

Demystifying neurotourism: An interdisciplinary approach and research agenda

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Abstract

The academic discourse surrounding tourism's interdisciplinary approach has long piqued the interest of the scholarly community. More recently, attention has pivoted towards the intersection of neuroscience and neuromarketing within the realm of tourism, giving rise to the concept of “neurotourism”. This emergence requires a comprehensive elucidation of the relevance of neuromarketing and neuroscience to the field of tourism, thereby addressing the imperative to bridge existing knowledge gaps. In light of this, the present paper endeavours to fulfil this objective by synthesizing global research in this domain. The study adopts an interdisciplinary approach, employing a hybrid systematic review methodology that encompasses a literature review encompassing nine key indicators and a bibliometric analysis through co-word analysis of author keywords. In total, our investigation unearthed 45 papers from Scopus, each exploring the application of neuroscience and neuromarketing theories and methods within the context of tourism. Among these, three papers delve into the concept of neurotourism. In this paper, we underscore the deep connection between neuroscience, neuroscientific methodologies, and neuromarketing within the realm of tourism research. The outcomes of this research significantly enhance our comprehension of the current state of neurotourism research, revealing both existing voids and emerging areas of interest. Furthermore, this study introduces a pioneering methodological approach, fusing Scival topic prominence and hybrid systematic review techniques into bibliometric analysis. Ultimately, our findings illuminate a notable research lacuna, presenting a fertile terrain for prospective investigations. Additionally, we deliberate on current trends and propose directions for future research within the neurotourism landscape.

Keywords: Neurotourism, neuroscience, neuromarketing, neuroscientific methods, hybrid systematic review, research agenda

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1. Introduction

1.1. *The multidisciplinary realm of tourism and the interdisciplinary of neuroscience*

Tourism is considered a multidisciplinary field (Marcano Anés, 2020). Tourism encompasses a wide range of interconnected aspects, including economics, geography, sociology, psychology, marketing, environmental science, and more. Researchers and practitioners in the field of tourism draw upon knowledge and methodologies from these diverse disciplines to gain a comprehensive understanding of the various facets of tourism. Therefore, tourism is currently understood as a multidisciplinary area (Marcano Anés, 2020). However, recently researchers have been pleading for more than a multidisciplinary approach, and urging for interdisciplinary approach (Okumus *et al.*, 2018). Oviedo-García (2016) argues that only through such an approach can tourism be conceived as a common scientific object, in which knowledge is co-produced.

One of the recent knowledge domains that have been incorporated into tourism studies is neuroscience. Neuroscience studies the nervous system through the manifestations of intellectual activity, allowing researchers to understand emotions, feelings, and affections (Bear *et al.*, 2015). Originated within the field of health sciences, this discipline gained great notoriety throughout the last century. Neuroscience is an interdisciplinary field that encompasses the study of the nervous system, including the brain, spinal cord, and peripheral nerves. It draws upon and integrates knowledge and methodologies from various disciplines, such as biology, psychology, chemistry, physics, computer science, and more (Sabbatini & Cardoso, 2002). Within the last decade, neuroscience reinforced its interdisciplinary character; for instance, it has been combined with cognitive science, giving birth to the cognitive neuroscience. This field combines principles and methods from neuroscience, psychology, and sometimes other related disciplines to investigate the neural basis of cognitive processes and behaviour studying the neural substrates of human cognition, attention, memory, emotion, language, motion and so on" (Ma *et al.*, 2014, p.1637). Subsequently, neuroscience has been applied to (or combined with) other fields of study, such as psychology – giving rise to neuropsychology – and economics – giving rise to neuroeconomics. These new disciplines applied neuroscientific methods to better understand the processes behind human behaviour and decisions, as did the social sciences (Lehmann, 2020; Xu & Wu, 2018). These integrations have strengthened an interdisciplinary nature to the neuroscience field.

