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Research Article

Bibliometric Analysis of Neuromarketing and Consumer Behaviour: A Comprehensive Review From 2000 To 2023

Arfan Rehman Sherief[1*], Associate Professor Dr. Arun Kumar Tarofder[2], Professor Dr. Zunirah Binti Mohd Talib[3]

[1*]PhD Candidate, School of Graduate Studies (SGS), Management & Science University, Shah Alam 40100, Malaysia arfanrsherief@hotmail.com
[2]Associate Professor, School of Graduate Studies (SGS), Management & Science University, Shah Alam 40100, Malaysia arun_kumar@msu.edu.my
[3]Dean, School of Graduate Studies (SGS), Management & Science University, Shah Alam 40100, Malaysia zunirah@msu.edu.my

***Corresponding Author:** Arfan Rehman Sherief
*PhD Candidate, School of Graduate Studies (SGS), Management & Science University, Shah Alam 40100, Malaysia arfanrsherief@hotmail.com

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ABSTRACT

This comprehensive bibliometric and bibliographic analysis focuses on the dynamic field of neuromarketing and consumer behaviour, examining trends, critical research clusters, and gaps for future exploration. The study encompasses various facets of bibliometrics, beginning with citation analysis to identify prominent articles, which aids in discerning the most influential research in this domain. Co-citation and bibliographic coupling analyses reveal the interconnectedness of journals, underscoring the interdisciplinary nature of neuromarketing. Subsequently, co-occurrence analysis of author keywords unveils the semantic landscape, emphasizing core topics like "neuromarketing" and "consumer neuroscience". These analyses not only showcase the past and present but also lay a foundation for future endeavours. The interdisciplinary nature of neuromarketing, intertwined with fields like neuroscience, psychology, economics, and marketing, indicates the necessity of fostering collaborative research initiatives. Furthermore, longitudinal studies, which track research trends over time, and an interdisciplinary approach may help unearth novel insights and interdisciplinary innovations in this constantly evolving field.

KEYWORDS: Neuromarketing, Bibliometric Analysis, Performance Analysis, VOSviewer, SCOPUS Database

1. INTRODUCTION

The term neuromarketing describes how neuroscientific methods are applied to markets and marketing exchanges in an attempt to assess, interpret, and comprehend human behaviour (Ramachandran, 2021). A neuromarketing strategy utilises neuroimaging technology as a tool for enhancing the effectiveness of an advertising campaign (Solomon, 2018). According to studies conducted by Alsmadi & Hailat (2021) and Casado-Aranda et al. (2019), neuroimaging measures can provide insights into customer preferences not previously available through traditional methods. The advertisement intake of individuals in economically advanced nations was assessed on a daily basis across several media platforms (media and the internet) (Aditya & Sarno, 2018; Alsharif, Salleh, Abdullah, et al., 2023; Alvino, L. et al., 2020).

A marketing professional must create distinctive ads in order to stand out from the crowd. So as to compete with others, they need to capture consumers' short attention spans and influence their minds and thinking. Ramachandran (2021) reported that sensory receptors receive 107 pieces of information every second. When ads are screened across multiple platforms regularly, they are more likely to succeed. Economic concerns have increased emphasis on producing superior advertisements (Dwivedi et al., 2021; KUYUCU, 2020). Consumers have been researched using focus groups and surveys. As a result of their bias and ambiguity, these methodologies do not give a reliable picture of consumer intentions (Harrell, 2019). According to researchers (Alsharif et al., 2023), the pre-trail of visual advertisements is inaccurate when combined with respondents' cognitive processes during an interview. Recall and perception are particularly affected.

Professor Ale Smitds introduced neuromarketing at Erasmus University in Rotterdam in 2002 to refer to neuroimaging techniques applied to marketing research (Mansor & Isa, 2020). His research has led him to hypothesize that neuroscientific tools, such as functional magnetic resonance imaging (fMRI), can be used to measure subconscious consumer processes, such as feelings, desires, and needs. Using fMRI, Bright House first introduced neuromarketing to marketing research (Mansor & Isa, 2020). The use of pupil measurement tools by Herbert Krugman in the early 1960s as a measure of consumer interest in packages and Galvanic Skin Response (GSR) as a symbol of customer emotional response to advertisements had been around since then (Eroglu & Kucun, 2020). In the late 1990s, Gerry Zaltman of Harvard University first reported on fMRI marketing (Alsharif et al., 2023; Mansor & Isa, 2020).

A better understanding of consumer influence and persuasion is vital for creating effective marketing campaigns (Dissanayake et al., 2019). Insights can be gained from neuromarketing by uncovering subconscious driving forces (Vinerean & Opreana, 2021). Using neuroscientific approaches will improve brand messages, product designs, and overall customer experiences. Marketing and research can be accurate with the right tools for data collection and interpretation. Research on neuromarketing provides valuable insight into consumer behaviour (Harrell, 2019; Ismajli et al., 2022). To influence consumer behaviour, researchers and marketers use neuromarketing.

Providing insight into best practices, potential pitfalls, and ethical considerations is the objective of this paper. Marketers will be able to formulate more responsible and customized marketing strategies based on the findings of this study. Marketing campaigns will be more successful if consumers can report to them more closely. This study will help researchers design more effective marketing strategies using the insight gained from this study. Understanding how neuromarketing influences consumers will lead to better marketing strategies.

2. BACKGROUND OF NEUROMARKETING AND NEUROSCIENCE TOOLS

2.1 Neuromarketing

Neuromarketing combines three primary fields - neuroscience, marketing, and psychology - to facilitate consumer decision-making processes by understanding their subconscious minds (H. Fauzi, Rizqullah, Ariyanti, Hadyningtyas, et al., 2022; Mansor & Isa, 2020; Ramachandran, 2021). Brands, products, advertisements, and decision-making interact with the brain and behaviour of individuals in order to identify a series of questions (Misra, 2023). Marketing and psychology are intertwined, which means consumer behaviour involves both mental and physical components. Neuroscience is intertwined with both areas as a way to learn more about and understand decision-making processes. Alvino et al. (2018) agreed that neuromarketing can assist marketers in gaining a more complete understanding of consumer behaviour. Figure 1 illustrates the collaboration among three major fields of neuromarketing. Three main factors need to be considered in a neuromarketing study. In the era of neuromarketing, findings are becoming increasingly relevant in delivering meaningful insights. Consumer preferences will be determined using neuromarketing data. By analysing the information, strategic advertising campaigns can be developed, and products or shopping environments can be updated.

Figure 1 shows the major fields of neuromarketing (Mansor & Isa, 2020)

2.2 Neuromarketing Tools

In the past, organizations have primarily relied on self-administered surveys, experiments, and focus groups to measure consumer wants, needs, and attitudes (Constantinescu et al., 2019; Hsu, 2017). This method has produced satisfactory results and helped organizations create a strategic marketing plan. In traditional market research, one of the major weaknesses is its dependence on respondents' honesty, as well as its inability to observe consumers' subconscious thoughts. It is easy to measure and understand the conscious part of the

consumer decision-making process, so most traditional research methods deal only with it. As a result of this traditional marketing approach, it fails to gather subconscious information about consumers (A. Kumar et al., 2020; Shukla, 2020) and leads to poor consumer behaviour predictions. In this case, the market research findings will not match the actual behaviour of the consumer at purchase (Brenninkmeijer et al., 2020). In Casado-Aranda et al., 2019 view, it is essential for marketers to know what consumers are thinking before they can shape, or modify, and communicate the right messages. According to Bhardwaj et al., (2020), Casado-Aranda et al. (2023) and Kari et al. (2020), neuromarketing involves measuring brain activity or electrical activity. Researchers have various tools available when conducting research, each with specific advantages and disadvantages based on the problem they are addressing. Arora (2020) and Mallik et al. (2021) use neuromarketing principles to create images that illustrate how the brain responds to marketing campaigns.
A neuromarketing analysis primarily involves Electroencephalography (EEG), Magneto Encephalography (MEG), Positron Emission Tomography (PET), and Functional Magnetic Resonance Imaging (fMRI), which provides the best evidence on how the brain processes information that drives purchasing decisions (Garczarek-Bąk et al., 2021; Gill & Singh, 2022; Robaina-Calderín & Martín-Santana, 2021). Figure 2 presents the available neuromarketing instruments. Consumers' brain responses to marketing stimuli are now primarily measured and mapped by fMRI, EEG, and MEG, which offer non-invasive measurement and mapping methods. Neuromarketing studies are largely conducted using these three methods, since many of them are non-invasive (Alvino, L. et al., 2020; Raiesdana & Mousakhani, 2022), EEG (Bhardwaj et al., 2020) and MEG (Mashrur et al., 2022). The majority of the results are presented in technical clinical terms, which makes it difficult for many social scientists to fully understand the research outcomes. Technologies used in neuroscience are advanced and expensive. A marketing or research professional who wishes to develop effective marketing strategies should understand the objectives of their marketing, the functionalities of each tool, how they work, and how to analyse data. Neuromarketing needs to be published and researched to fill in the knowledge gap and increase awareness of neuroscience as an important marketing concept.

