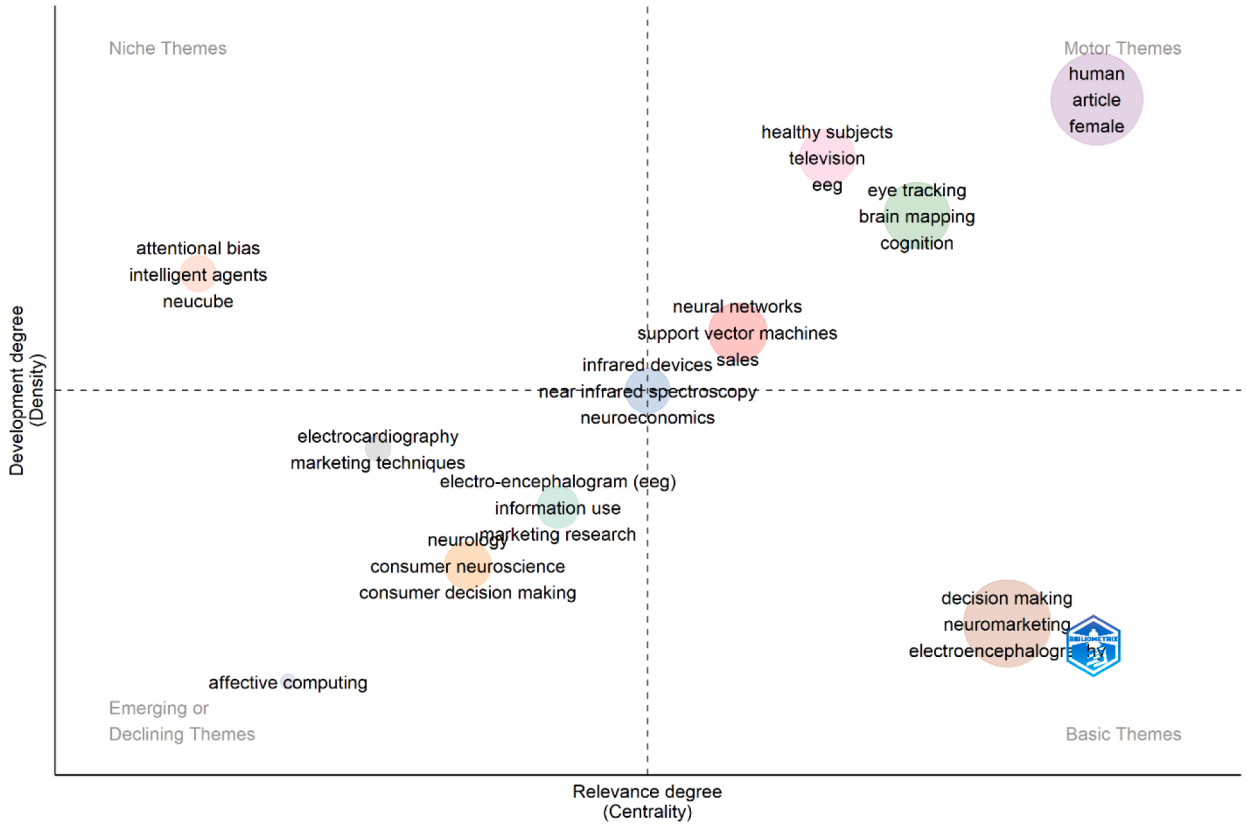

Fig. 6. The Thematic Evolution.
Source: Authors' thematic mapping analysis (2026).

In addition to these themes, the word cloud consists of technical vocabulary that helps explain consumer neuroscience further. Vocabulary including support vector machines, controlled study, cognition, functional neuroimaging, biomedical signal processing demonstrates the analytical approach taken in neuromarketing research. Vocabulary including attention, emotions, motivation, consumer preferences illustrate psychological concepts that are sometimes researched in behavioral studies.

By referring to "brain mapping," "functional magnetic resonance imaging," and "EEG," one recognizes the increased emphasis on neuroimaging research regarding brain response to advertising. The three keywords indicate a blended approach involving "computer science," "cognitive psychology," and modeling regarding human behavioral response as consumers.

The trending topics

Fig. 5 shows trending themes like machine learning, electroencephalography, neuroscience, and neuromarketing. These terms became more popular after the year 2020, indicating increasing research interest in the application of advanced technology and brain-computer concepts

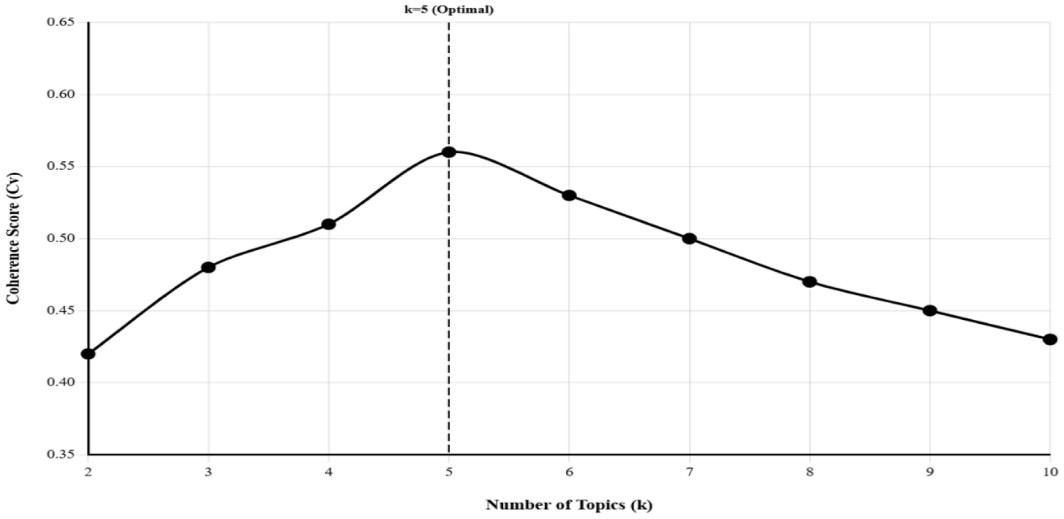

Fig. 7. Coherence Plot and No. of topics Selections.
Source: Authors' LDA coherence analysis (2026)