1.2. *The interdisciplinary nature of neuromarketing and neuroscience*

Neuromarketing is a specialized branch of marketing that leverages findings from neuroscience to better understand consumer behaviour and improve marketing strategies. Neuromarketing is an interdisciplinary field that aims to understand consumers' preferences, motivations, expectations, behaviour, and decision-making process, through the study of brain mechanisms (Pourfakhimi *et al.*, 2019; Lew, 2020; Scott, 2020; Singh, 2020; Li *et al.*, 2022). It focuses on the study of how marketing stimuli affect the brain, and subsequently, consumer behaviour (Alsakaa *et al.*, 2019). In this context, neuromarketing studies attempt to explain, for instance, the success factors of advertising campaigns, and thereby seeks to improve marketing strategies (Santos, Moutinho *et al.*, 2012; Santos, Seixas *et al.*, 2012). Furthermore, according to Lim (2018, p. 205), the potential of neuromarketing as a research field is substantial, as its discoveries can establish fresh foundations for the creation of new marketing theories or enhance existing theories within marketing and related disciplines (Liu *et al.*, 2023).

A particularly promising subfield of neuromarketing is consumer neuroscience, refers to the application of neuroscience principles and methods and involves the application of neuroscientific methods to understand how the brain responds to marketing incentives. Consumer neuroscience is an interdisciplinary field, a branch of neuroscience that applies neuroscientific methods to study consumer behaviour, decision-making, and preferences in the context of marketing and consumer research (Cardoso *et al.*, 2022). These methods include tools and techniques to record, map and measure brain and neural activity during a certain behaviour, and in response to certain stimuli (Lopes *et al.*, 2017).

Lim (2018) classifies these methods into three broad categories: 1. neuroscientific tools and techniques that record neural activity inside the brain (which include those that record electromagnetic activity, such as electroencephalography (EEG), and those that measure metabolic activity, such as functional magnetic resonance (fMRI), 2. neuroscientific tools and techniques that record neural activity outside the brain (e.g., electrocardiography, eye-tracking (ET), etc.); and 3. neuroscientific methods that manipulate neural activity (e.g., transcranial magnetic stimulation (TMS)).

The physiological signals observed by these methods, in turn, are divided by Chanel *et al.* (2006) into two categories: those originating from the peripheral nervous system (e.g., heart rate (HR), ElectroMyogram (EMG), Galvanic Skin Response (GSR), and those originating from the central nervous system (e.g., neural electroactivity, which is observed by EEGs). Recent studies, such as Singh *et al.* (2019), Alsakaa *et al.* (2019) and Cardoso *et al.* (2022), reveal that the most frequently used neuroscience methods in neuromarketing research are neuroimaging and psychophysiological measures, such as functional magnetic resonance imaging (fMRI) and eye tracking (ET).

1.3. The intersection of neuroscience and neuromarketing, both interdisciplinary fields, within the multidisciplinary realm of tourism.

With neuromarketing research techniques increasingly available and affordable, tourism scholars also started adopting them. In tourism studies, neuroscientific methods have a particularly promising potential. One of the main advantages of studying consumers' behaviours and decisions through the direct observation of their biometric signals, rather than by self-report methods (i.e., asking how they feel, how they would act, etc.), is overcoming the limitations of the latter. Human behaviour is affected by subjective, and often unconscious variables, which generate potential biases on marketing research methods that solely rely on what participants say about their own motivations, impressions, associations, images, etc. This is especially true in tourism research, as the tourism product, as an experience provided by an amalgam of more specific products, services, and non-industrial elements (Middleton *et al.*, 2009), is particularly subjective. Moreover, a trip is usually a high involvement consumption decision, as it not only comprises many other smaller decisions (regarding accommodation, transport, attractions, etc.), but also a relatively high financial and time investment (Ritchie & Crouch, 2003). Therefore, tourists' choices are amongst the most complex, subjective, and emotional consumption decisions. Consequently, it could be argued that the mechanisms that explain the effectiveness of destinations' and tourism services' marketing efforts are equally complex and subjective, which further limits the possibilities of fully understanding them through self-report methods.