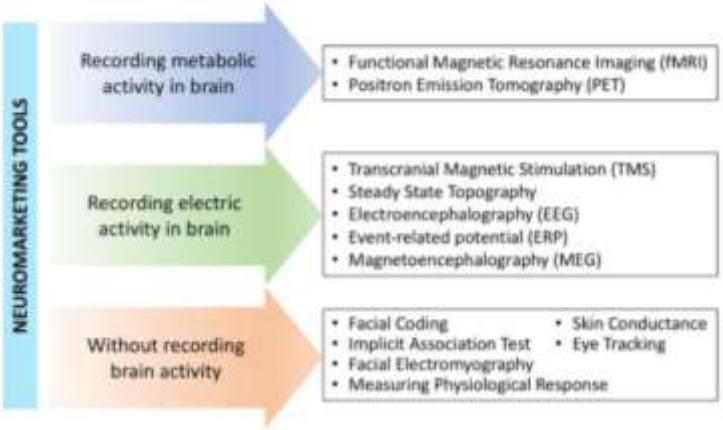

Figure 2 shows the various tools under Neuromarketing and their functions (Mansor & Isa, 2020)

2.2.1 Neuromarketing in consumer behaviour

In order to study consumption-related behaviours, such as selecting and consuming consumer products (i.e., consumer choices), functional magnetic resonance imaging (fMRI), electroencephalograms (EEGs), and magnetoencephalograms (MEGs) to name a few have been used. Research has been conducted to investigate the neuronal mechanisms involved in these actions (Fauzi & Widyarini, 2023; Narayanan & Praveen, 2020; Singh, 2020; Thomas, 2023). Marketing stimuli are examined in relation to their brain responses to those stimuli according to this method. Several studies are being conducted with the aim of improving marketers' understanding of how advertising by well-known companies affects the brain's many mechanisms of perception and memory.
ALSHARIF et al. (2021) & Alsmadi & Hailat (2021) have conducted research to better understand the neural connections between a cognitive response to memory and consumer preferences and decision-making. In this hierarchy of effects concept, advertising affects views (cognitions), which influence attitudes (feelings), which are in turn influenced by behavioural outcomes on consumption (behavioural outcomes on consumption) (Byrne et al., 2022; P. M. Oliveira et al., 2022). It is important to remember that many brain processes are involved in emotional outcomes, and the effects of one model cannot be predicted accurately (Gountas et al., 2019; Vences et al., 2020). Some of the most popular tools are studied below in detail.

- **Functional magnetic resonance imaging (fMRI)**

This method studies brain structure and data from activated areas by using radio waves combined with a magnetic field (Scholte et al., 2022). On a computer screen, blood rushes through various brain segments (Avinash et al., 2018). The data will be updated every five seconds. A strong correlation exists between neural activity and blood oxygen levels: as neural activity rises, blood oxygen levels increase (Brenninkmeijer et al.,

2020). A brain mapping technique is used to identify patterns in the consumer's brain that are common in response to marketing stimuli. Arousal, cravings, and feelings are assessed. Avinash et al. (2018) use this approach for product development, testing, packaging, and pricing.
A proxy for neural activity, functional magnetic resonance imaging (fMRI) monitors blood flow and oxygen levels in the blood (Rawnaque et al., 2020). Researchers can visualize and map brain activity with fMRI, but they can also measure how blood oxygenation changes when they perform certain tasks (Levallois et al., 2021). Advertisements, product images, or pricing strategies are commonly evaluated using fMRI. A series of images are taken by the scanner, allowing researchers to construct 3D brain maps. Non-invasive and ionizing radiation-free, this method is safe for humans (Mohsen & Mostafa, 2020), and ethical research practices require it.
To investigate consumer choices and preferences, researchers often use fMRI in the context of neuromarketing. This method identifies brain regions that respond emotionally to products and advertisements, revealing subconscious factors that influence consumer decisions (Plassmann, 2019). In order to create more effective marketing campaigns, marketers need to understand the neural basis of consumer behaviour. In the bibliometric/bibliographic analysis of neuromarketing and consumer behaviour, fMRI plays a significant role. Neuroscience, psychology, and marketing combine in neuroscience and fMRI studies (Neurensics, 2023). Consumer behaviour can be understood in greater depth by identifying and analysing studies that use fMRI. Using neuroimaging techniques like fMRI (HAMELIN & HARCAR, 2020) to develop future research directions and marketing strategies is imperative (HAMELIN & HARCAR, 2020).

• Positron Emission Tomography (PET): -

For the same purpose, PET and fMRI detect consumers' neural responses to marketing stimuli. Radioactive elements are injected into the subject's brain, which is measured with radiation pulses. Due to its cost and noise, this is considered inconvenient by both researchers and subjects (Alsmadi & Hailat, 2021). As a result, it is used in advertising and packaging to detect the emotions of subjects.
Neuromarketing uses Positron Emission Tomography (PET) to study customer behaviour neurally (Gurgu et al., 2020). Radiolabelled compounds are detected and visualized in PET scans, which provide valuable insight into brain activity. An isotope is trapped in the bloodstream by a radiopharmaceutical. These radiolabelled compounds mimic neurotransmitters and glucose, for instance. Once introduced into the body, radiopharmaceuticals naturally distribute to the brain regions where targeted processes or functions occur (Kiran & Prabhakar, 2022). During radioactive decay, positrons collide with electrons resulting in gamma rays. In a PET scanner, gamma ray detectors are used to identify them. It produces detailed images of the metabolic or neurochemical activity of the brain and can be used to analyse different brain regions (Fauzi & Widyarini, 2023). Different settings can be used to conduct this method. Thomas (2023) uses PET scans to study how marketing strategies and stimuli affect brain activity. When consumers view advertisements, make purchasing decisions, or respond to specific product features, it can reveal which areas of the brain are active. It is possible for marketers to better understand consumer behaviour by understanding neural mechanisms. Marketing campaigns and strategies can benefit from this knowledge.
A bibliometric/bibliographic analysis of PET imaging is essential to understanding neuromarketing's interdisciplinary nature (Singh, 2020). Researchers can access data from PET studies to understand consumer behaviour from a neurological perspective. The findings inform neuromarketing broader landscape, emphasizing the significance of neurochemical processes (Narayanan & Praveen, 2020). This will open up further exploration and insights into consumer behaviour by incorporating PET studies.

• Electroencephalography (EEG): -

In neuromarketing, electroencephalograms are used. A cap-like structure containing sensors is placed on the scalp to measure brain activity in the subcortical region, where decision-making occurs. Researchers, psychologists, neurologists, and neuroscientists use this method widely (Garczarek-Bąk, 2019). Moreover, Kaheh et al. (2021) report argues that EEGs and conventional marketing research surveys serve a similar purpose to a certain point in time. Although the EEG is similar to fMRI and PET technologies in terms of purposes, it is more expensive and requires different data collection methods. Many companies have already used this method to improve customer service (Byrne et al., 2022)..
In neuromarketing and consumer behaviour research, electroencephalography plays a crucial role. As a result of this measurement and recording, we gain valuable insights into neural processes underlying consumer decisions and responses (Khurana et al., 2021). A specialized cap or electrodes are placed on the scalp during EEG. An electrode is used to detect and record brain signals. Typically, electroencephalograms represent electrical activity as a series of waveforms, such as delta, theta, alpha, beta, and gamma waves, typically in frequency domains (Fauzi et al., 2022). These waves can be analysed, including frequency, amplitude, and distribution.
In addition to its exceptional temporal resolution, EEG allows researchers to capture brain activity in real time. Thus, Costa-Feito et al. (2023) describe it as an ideal tool to assess consumers' immediate reactions to advertisements, product presentations, and purchasing decisions. As a result of EEG, consumer choices can be explained in terms of attention, perception, and emotional engagement (Georgiadis et al., 2022). Research laboratories, simulated shopping environments, and even real retail spaces can be used to conduct EEG studies.

Using EEG for neuromarketing is valuable because it offers real-time insights into consumer behaviours (Raiesdana & Mousakhani, 2022). Specific neural patterns can be identified to better target marketing strategies, products, or consumer segments.
A bibliometric/bibliographic analysis of neuromarketing and consumer behaviour reveals that EEG studies play an important role in understanding the temporal aspects of consumer decision-making. Avinash et al. (2018) integrate EEG research findings to explore consumer behaviour at different points in their decision-making journeys. As a result, more effective marketing strategies are developed. The temporal precision of EEG makes it an essential part of neuromarketing research (Garczarek-Bąk, 2019).