in consumer research. The use of terms such as EEG, consumer behavior, consumer neuroscience, and various spellings of "decision-making" is very common, indicating the emphasis on thinking and behavior patterns of people.

The use of terms such as marketing and fMRI, which were popular in the earlier period, indicate foundational research, which later branched into various fields. The use of nodes and their size indicate the repeated use of tools from the neurotechnology domain and its increasing importance in understanding consumer decision-making, preferences, and behavior. This is consistent with the indication that the current research combines various streams and applies concepts from AI and neuroscience to marketing research.

Thematic evolution

This following Fig. 6 illustrates the thematic evolution of neuromarketing and consumer behaviour research along with its advancement from foundational scientific tools to sophisticated unique marketing applications in consumer behaviour. The field has originated from basic biometric measurements like electrocardiography and infrared devices used to study brain activity in healthy people who are watching television and establishing the physiological link to consumer response. It then evolved through a crucial phase of computational integration where advanced techniques like neural networks, support vector machines and affective computing were applied to neuroimaging data which have allowed researchers to move from simple observation to modeling complex cognitive processes like attention bias and decision-making.

This development has ultimately led to the current state of the field which is characterized by highly specialized sub-domains such as neuroeconomics and targeted consumer neurosciences where research is now refined enough to address specific niche themes which are motor responses to products or demographic specific studies, demonstrating the field's transition from a novel concept into a legitimate, data-driven scientific discipline with practical marketing applications.

Table 6
The LDA topics with their strategic focus.

Topic No.	Topic Name	Key Strategic Focus
Topic 1	Eco-Neural Analytics	Classifying subconscious triggers for sustainable consumer preferences using EEG.
Topic 2	The Visual Gaze	Mapping eye-tracking and neural engagement in digital branding and online spaces.
Topic 3	Cognitive Foundations	A high-level data synthesis of neuroscientific reviews and behavioral trends.
Topic 4	Neural Intelligence	Decoding real-time brain signals to predict intelligent consumer choice.
Topic 5	Behavioural Neuro-Nexus	Bridging the gap between traditional marketing research and deep neuroscience.

Source: Authors' analysis of LDA (2026)

For instance, the Motor Themes are exploring the connection between physical movement and product interaction, while studies on "Human Article Female" indicate a growing focus on gender-specific consumer responses. Similarly, the emergence of topics like "healthy subjects television" are indicating an ongoing interest in how traditional media consumption affects wellbeing and the presence of "eeg eye tracking brain mapping cognition" confirms that even as the field is getting diversified, its core foundation in severe cognitive measurement remains important for validating these new and uniquely specialized branches of research that can applied in marketing applications.

Topic model selection and validation

The optimal number of topics for the LDA model was determined by evaluating coherence scores, a standard metric for assessing the semantic interpretability of topics (Bakrey, 2023). As shown in Fig. 7, the coherence score peaked at five topics, indicating this model configuration provides the most semantically distinct and meaningful thematic structure for the corpus.