This complexity is further increased when considering that the potential stimuli that affect destination image and travel decisions are not limited to the places' official initiatives but include everything from the news to popular media (Cardoso *et al.*, 2019; Iwashita, 2008; Kim & Richardson, 2003). In this context, neuroscientific techniques allow tourism researchers to better understand how tourists make decisions, why they behave in certain ways and how they react to stimuli related to destinations and tourism products. The creation and induction of tourism product images, as well as the image of the tourism destination, are areas of marketing research, just as the decision-making processes of tourists and the processing of information in the tourist's memory also fall within the domain of marketing (Cardoso *et al.*, 2019). In this scenario, the application of neuroscientific methods falls within the purview of interdisciplinary fields such as cognitive neuroscience within the broader domain of neuroscience, as well as consumer neuroscience within the scope of neuromarketing. These fields amalgamate principles and techniques from neuroscience, psychology, marketing, and related disciplines. So, these two interconnected interdisciplinary fields, neurosciences and neuromarketing, cannot be separated in the case of tourism with a multidisciplinary domain.

Within the last decade, several studies have combined tourism research problems with neuroscience theories or methods (Halkiopoulou *et al.*, 2022), aiming to understand the behaviour and choices of travel consumers (Astolfi *et al.*, 2009; Smidts *et al.*, 2014). The bibliometric study carried out by Cardoso *et al.* (2022) in neuromarketing field reveals that consumer neuroscience is applied to tourism studies on, among other areas (e.g., product branding, cinema, journalism, and television), consumer research within the hotel industry. In this context, neuroscientific methods are employed to examine aspects of hotel experience such as human-robot interaction (Chung *et al.*, 2020). They are also employed to understand the effectiveness of marketing efforts, such as subliminal messaging in hotel advertising (Hsu & Chen, 2020). This application of neuroscientific methods to tourism research and practice has been referred to as neurotourism. When we contemplate the concept of neurotourism and grasp the full extent of its interdisciplinary nature, we empower the adoption of a deliberate and purposeful interdisciplinary approach to the study of tourism. This approach aligns with the perspective defended by Okumus *et al.* (2018) and Oviedo-García (2016), the interdisciplinary approach in tourism.

1.4. *The absence of uniformity regarding the concept of neurotourism*

The word “neurotourism” was introduced by Ma *et al.* (2014), according to whom, “Neurotourism mainly explores the neural mechanism underlying the tourists’ behaviours when they are travelling” (p.1638). The authors’ overriding idea is that tourism management should exploit the advantages of neuroscience to make more informed marketing decisions. In a more academic perspective, authors like Tosun *et al.* (2016, p.19) describe neurotourism as “a discipline that neuroscience and tourism establish through working together”. Similar definitions are provided by other theoretical studies (e.g., Giudici *et al.* 2017). Panyik and Gonçalves (2017, p.321), on the other hand, are the first authors to argue that neurotourism “goes beyond being merely an applied neuroscience tool in tourism management (...) as Augmented Reality and Virtual Reality technologies, using wearables, are likely to be only transitional in the delivery of the tourist experience”. In this sense, the authors argue that neuroscientific methods are increasingly being used in the delivery of the tourist experience itself, that virtual and augmented reality will be each time more ingrained in such experiences, and even that scenarios like totally artificially created memories are in the realm of possibilities.

It should be noted that although Panyik and Gonçalves (2017) adopt the premise that virtual and augmented reality are neuroscientific methods, considering the extant literature on the topic, they are not. They are technologies that can be used together with neuroscience techniques, either to deliver experiences for its own sake, or to induce experiences as part of an experimental study. Another instance can be found in the systematic review conducted by Al-Nafjan *et al.* (2023). In their attempt to explore the neurotourism concept by searching for keywords in the WoS Core Collection related to neuroscientific methods applied to tourism, they include the term “artificial intelligence (AI)”. Nevertheless, it's important to note that AI is not a neuroscientific method. AI aids neuroscience in processing extensive and intricate datasets, such as the results generated by neuroscientific techniques, to discern patterns, as argued by Savage (2019). This misconception highlights the broader issue of imprecise definitions and the scarcity of academic research in the field of neurotourism.

1.5. *Research gap and objective*

A brief overview of the literature on neurotourism shows that the concept is not yet sufficiently well defined. There is a lack of consistency in definitions and, as concluded by a recent literature review (Moral-Moral, 2021), the extant literature is limited. Moreover, despite the initial efforts found in the extant literature, much is still to be done and a systematic interdisciplinary approach in tourism field is still in its early days. This also applies to the general research on the neuroscience-tourism nexus (which does not necessarily call it “neurotourism”).