• Magnetoencephalography (MEG)

This non-invasive procedure uses magnetic potentials to gather brain activity data function (Massimo & Sara, 2022). The detectors are mounted onto the scalp. The method involves collecting information from subjects in a separate facility, as well as a room without electromagnetic fields, making it more expensive than EEG (Garczarek-Bąk, 2019). Consumer emotional responses have been studied using this technology (Levallois et al., 2021).
Within the context of neuromarketing research (Bhandari, 2020), magnetoencephalography (MEG) is an advanced neuroimaging technique. Using MEG, neuronal electrical currents create magnetic fields that reveal brain activity. As a result of its exceptional spatial and temporal resolution, researchers can pinpoint exact timing and location of neural processes related to consumer decisions. The brain generates weak magnetic signals, which are detected by MEG in a highly controlled electromagnetic environment (Gross, 2019). It involves wearing a helmet-like device with superconducting quantum interference devices (SQUIDs) that contain highly sensitive sensors (H. Fauzi, Rizqullah, Ariyanti, Anindhita Hadyningtyas, et al., 2022).
Consumer decision processes can be captured using MEG in neuromarketing research. Different marketing stimuli can trigger different patterns of brain activity, such as advertisements or product presentations. Insights such as these help identify cognitive and affective processes underlying consumer attention, emotional engagement, and preferences (Alsharif, Salleh, Hashem, Khraiwish, Putit, & Arif, 2023). MEG contributes unique information about brain activity's temporal aspects, complementing other neuroimaging methods such as fMRI and EEG. MEG strikes a balance between fMRI and EEG (Singh, 2020) which provide excellent spatial resolution but low temporal resolution and lower spatial accuracy. Researchers gain a comprehensive understanding of consumer preferences over time by integrating MEG data into bibliometric/bibliographic analysis of neuromarketing (Misra, 2023). With this multifaceted insight, neuromarketing becomes more precise and more consumer centric.

• Eye-tracking

Data on eye focusing is collected when advertising stimuli are presented. Moreover, it can assist in collecting data while shopping, investigating a product, and participating in advertising campaigns (Iloka & Anukwe, 2020). Two types of eye movements are identified: saccades and fixations. A saccade occurs when the eye moves between two locations, while a fixation is a continuous halt at one point. Eye-tracking is one of many methods used by market research firms, which is mainly conducted in regulated environments (R. De Oliveira et al., 2015). Product creation and decision-making can be aided by eye-tracking.
In neuromarketing, eye tracking is a sophisticated method of researching consumer behaviour. The study uses precise eye movements and gaze points to understand how people interact with various stimuli, like advertisements, packaging, and websites (Gheorghe et al., 2023). People's attention patterns, the order in which they pay attention, and the length of time they dwell on specific elements are all revealed by eye tracking. Mustikawan et al. (2021) perform eye tracking research in controlled laboratory settings or natural environments. Eye-tracking systems monitor eye movements, pupil dilation, and fixations on screens and real objects with infrared cameras. Azman et al. (2019) integrate these devices into glasses or head-mounted systems to offer a more natural and unobtrusive participant experience.
Research using eye tracking has a variety of implications for neuromarketing. Researchers can use this tool to identify which aspects of marketing materials are most captivating or distracting to consumers (Ionescu & Romanelli, 2019). As a result of eye tracking, marketing strategies are optimized by identifying how visual content affects consumer choice, brand recognition, and overall user experience. In particular, this method can be used to quantify consumer gaze patterns and visual engagement to evaluate the effectiveness of various visual elements (Sola et al., 2022). Since consumers are often unaware of their eye movements and attention shifts, eye tracking can provide data on subconscious reactions. Neuromarketing's unconscious element offers new insights into consumer choices by adding bibliometric/bibliographic dimension (Singh, 2020). With eye tracking data, you can enhance the understanding of how consumers process visual information and make informed decisions, leading to better marketing strategies.

3. BIBLIOMETRIC RESEARCH METHOD

3.1 Search terms

Table 1 lists the criteria for including and excluding. The researcher utilized SCOPUS on September 15, 2023, to explore publications between 2000 and 2023. A broad spectrum of relevant topics was encompassed in the initial search term. These variations were captured using the logical operators "OR" and "AND" as well as key terms such as "Neuromarketing," "Neuroscience," "fMRI," "eye tracking," "event-related potential," and "ERP." Using this comprehensive approach, the initial 4252 records included articles on neuromarketing techniques, consumer behaviour, and marketing strategies. As a result of further refinement, a focused dataset of 1359 articles were developed for advanced analysis within the realm of this bibliometric research.

Table 1 shows the Article inclusion and exclusion criteria.

SELECTION CRITERIA	EXCLUDE	INCLUDE
Database: Scopus		4252
Date of Search: 15 September 2023		4252
Period of Publications: 2000-2023		4252
Search term: Title-abs-key ("Neuromarketing" OR "Neuroscience*" OR "fMRI" OR "functional magnetic resonance imaging" OR "eye tracking" OR "event-related potential" OR "ERP" OR "electroencephalography" OR "EEG" OR "Magneto Encephalography" OR "MEG" OR "Positron Emission Tomography" OR "PET" OR "Steady State Topography" OR "SST" OR "Electrocardiography" OR "ECG" OR "Eye track*" OR "Facial electromyography" OR "fEMG" And "Consumer Behaviour" OR "Marketing" OR "Advertis*" OR "Marketing Strategies")		4252
Subject area: Business, management & account, Social sciences, Neuroscience, Economics, Econometrics and Financial, Psychology	2058	2194
Publication type: Articles, Review, Conference paper, Book chapter	146	2048
Language screening: English	68	1980
Keywords: Human, marketing, neuromarketing, article, eye tracking, consumer behaviour, eye-tracking, advertising, neuroscience, consumer neuroscience, consumer, neuroeconomics, EEG, eye movements, consumer behaviour, FMRI, consumption behaviour, neuroimaging, brain mapping, comer, sales, behavioural research, electronic commerce, eye movement, social media, internet, behaviour, choice behaviour, evoked potential, arousal, retailing, advertising effectiveness, evoked response, websites, methodology, customer satisfaction, systematic review, marketing research, strategic planning, stimulus responses, neurosciences, research, eye tracking technologies, advertisement, social marketing, green marketing, e-commerce	621	1359

3.2 Data Collection

The aim of this bibliometric article was to identify relevant publications within the period 2000-2023 from the SCOPUS database utilizing a systematic and comprehensive selection process. During the search conducted on September 15, 2023, 4252 records were identified. In order to ensure that the literature chosen is both relevant and up to date, the search restricted itself to publications published during the specified time period. Search terms were used extensively to capture a wide range of relevant research. The keyword strategy included keywords and phrases associated with neuromarketing, including neuroimaging techniques like fMRI and EEG, as well as eye-tracking techniques. The search was also enhanced with terms associated with consumer behaviour and marketing strategies, which ensured a comprehensive retrieval of relevant publications. Using "OR" operators within brackets meant that any record containing at least one of these terms was considered potentially relevant, thus the initial count of 4252 records.

As the research is multidisciplinary in nature, subject areas were used as an additional criterion for selection. A total of 2194 records were identified which were deemed relevant to the following subject areas: Business, Management & Accounts, Social Sciences, Neuroscience, Economics, Econometrics, Financial, and Psychology. It was also necessary to account for specific publication types as part of the selection process in order to maintain a focus on academic rigor, including Articles, Reviews, Conference Papers, and Book Chapters. With this refinement, only substantial scholarly contributions were retained, thus reducing the number of records to 2048. In addition, publications not written in English were excluded in order to align with the language of academic discourse and the target audience. As a result of this language screening step, the number of records has been reduced to 1980. As a last step, a carefully chosen to set of keywords was utilized for the purpose of identifying articles that directly addressed the research questions. This list of keywords includes topics such as marketing, neuromarketing, consumer behaviour, and neuroimaging techniques. Based on these criteria, the number of records was reduced to 1359, ensuring that the articles selected were closely aligned with the research's primary objective.

VOSViewer is a valuable tool frequently employed in bibliographic and bibliometric analyses and so has been utilised within the realms of this neuromarketing and consumer behaviour research. This sophisticated software facilitates the visualization and examination of complex bibliographic networks (Bayu et al., 2022). Researchers employ VOSViewer to explore relationships between various entities, such as authors, journals, countries, and institutions, in their extensive body of literature. Through intricate visualization techniques, VOSViewer aids in identifying crucial trends, patterns, and connections within the academic landscape, shedding light on key research themes, prolific authors, influential publications, and the collaborative networks that underpin the field (Saglam, 2022). By delving into these insights, researchers can gain a comprehensive

understanding of the structure and evolution of neuromarketing and consumer behaviour research, supporting informed data analysis, interpretation, and informed decision-making in their academic pursuits.

3.3 Finalising search techniques

Research on neuromarketing and consumer behaviour utilized VOSViewer for bibliometric analysis. A key objective of the study was to systematically evaluate and integrate the vast literature on these topics (R. R. Kumar et al., 2023). First, VOSViewer was used to construct co-authorship networks. A comprehensive dataset containing author names, publication titles, abstracts, and citation counts was imported for this purpose. Based on VOSViewer's advanced algorithms, authorship networks were formed (Guleria & Kaur, 2021). These networks helped identify research clusters within neuromarketing and consumer behaviour. VOSViewer visualizes author collaboration dynamics and key contributors to the field (Yu et al., 2020).