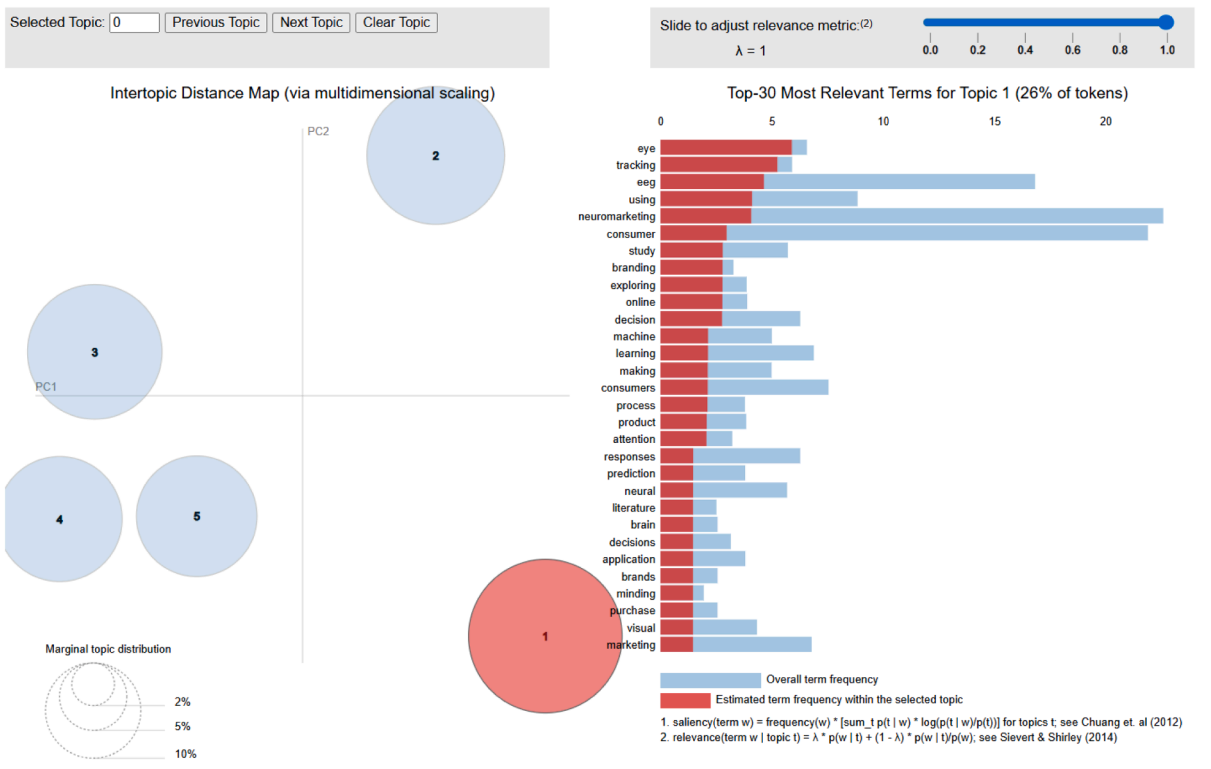

Fig. 8. The LDA Model with five distinct topics in the research domain of Neuromarketing in CB.
Source: Authors' analysis of LDA (2026).

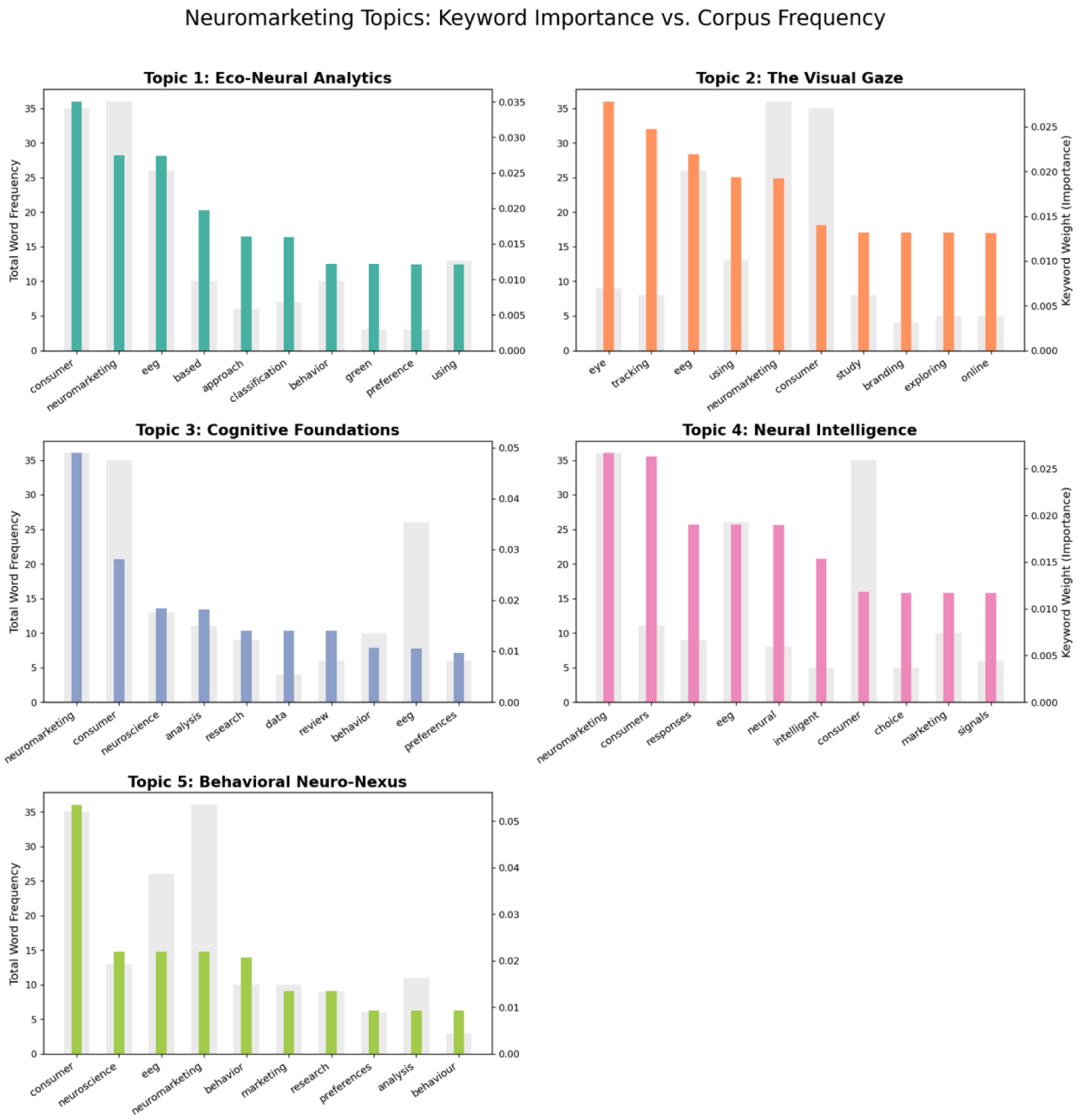

Fig. 9. keyword importance (LDA-derived weights) and overall corpus frequency.
Source: Authors' analysis of LDA (2026).

LDA modelling results

The Latent Dirichlet Allocation (LDA) topic modeling analysis results are displayed in Fig. 8 with inter-topic distance map. The multidimensional scaling (MDS) based spatial distribution of identified topics is shown in the left panel. Each circle represents a topic and the distance between circles indicates the semantic dissimilarity between them.