Regarding the inconsistency in definitions, as previously discussed, some authors narrowly define neurotourism as an academic discipline (e.g., Tosun *et al.*, 2016; Giudici *et al.*, 2017), while others envision it as the future of tourism experiences (Panyik & Gonçalves, 2017). Some argue that it should encompass not only the study of tourism consumers' emotions and decisions but also those of tourism stakeholders (Araújo, Kastenholz, & Santos, 2017), a dimension not explored in any known study by the authors. In the literature on neuromarketing applied to tourism, studies often simplify it as a tool for destination marketing (Palmatier *et al.*, 2017) or marketing research (Šerić *et al.*, 2015).

Concerning the limited research, as addressed in more detail in this study's results, not only very few studies address the topic, but most of them are literature reviews. The most recent study by Li *et al.* (2023a), is the first literature review that discusses and adopts an interdisciplinary view of neuroscience and neuromarketing applied to tourism presenting methods (including neuroscientific methods), theories and concepts. However, most of the studies included in this literature review, although they derive from psychology, marketing, neuromarketing, neuroscience, among other scientific areas, are not yet empirically applied to tourism. The great contribution of this study lies in bringing together theories and methods from various scientific areas that can be applied to tourism. Actually, the works that employ such theories to empirical tourism research are rare, and those that employ neuroscience methods *per se*, are limited to a few. This scenario is exacerbated by the multidisciplinary nature of the neurotourism concept Giudici *et al.*, (2017), and by the evolving nature of both neuroscience and tourism bodies of literature. This results in a lack of standardised metrics, which in turn further increase inconsistencies regarding the concept and the phenomena it addresses.

Moreover, although an increase in the number of studies that relate tourism and neuromarketing to other areas of knowledge has been noticed (Halkiopoulou *et al.*, 2022), the interdisciplinary aspect of such studies has not yet been well defined. This state-of-the-art on neuroscience and tourism reinforces Sop's (2021) urge for further research, namely descriptive studies with a focus on neurotourism or neuroscientific studies, to explore research gaps, current perspectives, and emerging trends. It also reinforces the need identified by Leiper (2000), Koseoglu *et al.* (2016), and Wang *et al.* (2020), who call for a truly multidisciplinary approach on tourism and neurosciences.

Furthermore, considering the novelty of this research domain, it is crucial to identify emerging themes and prospective research avenues stemming from empirical inquiries. In this context, performing a systematic literature review becomes essential, and the identification of emerging subjects is most effectively achieved through the utilization of Scival topic prominence – a dependable metric, as detailed by Cardoso *et al.* (2020). As posited by this author, bibliometric studies that amalgamate systematic and conventional literature reviews are well-suited for mapping emerging topics. In this context, Koseoglu (2016) also contends that bibliometric studies illuminate previously unrecognized patterns within research fields or disciplines, assisting researchers in formulating theories and examining hypotheses. To our knowledge, the study conducted by Al-Nafjan *et al.* (2023) is the sole instance of a systematic review applied to the field of neurotourism. Nonetheless, the keyword search parameters revolved around "tourism", "neuroscience", and "artificial intelligence", with the substitution of "neuroscience, neuromarketing, and neuroscientific" by terms like "eye tracking", "skin conductance", "EEG", "electroencephalography", "heart rate", "fMRI", and "emotion" or "affective computing". So, this process unveils an incongruity. On one hand, it arises from the fact that artificial intelligence does not qualify as a neuroscientific method, and on the other hand, the omission of neuroscience and neuromarketing prevents the holistic interdisciplinary nature of the neurotourism concept from emerging. To address this methodological research gap, our strategy encompasses a hybrid systematic review employing a comprehensive set of search keywords within Scopus. In order to demystify neurotourism, the primary objective of this paper is to assess the present state of

neurotourism and the integration of neuroscience and neuromarketing within the domain of tourism research, with a specific focus on the multidisciplinary aspect of the available literature. In this context, the study seeks to answer the following research questions: “What is the extent and scope of the concept of neurotourism?” and “What is the relationship of neurotourism with neuroscience and neuromarketing?”. To answer these questions, a hybrid systematic review, comprising a variable-oriented literature review and relational bibliometric co-word analysis was employed, relying on the body of literature available on the Scopus database. The methodological steps are described in more detail in the next chapter.