Additionally, VOSViewer provided the basis for generating co-citation networks by processing citations in the imported dataset. This enabled identification of seminal works and research themes that have greatly shaped neuromarketing and consumer behaviour discourse (McAllister et al., 2022). It facilitates the recognition of seminal theories, methodologies, and emerging trends (Oyewola & Dada, 2022). In addition, cluster analysis capabilities of VOSViewer were used to cluster related articles and authors into thematic clusters. This organized the extensive literature, allowing for easier interpretation. The tool finds distinct research themes and subfields within neuromarketing and consumer behaviour by clustering articles by their content and citation patterns. As a result, scholars were able to focus on specific research areas or emerging trends (Bayu et al., 2022).

This paper used VOSViewer to construct authorship networks, co-citation networks, and thematic clusters. VOSViewer enhanced the comprehensibility and interpretability of the research findings by visually representing and structuring the extensive body of literature. VOSViewer was an effective tool for conducting bibliometric analysis in neuromarketing and consumer behaviour by providing a rigorous and data-driven approach.

4. FINDINGS

4.1 Performance Analysis

From 2000 to 2024, Figure 3 presents a chronology of publications in neuromarketing, neuroscience, and consumer behaviour. It is crucial to understand these interdisciplinary domains as they have evolved over time. These publications appear to have been steadily increasing based on this progression. In 2000 and 2001, just eight publications per year, which was modest. However, research output is increasing steadily as we move into the mid-2000s. As the trend continues, it reaches its peak in 2022 with 151 publications. First, it highlights the growing interest and recognition of neuromarketing, neuroscience, and consumer behaviour in academic and community research. As a result of their potential implications for marketing strategies, consumer decision-making, and human behaviour in commerce, these fields have attracted considerable scholarly activity. Additionally, increasing publications indicate a deeper exploration of these topics, due to technology and design advances. Researchers are looking deeper into neuromarketing and consumer neuroscience as they mature.

In conclusion, the upward trajectory in neuromarketing and neuroscience research publications over the years underscores the enduring relevance of these fields. It highlights the evolving nature of consumer behaviour analysis and the growing importance of understanding the neurological underpinnings of decision-making in marketing. As these fields continue to evolve, they offer promising avenues for academic exploration, practical applications, and ethical considerations. There are numerous reasons for the sudden drop in publications in 2024, including the timing of data collection or a shift in research focus. A deeper investigation is needed to understand the underlying reasons and potential implications for future research. This table illustrates how research in neuromarketing, neuroscience, and consumer behaviour is dynamic and evolving. Researchers and scholars have an opportunity to track and interpret the evolution of knowledge in these fields with the help of this trend. Science and neuromarketing are relevant to academia and business, as illustrated in Figure 3. In light of the information that neuromarketing provides, it is obvious that it is crucial. Business needs this knowledge to optimize marketing strategies, improve consumer engagement, and drive sales. From improving academic knowledge to understanding consumer behaviour, this research trend provides numerous benefits. Business and marketers can increase the effectiveness of their marketing campaigns by incorporating neuromarketing findings. Consumer protection and ethics are also tasked with policymakers and ethicists. These fields remain relevant as neuromarketing, and neuroscience research publications grow. These fields are constantly evolving as academic exploration, practical applications, and ethical considerations lead to a deeper understanding of consumer behaviour.

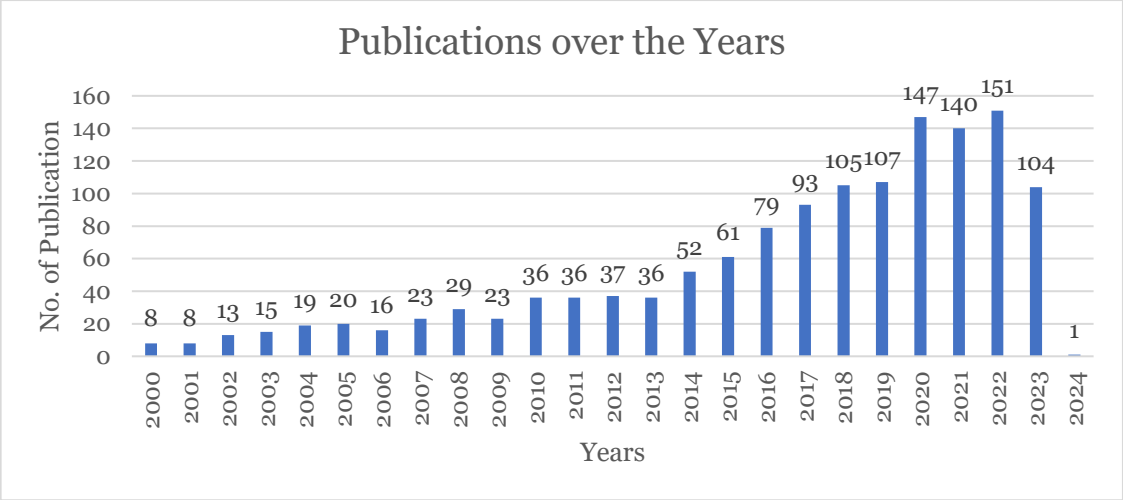

Figure 3 shows publication trends of Neuromarketing and Consumer Behaviour

4.2 Prominent authors, organisations, and countries for Neuromarketing

Figure 4 provides valuable insight into the collaborative landscape and the impact of individual researchers within neuromarketing and consumer behaviour research. As a result of the analysis, the number of publications and number of citations among researchers vary greatly (Sahudi et al., 2022). Despite producing a single document, Young W., Hwang K., McDonald S., and Oates C.J. have combined to receive 934 citations for a single document. Their research or groundbreaking findings may have had a significant impact on the field.

As well, several authors collaborated on multiple papers, indicating a sustained research partnership. Chatterjee A. and Vartanian O. have co-authored two papers, demonstrating a productive research partnership. Two documents have been authored together by Ohme R., Reykowska D., Wiener D., and Choromanska A., indicating a persistent neuromarketing research agenda. In addition to being interdisciplinary, research in these fields is also diverse, ranging from psychology, neuroscience, to marketing. This interdisciplinary collaboration improves the research landscape by bringing together multiple perspectives and methodologies. Also, the presence of authors such as Plassmann H., who have co-authored multiple publications, indicates their involvement and leadership. Within neuromarketing and consumer behaviour research, this suggests a significant role in shaping the research agenda.

Research productivity and impact in neuromarketing and consumer behaviour are heterogeneous among authors in this coauthorship analysis. Researchers' influence, collaborative patterns, and interdisciplinary nature are evident. It is crucial to understand these trends in order to evaluate the field comprehensively and identify key contributors. To provide better understanding and clarity, Table 2 shows the list of authors with their citations, publication numbers, and citation numbers.

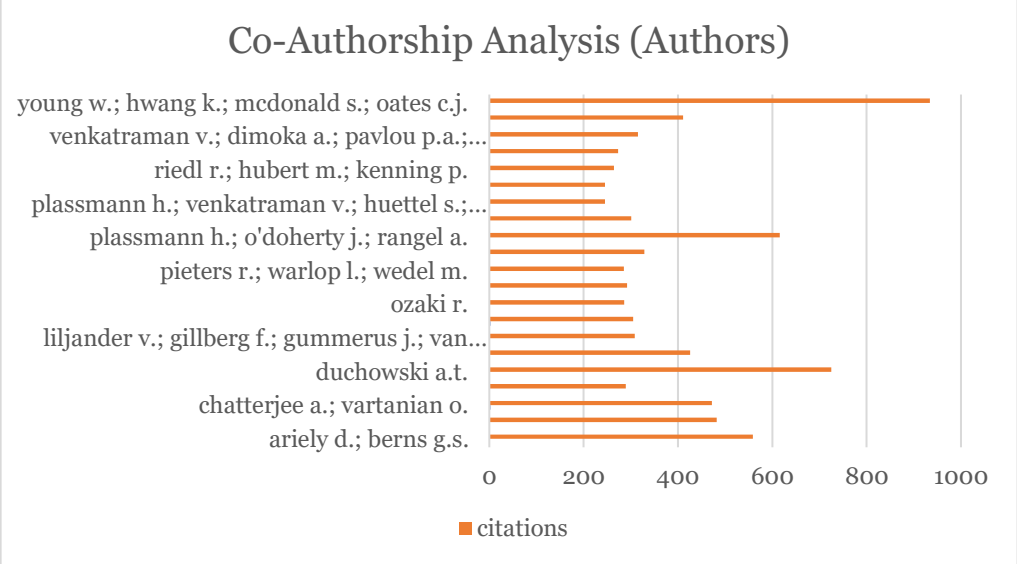

Figure 4 shows the citations made by various authors and their level of prominence in this field.

Table 2 shows the list of authors with their citations, publication numbers and their authority on this research topic, neuromarketing and consumer behaviour.