The relevance metric ($\lambda = 1$) which highlights term probability within the topic is used to rank the top 30 most relevant terms for the chosen topic in the right panel. The blue bars show the terms overall frequency throughout the corpus while the red bars show the estimated frequency of each term within the chosen topic. Dominant keywords for Topic 1 include eye tracking, EEG, neuromarketing, consumer and decision making, indicating a strong emphasis on neuroscience-based tools and their use in branding and marketing decision processes and consumer responses. The LDA model offers a solid data-driven basis for identifying dominant research streams and guiding the creation of subsequent thematic classification and frameworks by combining topic prevalence, inter-topic distance and keyword relevance.

The following Table 6 summarizes the five dominant themes identified through LDA topic modeling in the neuromarketing literature. Topic 1, Eco-Neural Analytics, emphasizes the use of EEG-based methods to uncover subconscious drivers of sustainable consumer preferences. Topic 2, The Visual Gaze, focuses on eye-tracking and neural engagement to understand attention and interaction within digital branding and online environments. Topic 3, Cognitive Foundations, represents integrative and review-oriented research that synthesizes neuroscientific evidence with broader behavioral trends. Topic 4, Neural Intelligence, highlights predictive applications of real-time brain signal analysis for modeling intelligent consumer decision-making. Finally, Topic 5, Behavioral Neuro-Nexus, reflects studies that integrate traditional marketing research approaches with advanced neuroscientific techniques, indicating an emerging interdisciplinary convergence

Fig. 10. The Word Cloud for each LDA Identified Topics.
Source: Authors' analysis of LDA-derived term weights (2026)

within the field.

The keywords characteristics

The following Fig. 9 compares keyword importance and overall corpus frequency across the five identified neuromarketing topics as found from LDA analysis. The visualization highlights that highly weighted keywords within each topic (e.g., EEG, eye-tracking, neural signals) are not always the most frequent across the corpus which is emphasizing the distinction between thematic relevance and mere prevalence.

Topics such as Eco-Neural Analytics and The Visual Gaze show a very strong methodological concentration around specific neuroscientific tools, while Cognitive Foundations show a broader, combination of various vocabulary which is indicative of review and conceptual work. In contrast, Neural Intelligence strongly emphasizes the predictive and real-time analytical terms which is indicating an emerging shift toward intelligent decision modeling. However, the overlap of high-frequency terms (e.g., "consumer," "marketing," "neuromarketing") across topics are suggesting partial conceptual convergence which in turn indicating that while methodological differentiation is increasing theoretical

boundaries within neuromarketing research remain relatively permeable.

The word cloud of LDA topics

Finally, Fig. 10 presents word clouds for each of the five topics, providing an intuitive visual summary of the dominant vocabulary characterizing each research stream, from the "sustainability" and "EEG" focus of Topic 1 to the "tourism," "food," and "purchase" context of Topic 5.

Topic 1 Eco-Neural Analytics

It represents a strategic change in the direction of decoding green consumer preferences using EEG signals and classification techniques. Crucially this implies that in order to address the attitude-behavior gap in sustainability, neural data offers a more accurate evaluation of environmental commitment than conventional self-reports in the field that is going beyond straightforward preference testing.

Topic 2 The Visual Gaze

It can be regarded as the corpus methodological powerhouse; it emphasizes the integrated application of EEG and eye tracking in online branding and decision-making contexts. This supports the multi-modal gold standard in contemporary research which links cognitive engagement and visual attention to maximizing digital consumer interfaces.

Topic 3 Cognitive Foundations

It is showcasing the academic maturity of the field and is exemplified by its deep focuses on bibliometric reviews and methodical examination of attentional strategies. From a strategic perspective this cluster serves as the theoretical audit of the field guaranteeing that neuro-scientific applications such as spatial-temporal analysis and fMRI are based on solid literature rather than isolated empirical observations.

Topic 4 Neural Intelligence

The technological frontier of the neuromarketing research where deep machine learning and intelligent systems are being employed to forecast customer preference. With the use of intricate neural signals as features for automated decision-modeling this crucial shift represents the industry's shift from descriptive neuroscience (what the brain is doing) to predictive analytics (what the consumer will do).

Topic 5 Behavioral Neuro-Nexus

It demonstrates how neuromarketing can be practically expanded into niche industries like retail food and tourism. In order to improve marketing strategies, the researchers apply neural frameworks to real-world and sector-specific consumer processes. This diversification shows a drive towards ecological validity.

Discussion

This integrated bibliometric and LDA topic modeling analysis directly addresses the identified gaps in neuromarketing literature as depicted in Table 7 by: (1) providing a structured, data-driven theoretical integration of neuroscientific and consumer behavior research; (2) revealing the translational pathway from neuroscientific accuracy to practical marketing applications; and (3) modeling the multifaceted interaction between conscious and unconscious processes through distinct yet interconnected thematic pillars.

Topic 3 (Cognitive Foundations) = The theoretical bedrock (past/consolidation). Topics 1 & 2 (Eco-Neural Analytics & Visual Gaze) = The methodological core (present/application). Topics 4 & 5 (Neural

Table 7
LDA-derived research framework for neuromarketing in consumer behavior*.