2. Research methodology

To address research questions, the present study adopted a hybrid review approach, which includes bibliometric and qualitative methods. Bibliometric methods were employed because they are an effective tool to highlight unknown patterns in specific research fields (Koseoglu *et al.*, 2016), and in doing so, describe their development and identify predominant themes over time (Rojas-Lamorenna *et al.*, 2022). Additionally, analogous to other research fields, this sort of analysis has been employed in recent tourism and neuromarketing studies, where it has been growing in importance (Cardoso *et al.*, 2020; Hall *et al.*, 2004). However, when used alone, bibliometric analysis can lead to excessively data-driven approaches, leading researchers to miss more nuanced aspects of the analysed literature. More specifically, Paul and Criado (2020) argue that purely bibliometric studies can lead to concentration on authors and keywords rather than on theories and methods. To mitigate this risk, the bibliometric analysis was employed in conjunction with the variable-oriented qualitative literature review.

Literature reviews encompass several variations. In this context, Koseoglu *et al.* (2016) and Cardoso *et al.* (2022) state that review techniques include structured literature reviews, systematic literature review, and meta-analyses/reviews, all of which are called traditional review methods. Systematic reviews, in particular, can be domain-based, theory-based, method-based (Palmatier *et al.*, 2018), meta-analytical (Paul & Criado, 2020), or meta-systematic (Lim & Weissmann, 2023). The present review, naturally, falls under the first category, as it concentrates on the state-of-the-art of an area of study, namely, neurotourism, neuroscience and neuromarketing applied to tourism, hospitality, and travel.

Domain-based reviews, however, also include a variety of sub-forms, which according to Paul and Criado (2000), include: structured reviews (e.g., Canabal & White III, 2008), framework-based reviews (e.g., Lim *et al.*, 2021), bibliometric reviews (e.g., Hall *et al.*, 2004), hybrid or integrated reviews (e.g., Chakma *et al.*, 2021), and reviews aiming for theory development (Paul & Mas, 2019). Amongst those, the present study can be classified as a hybrid bibliometric study, as it integrates a bibliometric review and a systematic variable-orientated review. In addition, the relational bibliometric technique of co-word analysis is also used. This combination of review approaches helped mitigate the issues normally associated with purely bibliometric reviews and allowed the achievement of more nuanced and rich results.

2.1. Research protocol and systematic review procedures

Considering the problematics and approach of this study (i.e., the lack of a consistent definition for neurotourism, and the lack of knowledge on the interdisciplinarity between neurotourism, neuroscience and neuromarketing applied to the tourism sector) the following specific objectives were adopted:

- 1) To determine the extent and scope of the neurotourism concept.
- 2) To identify the most prominent topics within neurotourism, and neuroscience and neuromarketing applied to tourism, hospitality, and travel.
- 3) To determine the structure and dynamics of neurotourism, neuroscience and neuromarketing applied to tourism, hospitality, and travel.

To fulfil these objectives, Paul's *et al.* (2021) Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) protocol was adopted. This protocol involves three stages, each comprising of their respective sub-stages: (1) Assembling (Identification and Acquisition); (2) Arranging (Organization and Purification); and (3) Assessing (Evaluation and Reporting), which have been adapted to the specific circumstances of the present study. The procedures performed at each stage of the SPAR-4-SLR protocol are summarised in figure 1 and described in detail in the following sections.