AUTHORS	PUBLICATIONS	CITATIONS
Ariely D.; Berns G.S.	1	559
Chandon P.; Hutchinson J.W.; Bradlow E.T.; Young S.H.	1	482
Chatterjee A.; Vartanian O.	2	472
Deacon B.J.	1	289
Duchowski A.T.	1	725
Lee N.; Broderick A.J.; Chamberlain L.	1	426
Liljander V.; Gillberg F.; Gummerus J.; Van Riel A.	1	308
Ohme R.; Reykowska D.; Wiener D.; Choromanska A.	2	305
Ozaki R.	1	286
Peattie K.	1	292
Pieters R.; Warlop L.; Wedel M.	1	285
Pieters R.; Wedel M.; Batra R.	1	329
Plassmann H.; O'doherty J.; Rangel A.	1	616
Plassmann H.; Ramsøy T.Z.; Milosavljevic M.	1	301
Plassmann H.; Venkatraman V.; Huettel S.; Yoon C.	1	245
Prakash A.	1	245
Riedl R.; Hubert M.; Kenning P.	1	264
Sammer K.; Wüstenhagen R.	1	273
Venkatraman V.; Dimoka A.; Pavlou P.A.; Vo K.; Hampton W.; Bollinger B.; Hershfield H.E.; Ishihara M.; Winer R.S.	1	315
Welle F.	1	411
Young W.; Hwang K.; McDonald S.; Oates C.J.	1	934

In Figure 5, several organizations have contributed significantly to neuromarketing, neuroscience, and related research. Aside from that, it offers valuable insights into the collaborative landscape and impact of various institutions and research centres in neuromarketing. As a result of this analysis, some key trends and characteristics emerge. The number of publications and citation counts of organizations contributing to research on neuromarketing and consumer behaviour is evident. There are several notable examples, including the "University of Pennsylvania" and the "University of Toronto Scarborough." While the latter has contributed two documents and received 472 citations, the former has authored four documents and received 511 citations. In addition to their extensive research output and impact, these institutions demonstrate a strong commitment to knowledge advancement.

Alternatively, there are organizations with low research outputs and citations. The Stern School of Business, New York University, has two documents, but its citation count is low, indicating its research focus is different. Likewise, "Fraunhofer Institute for Process Engineering and Packaging (IVV)" produced one document with 411 citations, suggesting a niche in neuromarketing and consumer behaviour. An important trait to consider is the total link strength, which measures how well organizations collaborate. In some cases, institutions with high total link strength values of 5, such as "Department of Marketing, INSEAD" and "Perception Research Services Inc.," are actively engaged in collaborative research efforts, which can enhance understanding. Additionally, organizations that participate in neuromarketing, and consumer behaviour research span a wide range of geographical regions. Globally, institutions in the United States, the United Kingdom, Germany, and Canada are actively involved in this field. This highlights the international nature of this research.

Consequently, the coauthorship analysis reveals diverse trends in research output, impact, collaborative networks, and geography. In this bibliometric/bibliographic analysis, you can identify key contributors, evaluate global reach, and understand the variation in research focus and impact among organizations. Figure 6 displays a network visualization of co-authorships based on the top 20 publishing organizations. The blue nodes represent publications in 2015, green nodes represent publications in 2017, and yellow nodes represent publications in 2019.

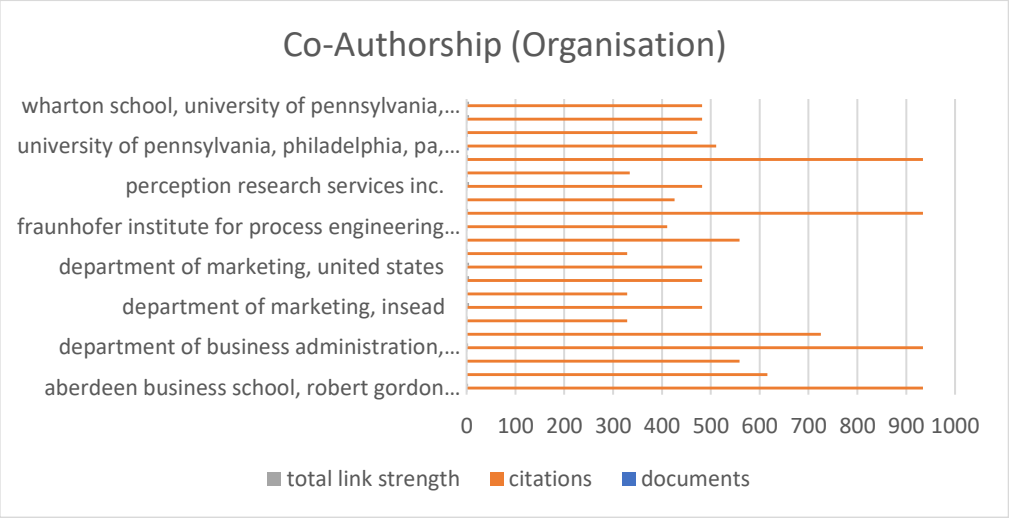

Figure 5 the coauthorship analysis on the basis of publishing organisations with their respective number of publications

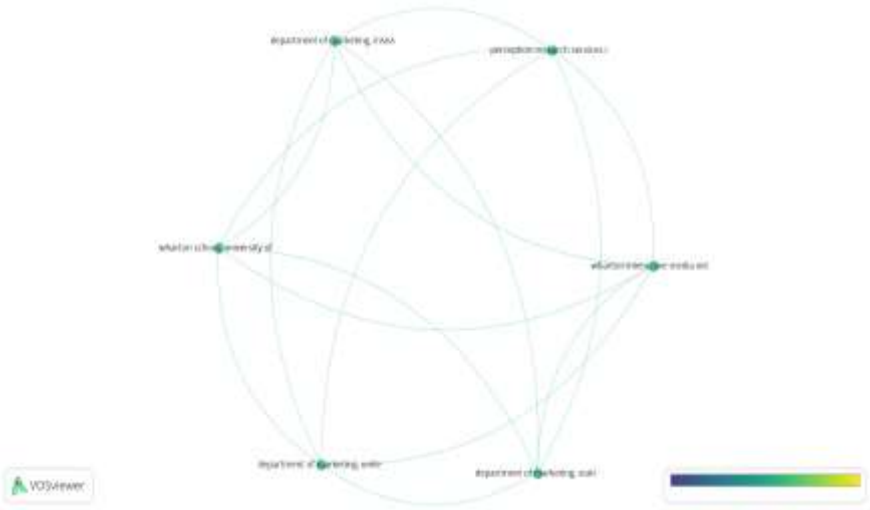

Figure 6 shows the network visualisation of co-authorship on the basis of top 20 publishing organisations in this field.

An in-depth analysis of co-authorship in neuromarketing, neuroscience, and related fields is presented in Figure 7, with countries as the unit of analysis. An in-depth bibliometric/bibliographic analysis of this field needs to take into account several prominent trends. A significant part of the United States' contribution to neuromarketing and consumer behaviour lies in its 321 documents and 14,394 citations. It suggests a robust research ecosystem fuelled by substantial funding, academic institutions, and research initiatives.

In contrast, some nations have lower research output and impact. For instance, Malaysia has 26 documents and 550 citations. In Malaysia, the lower numbers may indicate a nascent or less extensive research environment. These countries can be analysed for growth and development insights. Additionally, total link strength reflects the strength of collaborative networks among countries. The United Kingdom has 68 total link strengths, indicating extensive international research collaboration. By engaging in global research partnerships, he or she is able to gain a comprehensive understanding of the subject. Insights into the evolution of neuromarketing and consumer behaviour can also be gained by examining trends in documentation and citations. A sustained commitment to advancing knowledge may be indicated by countries with consistent growth in document count and citations. As shown in Figure 8, there is a visual representation of the coauthorship analysis based on countries with the blue nodes representing research published in 2015 and moving to the brighter yellow nodes representing research published in 2019.

In summary, the coauthorship analysis on countries reveals disparities in research output and impact, highlights global leaders and emerging contributors, highlights international collaboration, and provides a historical perspective. In order to conduct an in-depth bibliometric/bibliographic analysis and understand the research landscape in these areas, it is crucial to analyse these trends.