Neuromarketing Topics: LDA Analysis Framework			
Main Topic	Sub - Topic	Research Framework	Key Citations
Eco-Neural Analytics	Consumer Environmental Decision-Making	Examines the neural correlations (e.g., vmPFC, insula) of evaluating sustainable products vs. conventional alternatives.	(Krajbich et al., 2010; Plassmann, Ramsoy, et al., 2015)
	Neuromarketing for Sustainable Products	Applies neuromarketing tools to test the effectiveness of green advertising, eco-labels, and sustainable brand messaging.	(Baldo et al., 2015; Hubert & Kenning, 2008)
	EEG-Based Green Consumer Segmentation	Uses EEG response patterns (e.g., frontal asymmetry, P300) to classify consumers based on their subconscious commitment to sustainability.	(Cherubino et al., 2019; Vecchiato et al., 2011)
	Neural Basis of Eco-Label Processing	Investigates how the brain processes certification logos (e.g., Fair Trade, Organic) and how this processing influences trust and willingness-to-pay.	(Hartmann & Apaolaza-Ibáñez, 2012; Ma et al., 2014)
	Approach-Avoidance in Eco-Choice Behavior	Studies the neural conflict (anterior cingulate cortex activity) and emotional response when choosing between hedonic desires and sustainable options.	(Reimann et al., 2012; Santos et al., 2011)
	Classification Models for Green Preferences	Develops machine learning models using neural features to predict individual green purchase intentions more accurately than surveys.	(Boksem & Smidts, 2015; Venkatraman et al., 2012)
	Predictive Neural Analytics for Sustainability	Aims to forecast market-level adoption of sustainable innovations or campaigns using aggregated neural response data.	(Ariely & Berns, 2010; Knutson et al., 2007)
The Visual Gaze	Eye-Tracking in Consumer Research	Foundational studies on using fixations, saccades, and heatmaps to understand visual attention to ads, packaging, and shelves.	(Duchowski and Duchowski, 2017; Wedel & Pieters, 2008)
	Visual Attention Tracking for Brand Assets	Specifically maps how consumers visually engage with logos, brand colors, and mascots in static and dynamic media.	(Pieters & Wedel, 2004; Rayner, 2009)

(*continued on next page*)

Table 7 (*continued*)

Neuromarketing Topics: LDA Analysis Framework			
Main Topic	Sub - Topic	Research Framework	Key Citations
	EEG-Eye Tracking Integration Studies	Correlates neural metrics of engagement (e.g., alpha/beta power) with visual attention patterns to understand the cognitive load and emotional valence of what is seen.	(Dmochowski et al., 2014; Khushaba et al., 2013)
	Gaze Patterns in Online Shopping	Analyzes scanpaths on e-commerce websites to optimize webpage layout, product displays, and call-to-action placement for conversion.	(Chandon et al., 2009; Russo & Leclerc, 1994)
	Neuromarketing Applications of Gaze Behavior	Translates gaze behavior metrics (e.g., time to first fixation) into actionable insights for advertising testing and package design.	(Krajbich & Rangel, 2011; Plassmann, Ramsoy, et al., 2015)
	Consumer Visual Information Processing	Explores the pre-attentive and attentive stages of visual processing in marketing contexts, often using short exposure times.	(Atalay et al., 2012; Milosavljevic et al., 2012)
	Brand Perception Through Visual Study	Investigates how visual elements of branding unconsciously shape brand personality perceptions and attitudes.	(Ramsøy et al., 2012; Venkatraman et al., 2015)
Cognitive Foundations	Neuromarketing Theoretical Frameworks	Review and proposition papers that integrate neuroscience constructs (e.g., dual-process theory) into marketing theory.	(Atalay et al., 2012; Russo & Leclerc, 1994)
	Consumer Decision-Making Neuroscience	Foundational research identifying brain regions and networks associated with valuation, choice, preference formation, and loss aversion.	(Chandon et al., 2009; Knutson et al., 2007)
	Neural Processing in Marketing Contexts	Studies examining how specific marketing actions (pricing, branding) modulate neural activity in regions associated with reward and pain.	(Krajbich & Rangel, 2011; McKnight et al., 2002)
	Cognitive Analysis of Brand Preferences	Uses neuroscientific methods to deconstruct the cognitive and emotional components of brand loyalty and attachment.	(Deppe et al., 2005; Schaefer & Rotte, 2007)

Table 7 (*continued*)

Neuromarketing Topics: LDA Analysis Framework			
Main Topic	Sub - Topic	Research Framework	Key Citations
	Consumer Research Methodology	Papers debating methodological rigor, validity, and best practices for applying neuroscientific tools in consumer research.	(Hubert, 2010; Morin, 2011)
	Data-Driven Consumer Insights	Emphasizes the shift from small-sample, hypothesis-driven neuroscience to larger-scale, exploratory analysis of neural datasets.	(Ariely & Norton, 2008; Fisher et al., 2010)
	Neural Networks and Behavioral Prediction	Early work on using basic neural activity patterns to forecast simple choices, laying groundwork for today's "Neural Intelligence."	(Hsu & Yoon, 2015; Levy & Glimcher, 2012)
Neural Intelligence	Neuromarketing Intelligence Systems	Conceptual frameworks for integrating real-time neural data streams into marketing decision-support systems.	(Hubert, 2010; Smidts et al., 2014)
	Consumer Neural Response Patterns	Research dedicated to identifying robust, generalizable neural signatures (biomarkers) for specific marketing-relevant states like desire, trust, or confusion.	(Knutson & Genevsky, 2018; Plassmann et al., 2008)
	AI and Deep Learning in Consumer Analytics	Application of advanced algorithms (CNNs, LSTMs, Transformers) to raw or processed neural data for automated classification and prediction.	(Davenport & Ronanki, 2020; Grewal et al., 2020)
	EEG-Based Emotion Recognition	Specific focus on using multi-channel EEG data to classify discrete emotional states (joy, surprise, disgust) in response to marketing stimuli.	(Golnar-Nik et al., 2019; Vecchiato et al., 2014)
	Neural Prediction Models	Development and validation of models that use neural features to predict out-of-sample consumer behavior (click-through, purchase, churn).	(Berns & Moore, 2012; Falk et al., 2012)
	Consumer Intelligence Extraction	Focus on the data mining and feature extraction process from complex neuro-datasets to derive actionable	(Hsu & Yoon, 2015; Krampe et al., 2018)

(*continued on next page*)

Table 7 (*continued*)

Neuromarketing Topics: LDA Analysis Framework			
Main Topic	Sub - Topic	Research Framework	Key Citations
		marketing variables.	
	Choice Modeling Using Neural Signals	Incorporates neural measures as covariates or dependent variables in advanced econometric choice models to improve predictive accuracy.	(Smith et al., 2014; Tusche et al., 2010)
Behavioral Neuro-Nexus	Consumer Behavioral Neuroscience	Studies that explicitly pair a neuroscientific measure with a corresponding behavioral metric (e.g., reaction time, choice) to provide a multi-level explanation.	(Karmarkar & Plassmann, 2019; Venkatraman et al., 2012)
	Neuroscience of Purchase Decisions	Focuses on the final stages of the decision journey, studying the neural activity immediately preceding and during a purchase action.	(Knutson et al., 2007; McClure et al., 2004)
	EEG and Behavioral Integration	Methodological papers on synchronizing EEG recordings with behavioral tasks in shopping simulations or virtual store environments.	(Grewal et al., 2020; Tusche et al., 2010)
	Neuromarketing Campaign Effectiveness	Field studies or quasi-experiments measuring the neural impact of an advertising campaign and linking it to traditional campaign KPIs (sales, recall).	(Falk et al., 2012; Venkatraman et al., 2012)
	Consumer Behavior Pattern Analysis	Uses neuroscience to explain why certain behavioral patterns (e.g., impulse buying, brand switching) occur at a mechanistic level.	(Rayner, 2009; Yoon et al., 2006)
	Marketing Strategy and Neural Research	Works that translate neuroscientific findings into concrete recommendations for marketing strategies in segmentation, targeting, and positioning.	(Kenning et al., 2007; Plassmann, Venkatraman, et al., 2015)
	Preference Formation and Neural Mechanisms	Longitudinal or multi-session studies tracking how neural representations of preference evolve with repeated exposure or learning.	(Risk, 2007; McClure et al., 2004)

Source: Author's Work (2026).

Intelligence & Behavioral Neuro-Nexus) = The future trajectory (prediction & real-world integration).

Thematic synthesis and contribution to literature

The proposed framework Table 7 represents a significant contribution to the literature by systematizing the fragmented landscape of neuromarketing into five distinct yet interconnected pillars. It moves beyond a mere list of keywords, offering a structured taxonomy that bridges the gap between foundational neuroscientific theory and cutting-edge computational applications. By categorizing "**Cognitive Foundations**" as the theoretical bedrock, the framework acknowledges the evolution from early works by Lee et al. (2007) to the contemporary "**Neural Intelligence**" paradigm, where AI and deep learning transform raw neural signals into predictive market-level insights.

A critical contribution of this table is the identification of "**Eco-Neural Analytics**" as a standalone research domain. This suggests that the field is pivoting toward high-stakes societal challenges specifically, using EEG and neural classification to bypass the social desirability bias inherent in sustainable consumer research. Furthermore, the "**Visual Gaze**" and "**Behavioral Neuro-Nexus**" topics highlight a shift from clinical, laboratory-based observations toward ecological validity in retail and digital environments. Strategically, this framework allows researchers to locate "white spaces" in literature, such as the intersection of predictive neural modeling and specific industry verticals like food or tourism, thereby providing a roadmap for future interdisciplinary investigations.

The role and function of neuromarketing in the age of AI and machine learning

As its core, neuromarketing serves as a translational discipline that applies neuroscientific measurement tools including EEG, eye tracking, fMRI, fNIRS, GSR, and facial coding, to decode the subconscious neural and physiological processes that underline consumer decision-making. The fundamental process of neuromarketing involves three interconnected stages: (1) stimulus presentation, wherein consumers are exposed to marketing and media stimuli such as advertisements, product packaging, brand logos and digital interfaces; (2) neural and biometric data acquisitions, wherein brain signals and physiological responses are recorded in real-time using neuroimaging and biosensor technologies; and (3) data interpretation and insight generation, wherein the recorded signals are analyzed to infer attention, cognitive load, memory encoding, purchase intent, and emotional engagement (Plassmann et al., 2015a, 2015b; Alsharif et al., 2025).

The emergence of artificial intelligence and machine learning has fundamentally transformed and enabled a paradigm shift from descriptive neuroscience to predictive consumer analytics, whereas earlier neuromarketing studies relied on traditional statistical methods to identify correlations between neural activation patterns and consumer preferences as contemporary research increasingly employing deep learning software such as convolutional neural networks (CNNs), and long short-term memory (LSTM) networks, and support vector machines (SVMs); to classify and predict consumer preferences directly from raw neural signals with classification accuracies exceeding 90 %. The computational turn captured primarily within the neural

intelligence topic identified in our LDA analysis, reflects a broader convergence between neuroscience and data science, reshaping how consumer behavior is understood and anticipated. Machine learning algorithms enable real-time processing of high-dimensional neuro-data streams, making it feasible to deploy neuromarketing insights in dynamic commercial environments such as e-commerce platforms, programmatic advertising systems, and personalized recommendation engines (Davenport & Ronanki, 2020; Grewal et al., 2020).