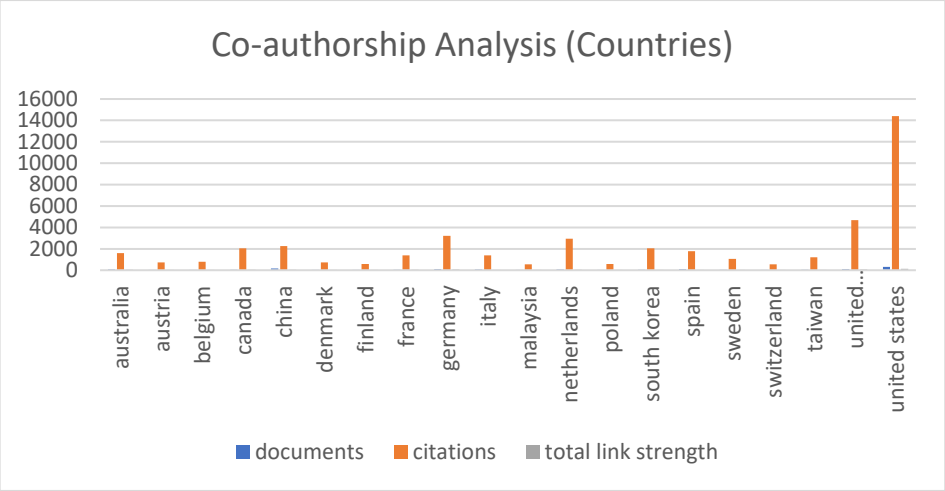

Figure 7 shows coauthorship analysis on the basis of top publishing countries with their respective publication numbers.

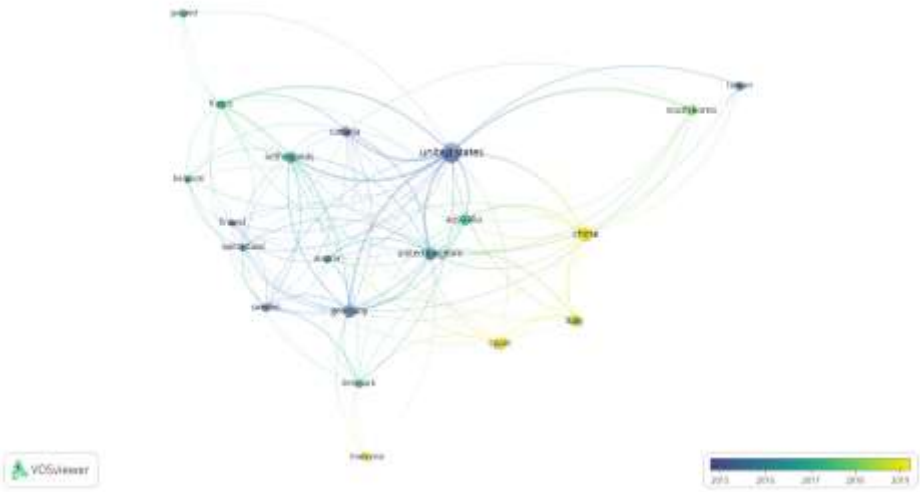

Figure 8 shows the network visualization of coauthorship analysis on the basis of countries.

4.3 Prominent journal for Neuromarketing and Consumer Behaviour

Table 3 discusses prominent neuromarketing and consumer behaviour journals, focusing on the titles, citations, and marketing journals. The findings provide insight into Firstly, "Sustainable Development" has the highest number of citations (934). Research in neuromarketing and consumer behaviour is interconnected with sustainability, suggesting a potential interdisciplinary aspect.

The citation counts of journals like "Business Strategy and the Environment" (2001) and "Management Science" (2002) are lower (292 and 285). It may be that these journals have had less impact on research. It may also reveal unique perspectives or niche areas within neuromarketing and consumer behaviour to explore their content. Several marketing journals are also appearing consistently across different years, indicating their relevance in the field. Some of the journals in this category are "Journal of Marketing," "Journal of Marketing Research," and "Journal of Consumer Psychology". These journals provide insights into changing research landscapes by analysing their content evolution. In addition to the inclusion of journals such as Trends in Cognitive Sciences and Journal of Neuroscience, neuromarketing demonstrates its interdisciplinary nature. An in-depth analysis requires an understanding of interdisciplinary collaboration within a field.

In conclusion, the research into neuromarketing and consumer behaviour shows the interdisciplinary nature of these fields, their sustainability potential, and their enduring relevance. Providing an in-depth analysis of these journals' content and impact will enhance this bibliometric/bibliographic study.

Table 3 shows top 20 most influential journals in the field of Neuromarketing and Consumer Behaviour

YEAR	JOURNAL TITLE	CITED BY	MARKETING JOURNAL
2010	Sustainable Development	934	
2002	Behaviour Research Methods, Instruments, and Computers	725	
2007	Journal of Neuroscience	616	
2010	Nature Reviews Neuroscience	559	
2009	Journal of Marketing	482	x
2007	International Journal of Psychophysiology	426	
2011	Resources, Conservation and Recycling	411	
2010	Journal of Marketing	329	x
2015	Journal of Marketing Research	315	x
2014	Trends in Cognitive Sciences	314	
2006	Journal of Retailing and Consumer Services	308	
2012	Journal of Consumer Psychology	301	
2001	Business Strategy and the Environment	292	
2013	Clinical Psychology Review	289	
2011	Business Strategy and the Environment	286	
2002	Management Science	285	
2006	Business Strategy and the Environment	273	
2010	MIS Quarterly: Management Information Systems	264	
2015	Journal of Marketing Research	245	x
2002	Business Strategy and the Environment	245	

4.4 Prominent article for Neuromarketing

When conducting a bibliometric and bibliographic analysis on neuromarketing and consumer behaviour, it is essential to consider the prominence of articles based on their citation counts. The highest-cited articles, especially those addressing sustainability and green consumer behaviour, offer valuable insights, while older foundational research also plays a crucial role in understanding the field's development. Additionally, articles from the early 2010s indicate ongoing interest and relevance in this research area.

A summary of some of the most important articles published in neuromarketing and consumer behaviour can be found in Table 4. Based on citations and attention, this article significantly impacted ongoing research. These articles provide insight into the prominence and impact of neuromarketing and consumer behaviour articles. With 934 citations, "Sustainable Consumption: Green Consumer Behaviour When Purchasing Products" by Young et al. in 2010 stands out. Consequently, neuromarketing has explored sustainability and green consumer behaviour. In contrast, the lowest-cited articles, "Consumer Neuroscience: Applications, Challenges, and Possible Solutions" by Plassmann et al. in 2015 and "Are there neural gender differences in online trust?" by Riedl et al. in 2010, have received 245 citations each. Even though these articles have fewer citations, their publication years reveal interesting trends when analysing the data further. The early 2000s saw articles like "A Breadth-First Survey of Eye-Tracking Applications" by Duchowski and "Golden Goose or Wild Goose?" by Peattie, which appeared in 2001, received considerable attention, indicating that foundational research laid the foundation. In addition, articles from 2010 include "Neuromarketing: Hope and Hype of Neuroimaging in Business" by Ariely et al. Neuromarketing continues to be relevant and popular, as evidenced by citation counts for "The Stopping Power of Advertising: Measures and Effects of Visual Complexity" by Pieters et al.

Research on neuromarketing and consumer behaviour requires a bibliometric and bibliographic analysis that considers how prominent articles are based on how many times they are cited. In addition to the most cited articles, older foundational research also contributes to understanding the field's development. This research area continues to be relevant and attracts articles from the early 2010s.

Table 4 shows a list of the most influential journal articles on Neuromarketing and Consumer Behaviour

AUTHORS	TITLE	YEAR	CITED BY
Young W.; Hwang K.; McDonald S.; Oates C.J.	Sustainable consumption: Green consumer behaviour when purchasing products	2010	934
Duchowski A.T.	A breadth-first survey of eye-tracking applications	2002	725
Plassmann H.; O'Doherty J.; Rangel A.	Orbitofrontal cortex encodes willingness to pay in everyday economic transactions	2007	616
Ariely D.; Berns G.S.	Neuromarketing: The hope and hype of neuroimaging in business	2010	559
Chandon P.; Hutchinson J.W.; Bradlow E.T.; Young S.H.	Does in-store marketing work? effects of the number and position of shelf facings on brand attention and evaluation at the point of purchase	2009	482
Lee N.; Broderick A.J.; Chamberlain L.	What is 'neuromarketing'? A discussion and agenda for future research	2007	426
Welle F.	Twenty years of PET bottle to bottle recycling - An overview	2011	411
Pieters R.; Wedel M.; Batra R.	The stopping power of advertising: Measures and effects of visual complexity	2010	329
Venkatraman V.; Dimoka A.; Pavlou P.A.; Vo K.; Hampton W.; Bollinger B.; Hershfield H.E.; Ishihara M.; Winer R.S.	Predicting advertising success beyond traditional measures: New insights from neurophysiological methods and market response modelling	2015	315
Chatterjee A.; Vartanian O.	Neuroaesthetics	2014	314
Liljander V.; Gillberg F.; Gummerus J.; van Riel A.	Technology readiness and the evaluation and adoption of self-service technologies	2006	308
Plassmann H.; Ramsøy T.Z.; Milosavljevic M.	Branding the brain: A critical review and outlook	2012	301
Peattie K.	Golden goose or wild goose? The hunt for the green consumer	2001	292
Deacon B.J.	The biomedical model of mental disorder: A critical analysis of its validity, utility, and effects on psychotherapy research	2013	289
Ozaki R.	Adopting sustainable innovation: What makes consumers sign up to green electricity?	2011	286
Pieters R.; Warlop L.; Wedel M.	Breaking through the clutter: Benefits of advertisement originality and familiarity for brand attention and memory	2002	285
Sammer K.; Wüstenhagen R.	The influence of eco-labelling on consumer behaviour - Results of a discrete choice analysis for washing machines	2006	273
Riedl R.; Hubert M.; Kenning P.	Are there neural gender differences in online trust? An fMRI study on the perceived trustworthiness of eBay offers	2010	264
Plassmann H.; Venkatraman V.; Huettel S.; Yoon C.	Consumer neuroscience: Applications, challenges, and possible solutions	2015	245
Prakash A.	Green marketing, public policy, and managerial strategies	2002	245

4.5 Knowledge foundations of Neuromarketing and Consumer Behaviour through co-citation analysis

The highest, lowest, and other important traits within a dataset must be identified and analysed when conducting a co-citation analysis (Hedlund, 2020). Figure 9 illustrates how specific references can be significant and relevant to the bibliometric and bibliographic analysis of neuromarketing and consumer behaviour. In the dataset, the reference "Neuromarketing: The Hope and Hype of Neuroimaging in Business" by Ariely and Berns in 2010 has 39 citations and 105 links. Thus, this article may play a key role in neuromarketing's co-citation network.