The emergence of Neural Intelligence as a distinct LDA-derived theme confirms that AI and machine learning are no longer peripheral but central to contemporary neuromarketing research. While our bibliometric-LDA approach effectively maps this intellectual shift as reflected in the published literature, the rapid proliferation of specific AI architectures and their industry applications calls for dedicated systematic reviews that benchmark technical performance and adoption patterns. We therefore position this as a critical priority in our Future Research Roadmap (Section 5.2), where we call for comparative studies of neuro-AI models and the development of open-source benchmarks to accelerate translational impact. Future research should therefore complement these findings with dedicated systematic reviews of AI tools in neuromarketing practice, incorporating perspectives from leading researchers and industry practitioners to fully capture the operational impact of machine learning on consumer behavior analytics.

Implications

The paper provides significant implications for theory, methodology and marketing practices by the integrated bibliometric and topic modeling analysis which provides an organized way to develop neuromarketing as a developed translational field.

Implication for theory

By going beyond fragmented literature reviews the study theoretically offers a unified thematic framework that identifies five related topics: Eco-Neural Analytics, The Visual Gaze, Cognitive Foundations, Neural Intelligence and the Behavioral Neuro-Nexus. This framework unifies different lines of research by establishing basic cognitive theories as the foundation for applied and predictive research. Additionally, Kahnemans dual-process theory in marketing contexts is empirically supported by the thematic prevalence of subconscious triggers and real-time prediction which shows that System 1 and System 2 processes are not only psychologically distinct but also separable using neurophysiological tools. The rise of neural intelligence as a separate field also points to a paradigm shift away from descriptive neuroscience and toward predictive modeling. This means that dynamic data-driven feedback loops involving neural signals as direct input variables for predicting consumer choice must be incorporated into future theoretical models.

Implication for methodology

In terms of methodology the result of this study confirms that multimethod integration is the best way to capture the difficulty of customer responses. Multimodal research designs are crucial for triangulating cognition, emotion and attention which enhances the validity and depth of findings. This is demonstrated by The Visual Gazes strong thematic presence which combines GSR, EEG and eye tracking. The topic of neural intelligence also highlights how advanced analytics such as CNN and LSTM models are now essential to modern neuromarketing rather than an add-on. To assure reproducibility and ethical application. Standardized systems for neuro-data preprocessing feature extraction

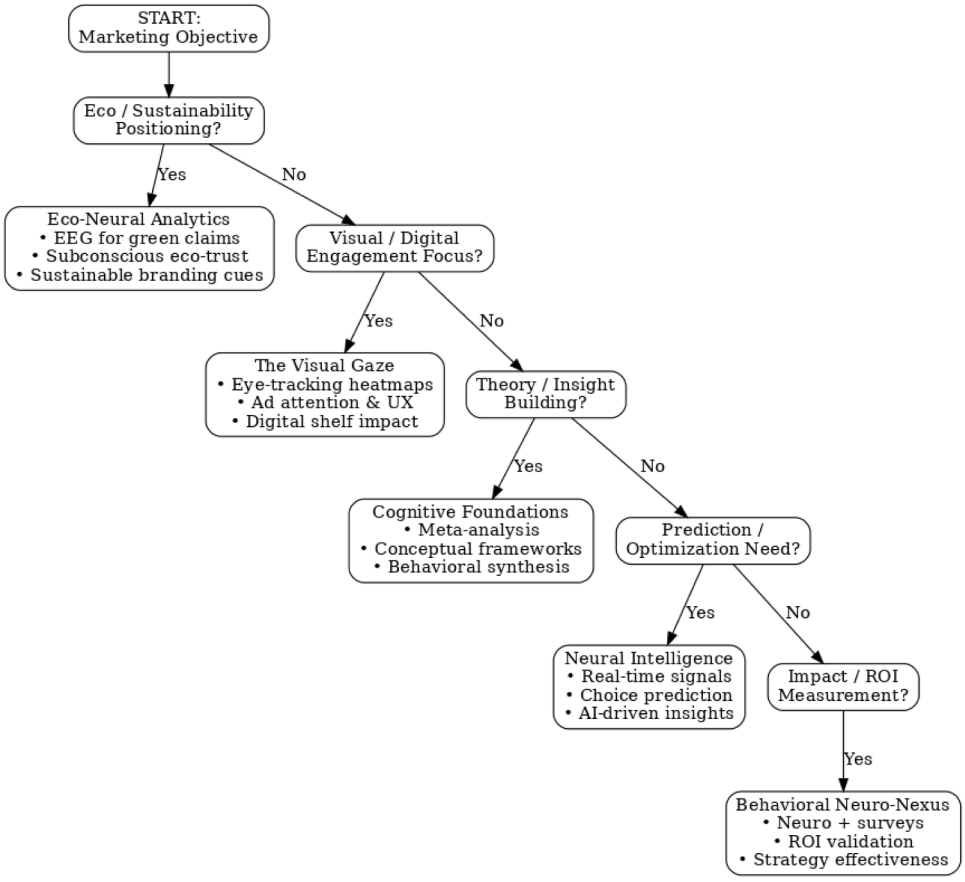

Fig. 11. The Decision Tree for the Marketers Applying Neuromarketing Techniques.
Source: Author's Work (2026)

and model validation are required. Finally, the topic of Behavioral Neuro-Nexus emphasizes the importance of ecological validity by showing how neuroscientific tools are applied in real-world domains like retail and tourism. It also inspires the researchers to shift from lab settings to field research virtual shopping simulations and longitudinal designs that produce practical applicability.