However, Rayner's 1998 "Eye Movements in Reading and Information Processing: 20 Years of Research" reference has fewer citations and link strengths, with 28 citations and 26 total links. Though foundational, these references may not have as much impact. A study conducted by Hubert and Kenning in 2008, "A Current Overview of Consumer Neuroscience", and "Application of Frontal EEG Asymmetry to Advertising Research," by Ohme et al., were cited and linked moderately in 2010 to indicate their contribution to the field.

Furthermore, references like "Consumer Neuroscience: Assessing the Brain Response to Marketing Stimuli Using Electroencephalogram (EEG) and Eye Tracking" by Khushaba et al. in 2013 and "The Contribution of Neuroscience to Consumer Research" by Solnais et al (2013). In 2013, they had a high citation number and moderate link strength, which underscored their relevance and significance. A co-citation analysis reveals the seminal works and their interconnections in the context of neuromarketing and consumer behaviour bibliometrics and bibliography. By identifying influential research and integrating it into a comprehensive understanding of the field, highly cited references serve as pillars of knowledge.

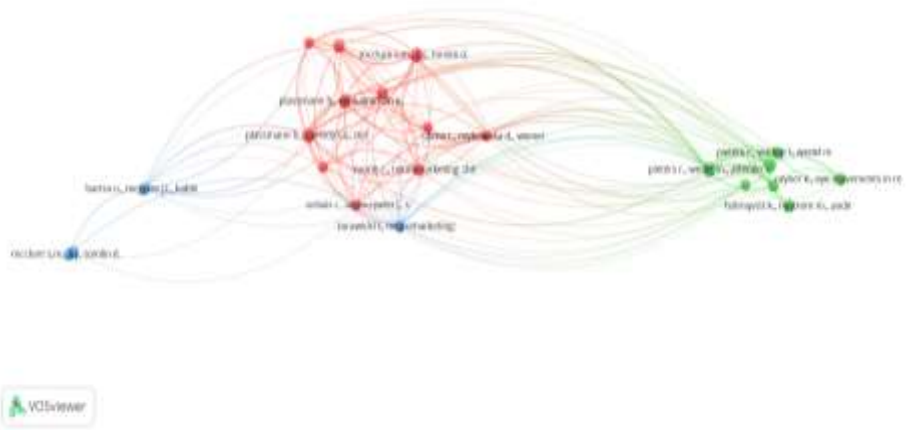

Figure 9 shows the co-citation analysis on the basis of references cited together, interconnectedness and influence on this research issue.

4.6 Thematic and influence structure analysis through bibliographic coupling

Bibliometric coupling analyses citations within scholarly works to determine how closely related academic papers, articles, or journals are (Sahu, 2021). "Bibliographical coupling" assesses the degree to which two or more works share common references, indicating a similarity in theme or concept. By analysing documents, they are able to establish relationships among them. The stronger the bibliographic coupling, the more closely related their subjects are (Yu et al., 2020). Using bibliographic coupling, researchers can identify key works, emerging trends, and the significance of various publications in a specific subject area (Rathinam & Amudha Sankar, 2019).

At the journal level, it is critical to identify and analyse trends that indicate the highest, lowest, and other essential traits (Guleria & Kaur, 2021). "Neuromarketing and consumer behaviour" bibliometrics and bibliographic analysis benefit from these trends. It is interesting to note that "Journal of Business Research" has the highest total link strength, with 655. As a result, "Journal of Business Research" is highly connected with other journals in the dataset. Neuromarketing and consumer behaviour publications are central to its network.

"Behavior Research Methods, Instruments, and Computers" and "International Journal of Production Research" have notably lower total link strengths, with 6 and 3. Despite being relevant, these journals may have limited bibliographic connections. Journals like "Journal of Marketing Research" and "Journal of Consumer Psychology" are a notable trend. Despite their low total link strength in the dataset, they have received a substantial number of citations and are highly cited, suggesting their importance in neuromarketing and consumer behaviour.

This journal, "European Journal of Marketing," has a high total link strength of 483. As a hub for research in this field, it is important to understand these trends in bibliographic coupling analysis. The tool helps you identify the key journals that serve as foundations and that connect neuromarketing and consumer behaviour to one another. Using these insights, this literature review is able to integrate relevant research into a comprehensive and well-informed study.

Six clusters of journals are identified from bibliographic coupling analysis, providing valuable insight into the scholarly landscape. Based on the co-occurrence of citations between the sources, Figure 10 shows the bibliographic coupling analysis. Blue nodes indicate publications from 2010 while yellow indicate those from 2018. Bibliometric coupling analyses citations within scholarly works to determine how closely related academic papers, articles, or journals are (Sahu, 2021). "Bibliographical coupling" assesses the degree to which two or more works share common references, indicating a similarity in theme or concept. By analysing documents, they are able to establish relationships among them. The stronger the bibliographic coupling, the more closely related their subjects are (Yu et al., 2020). Using bibliographic coupling, researchers can identify key works, emerging trends, and the significance of various publications in a specific subject area (Rathinam & Amudha Sankar, 2019).

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Six clusters of journals are identified from bibliographic coupling analysis, providing valuable insight into the scholarly landscape. Journal clusters in this area can offer insights into this multidisciplinary research topic. Based on the results of a bibliographic coupling analysis, Table 5 provides a complete list of journals, number of published documents, and number of citations of these publications for thematic clustering of articles on Neuromarketing and Consumer Behaviour.

Journals in Cluster 1 emphasize sustainability, ethical business practices, and consumer behavior, including "Business Strategy and the Environment," "Corporate Social Responsibility and Environmental Management," and "Sustainable Development." It is imperative to study how environmental and ethical factors influence consumer behavior.

"Frontiers in Psychology" and "Nature Reviews Neuroscience" are two of the journals in Cluster 2. Neuromarketing emphasizes the importance of understanding neural processes that underlie consumer decisions.

Cluster 3 includes "Behavior Research Methods, Instruments and Computers" and "Journal of Consumer Psychology." Identifying these clusters is important for enhancing neuromarketing research rigor and validity.

Among cluster 4, "Journal of Business Research" and "European Journal of Marketing" offer useful insights into marketing strategies, trends, and innovations.

In Cluster 5, "Journal of Marketing," "Journal of Marketing Research," and "Management Science," the focus is on marketing strategies, consumer insights, and decision-making.

The journal "Appetite" in Cluster 6 offers a unique perspective on consumer behavior. It may interest you if you are interested in the psychology of appetite or the broader consumer preference landscape.

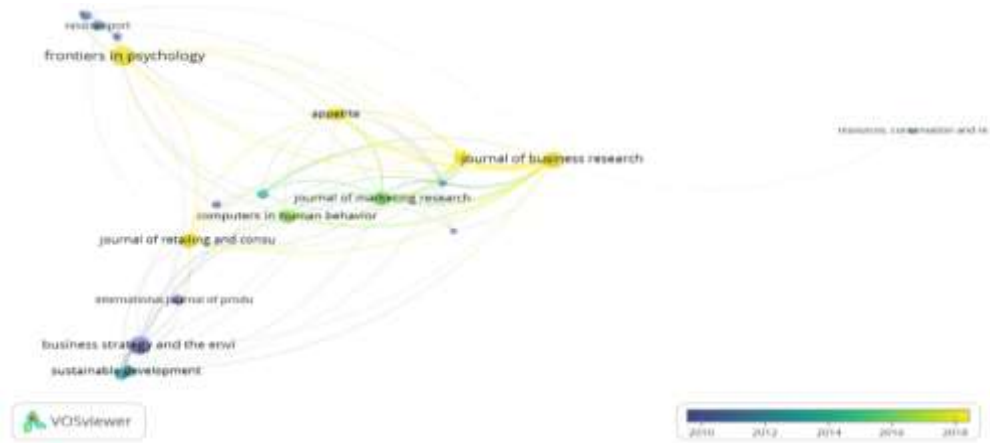

Figure 10 shows the bibliographic coupling analysis on the basis of co-occurrence of citations between the sources based on publication year.

Table 5 shows the full list of Journals for making thematic clusters on Neuromarketing and Consumer Behaviour via bibliographic coupling.

SOURCE	SUM OF DOCUMENTS	SUM OF CITATIONS
Frontiers In Psychology	48	723
Business Strategy and The Environment	36	3533
Journal Of Business Research	31	802
Journal Of Retailing and Consumer Services	20	897
Appetite	18	484
Computers In Human Behavior	17	759
Journal Of Marketing Research	16	1670
European Journal of Marketing	14	424
Sustainable Development	12	1590
Corporate Social Responsibility and Environmental Management	8	519
Neuroreport	8	459
International Journal of Production Research	7	425
Journal Of Marketing	5	870

Journal Of Neuroscience	5	907
International Journal of Psychophysiology	3	468
Management Science	3	408
Journal Of Consumer Psychology	2	419
Resources, Conservation and Recycling	2	427
Behavior Research Methods, Instruments, And Computers	1	725
Nature Reviews Neuroscience	1	559
Total	**257**	**17068**

4.7 Thematic trends of digital marketing research in on Neuromarketing and Consumer Behaviour

Bibliometric research uses co-occurrence analysis to identify patterns and relationships between keywords or terms used in academic publications (D. Kumar et al., n.d.). In this process, keywords are compared to each other in the literature to determine whether they are associated or co-occurring. Researchers conducted co-occurrence analyses of author keywords by balloting the scholarly article metadata. In this way, key themes and research trends can be identified within a domain or field (Escher, 2020). As a result, it assists in revealing the common themes or niches within a given field of research.

In Figure 11, co-occurrence analysis is illustrated based on author keywords based on publication year, with blue nodes indicating publication in 2016 and yellow nodes indicating publication in 2019. Among the author keywords, "neuromarketing" and "consumer neuroscience" exhibit the strongest cooccurrence strength, indicating a strong connection. Consumer neuroscience examines the neural underpinnings of consumer decisions, whereas neuromarketing employs neuroscientific methods to understand consumer behavior. A link strength of 358 illustrates their interdisciplinary nature and shared research focus. On the other hand, the author keyword "event-related potentials" has a low total link strength of 17, suggesting that it is not as widely used in consumer neuroscience research. Consumer behavior remains a key component of the study, despite its less prevalent use in the literature.

"Advertising" accounted for 92 occurrences and "marketing" for 78 occurrences. Neuromarketing focuses on understanding how advertising strategies influence consumer behavior. Their substantial relevance to this field is highlighted by their high total link strength (114 for "advertising" and 112 for "marketing"). A strong association between advertising and marketing practices and other keywords indicates their importance in consumer behavior research. With 27 occurrences and a link strength of 51, "neuroeconomics" indicates neuromarketing's interdisciplinary nature. In neuroeconomics, economic principles and consumer neuroscience are merged, and its association with neuromarketing keywords highlights the convergence between them. Insights into consumer behavior are gained through this merger. Its high link strength (56) underscores the significance of "decision-making" (29 occurrences). Consumer behavior is an integral part of neuromarketing research, making it a fundamental one. As "eye tracking" (183 occurrences) and "eye-tracking" (148 occurrences) prove, visual attention is crucial to consumer behavior analysis. Understanding where and how consumers pay attention to marketing materials is critical. An analysis of co-occurrences based upon the Author's keyword criteria is shown in Table 6.

These nuanced trends enrich our understanding of neuromarketing and consumer behavior as an interdisciplinary and multifaceted field. Using these findings, you can identify research gaps, understand key methodologies, and recognize connections between various aspects.

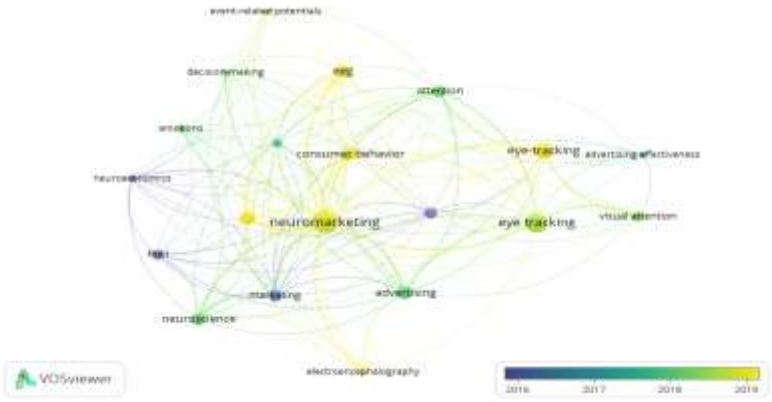

Figure 11 shows the cooccurrence analysis on the basis of author keywords based on publication year.

Table 6 shows the cooccurrence analysis via Author's keyword.

KEYWORD	OCCURRENCES	TOTAL LINK STRENGTH
Advertising	92	114
Advertising Effectiveness	23	30
Attention	72	113
Consumer Behavior	86	118
Consumer Behaviour	66	55
Consumer Neuroscience	106	156
Decision-Making	29	56
EEG	84	107
Electroencephalography	26	47
Emotion	41	69
Emotions	28	47
Event-Related Potentials	25	17
Eye Tracking	183	123
Eye-Tracking	148	105
FMRI	58	56
Marketing	78	112
Neuroeconomics	27	51
Neuromarketing	280	358
Neuroscience	87	118
Visual Attention	59	72

5.0 RECOMMENDATIONS FOR THE FUTURE

Neuromarketing and consumer behaviour research can be shaped by the extensive data and analysis provided. In addition to academically rigorous research, practical impact is ensured by these recommendations. Neuroscientists, psychologists, economists, and marketing experts should collaborate interdisciplinary. Consumer behavior is intricately driven by neural and psychological mechanisms. Collaborating across these disciplinary boundaries enhances research depth and breadth. Through this, we can better understand consumer decision-making, bridging neural mechanisms, psychological responses, economic implications, and marketing strategies. Research that uses cross-disciplinary teamwork advances both theoretical and practical knowledge.

In addition, longitudinal studies are urgently needed in neuromarketing and consumer behavior due to its dynamic evolution. Insights into the stability of neural and psychological patterns and the impact of societal, technological, and cultural change can be gained from longitudinal studies. Given the rapid changes in technology and communication channels, this longitudinal perspective is particularly important. Future research endeavours must also address ethical concerns comprehensively as neuromarketing techniques continue to advance. In collecting and analysing data, researchers should adhere to ethical guidelines. To maintain neuromarketing's integrity as a responsible research field, researchers, and companies must foster trust.

Consumer behaviour can be influenced by contextual factors. Culture, socioeconomic status, and individual differences can significantly influence neural and psychological responses to marketing stimuli. By understanding how context affects consumer behaviour, marketers can better tailor their marketing strategies. Furthermore, neuromarketing research should constantly incorporate technological advances. By analysing vast datasets, one can gain a deeper understanding of consumer behaviour using innovative technologies. In addition, data collection and analysis should remain open to new methodologies that can enhance precision and granularity.

6.0 CONCLUSION

Data from neuromarketing and consumer behaviour are analysed extensively in this study. This comprehensive investigation provides insights into future research directions in addition to contributing to current knowledge. Firstly, the data show how intertwined and complex consumer behaviour is.

Neuroimaging techniques like fMRI and EEG, along with eye-tracking, show that human decision-making is complex and has multiple dimensions. When examining consumer behaviour from a comprehensive perspective, it is crucial to take into account both conscious and subconscious elements. Neuroscientists, psychologists, economists, and marketers work together in the research project. The combination of neural mechanisms, psychological responses, economic implications, and marketing strategies aids in comprehending consumer decision-making. A diverse expertise is valuable for advancing this field since it bridges the gap between basic science and practical applications.

Neuromarketing future research should also take into account ethical considerations. In order to ensure responsible and transparent advancement of this field, robust ethical guidelines and respect for consumer privacy and consent are important. Neuromarketing can be viewed with trust and integrity if ethical concerns are addressed head-on. A longitudinal study is another crucial element. A number of social, technological, and cultural factors influence consumer behaviour, so monitoring the evolution of consumer behaviour over time

becomes imperative. Observing neural and psychological patterns over time helps us understand the constantly changing consumer landscape.

An interdisciplinary, holistic, ethical, and holistic approach is required to understand neuromarketing and consumer behaviour. Developing modern technologies, exploring contextual variables, and integrating emerging methodologies should be the basis for this approach. These elements together will ensure the future of marketing and consumer engagement remains dynamic, rigorous, and adaptive, thus holding immense potential. Throughout this multidisciplinary journey, new insights, refined knowledge, and a global impact will undoubtedly emerge as consumer behaviour continues to evolve.

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