Implication for marketers

According to the five-topic framework, it will help marketers to make strategic decisions by helping them to choose the best neuroscientific techniques. Brands are testing eco-friendly packaging like Eco-Neural Analytics which combines EEG and classification algorithms while those optimizing digital advertising can use The Visual Gaze which combines eye-tracking and EEG. A direct solution to ROI-driven campaign optimization is provided by the Neural Intelligence stream which also makes real-time preference forecasting and personalized content possible. Furthermore, the Behavioral Neuro-Nexus creates a concrete link between neural metrics and market outcomes enabling practitioners to correlate conversion rates with emotional engagement through frontal asymmetry or ad memorability through P300 components. To build consumer trust and adhere to new neuroprivacy laws, the marketing executives must establish governance policies addressing consent transparency, data ownership and algorithmic bias because the increasing predictive power of these tools presents serious ethical issues.

The actionable framework for the marketers: It is presented in the following Fig. 11, the framework operationalizes neuromarketing themes into decision-oriented strategic pathways, enabling marketers to align research tools with specific managerial objectives.

Limitations and future research directions

This integrated review provides a structured map of neuromarketing in consumer behaviour, yet it is subject to inherent limitations that both qualify its findings and explain clear pathways for future inquiry. Acknowledging these limitations allows us to transform the identified thematic pillars into a concrete research agenda that addresses both methodological gaps and substantive frontiers.

Limitations

Four primary limitations could be there in the present analysis. First, while Scopus provides extensive coverage, reliance on a single database may introduce selection bias potentially omitting impactful works in non-indexed journals, books or conferences or those published in languages other than English. Second, while LDA offers a powerful, data-driven lens for theme extraction the interpretation and labeling of topics involve a degree of researcher subjectivity alternative modeling techniques (e.g., BERTopic, structural topic modeling) or parameter choices might yield slightly different thematic configurations. Third, our analysis operates at the metadata level (titles, abstracts, keywords). A subsequent, complementary full-text content analysis would be required to critically evaluate the methodological rigor, theoretical depth, or potential replication crises within the identified clusters. Finally, this study maps the production of knowledge but does not empirically assess its translation; the persistent "valley of death" between laboratory neuroscientific findings and scaled, ethical application in real-world marketing ecosystems remains a critical, unexamined challenge.

A roadmap for future research

The five-pillar framework developed in this study both extends and contextualizes recent neuromarketing scholarship published in Strategic Business Research. we propose the following integrated research agenda designed to advance the field from descriptive mapping to predictive, ecologically valid and ethically grounded science.

Progressing eco-neural analytics

Correlational studies need to give way to causal predictive frameworks for sustainable consumption in future research (Bansal et al., 2026). Developing hybrid models that combine behavioral data and neural conflict markers to precisely close the attitude-behavior gap at the individual level designing longitudinal neuro-intervention trials to measure causal changes in valuation circuitry and performing cross-cultural neuro-prediction studies to test the generalizability of green engagement signatures are important approaches.

Enhancing the visual gaze

In complex digital environments dynamic predictive modeling should be the focus of the next stage of visual attention research (Rahman, 2026). Priorities include using machine learning to simulate gaze patterns for new stimuli developing integrated EEG-eye-tracking protocols for real-time intent prediction in scrolling feeds or VR stores and extending research to model the interaction of visual attention with haptic and auditory cues in multisensory branding contexts.

Strengthening cognitive bases

Future research should use multi-method neuroscience to dissect and validate complex marketing constructs like brand love or perceived value into their fundamental neural components as well as formally revise consumer behavior models by adding neuro-constructs as mediating variables. This will increase the explanatory power of frameworks like the Theory of Planned Behavior (Chowdhury & Hoque, 2026).

Managing neural intelligence

The focus of research must shift from proving AIs predictive accuracy to proving its practical and ethical resilience. Developing audit frameworks for neuro-AI models fairness and transparency methodically determining whether neural-feature models perform better than digital-behavioral models and encouraging open science through carefully selected multimodal datasets to guarantee reproducibility and benchmark advancement are all crucial steps (Mondo et al., 2026).

Behavioral neuro-nexus expansion

To relate neural metrics to actual business outcomes translational field studies are necessary. In order to better understand the dynamics of loyalty formation and decay future research should concentrate on longitudinal field experiments that correlate in-store neuro-sensor data with sales KPIs create sector-specific neural biomarkers for domains such as finance or health and monitor neural responses to brands over time (Teixeira & Teixeira, 2026).

Conclusion

This integrated review shows how neuromarketing has developed into a sophisticated multidisciplinary field with an organized intellectual framework from a specialized method-focused exploration. The five main themes Eco-Neural Analytics, The Visual Gaze, Cognitive Foundations, Neural Intelligence and Behavioral Neuro-Nexus are collectively indicating a move away from descriptive neuroscience and toward applications that are predictive, ecologically sound and socially relevant. This study offers a unified framework that fills theoretical gaps, makes methodological priorities clear and provides a translational pathway for both researchers and practitioners by combining bibliometric trends with LDA-derived topics. The ethical incorporation of neural intelligence into marketing systems and the ongoing search for insights that resonate at the subconscious level of consumer decision-making will define the field's future.

Ethics approval and consent to participate

This article does not involve any studies with human participants or animals performed by any of the authors. Therefore, ethical approval was not required. All data and materials used in this work are publicly available or obtained through legal and ethical means.

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Authors' contributions

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Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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