Assembling	Identification Domain: The neurotourism, neuroscience and neuromarketing interdisciplinary research. Research questions: What is the extent and scope of the concept of neurotourism? What is its relationship with neuroscience and neuromarketing? Source type: Only articles Source quality: All type of Journals indexed in Scopus database.	Acquisition Search mechanism and material adquisition: Search mechanism in Elicit platform (search for semantic keywords). Search Acquisition in Scopus with predefined keywords. Search period: All (Scopus output is 2009 to 2022) Search keywords: Criteria groups of keywords (neurotourism or neuro-tourism group; neuroscience group; neuromarketing group). Total number of articles returned from the search: (n=175) Eliminating non related articles: (n=148) Total articles included: (n=27)
	Organization Organization codes: No organization codes used. Organization framework sequence: SciVal topic prominence and prominence percentile information was manually added from Scopus. Qualitative variable-oriented literature review.	Purification No organization codes used and no purification sub-stage.
Assessing	Evaluation Analysis method: Bibliometric relational technique of Co-word analysis; Bibliometric review with qualitative variable-oriented literature review using nine variables: Research aim, SciVal topic prominence, SciVal Topic prominence percentile, Methodology type, Theoretical model, Discussed concepts, Neuroscience/neuromarketing Technology Used, Tourism application, Future research lines/study limitations. Agenda proposal method: Triangulated analysis between the variables according to the type of methodology used in the articles (from Appendix A)	Reporting Reporting presentation and discussion: Author keywords through the co-word analysis and Appendix A table of the qualitative variable-oriented literature review using nine variables. Definition of the agenda proposal method: Future research agenda with the gaps and areas for future research. Reporting convention: Definition of the state of acknowledgements and summarize findings.

Figure 1. SPAR-4-SLR systematic review protocol

2.1.1. SPAR-4-SLR protocol - Stage 1: Assembling

The first step consisted of defining the research domain – neurotourism and neuroscience and neuromarketing applied to tourism – the research questions and the research objectives. Next, Scopus database was chosen as a data source, as it is the largest top-quality abstract and citation dataset of peer reviewed literature (Alsharif *et al.*, 2020; Cardoso *et al.*, 2020). Regarding the research mechanism, the material acquisition, the period and keywords search, a two-step approach was adopted. In this context, before advancing to the Scopus database, the keywords were fine-tuned using the Elicit platform (<https://elicit.org>). The platform was selected because it performs a semantic search for words, which allow researchers to eliminate the screening conflicts and more accurately determine the search keywords. The two co-authors involved in this step both adopted the strategy of carrying out the first search with "neurotourism and neuro-tourism", followed by the search with "neuromarketing and neuroscience applied to tourism". This initial search generated a set of works related to "neuropsychology, hotel, hospitality, destination, and travel". So, this first search was confirmed by the literature review. The term "neurotourism" is also written as "neuro-tourism", and thus, we have included both spellings in our search in Scopus. The word "Neuropsych*" aims to establish a connection

between psychology (a branch of neuroscience), neuroscience, and neuromarketing. This connection is warranted for two main reasons. Firstly, it encompasses neuropsychological methods and data utilized in neuroscience research. Secondly, it holds relevance in the context of neuromarketing, where it finds applications in understanding consumer behaviour, assessing the effectiveness of advertising, and enhancing product design. In the application of neuroscientific methods, Galvanic Skin Response (GSR), which is also referred to as Electrodermal Activity (EDA) or Skin Conductance Response (SCR), was employed in all three variations to minimize potential bias in the screening process. The keywords used in the search in Scopus are identified in Figure 2.

The data collection procedures took place on September 26th, 2023. The Scopus search was conducted in English by two experts in systematic review analysis. The adopted parameters were: Keyword AND (LIMIT-TO (EXACTEDKEYWORD) + IN TITLE OR ABSTRACT OR KEYWORDS + ONLY ARTICLES. The database containing the retrieved articles was downloaded in Bibtex format from Scopus, then R Studio software version 1.2.5042 was used to eliminate duplicates and create a unified file. Upon the finalisation of the first review cycle, a total of 909 articles were downloaded.

The next step consisted of a second screening procedure, performed through a qualitative approach, in which each paper was reviewed by the two researchers involved. Namely, the researchers scanned the titles, abstracts, and authors' keywords, which allowed them to exclude 864 papers that were unrelated to the topics of interest. The excluded articles were related to neurological diseases, memory disorders, automotive industry, and the majority of those that included the word "destination" were related to the destination memory of Alzheimer's disease patients. In the majority of instances, the term "travel" was associated with mental travel and emotion mental travel, while "emotions" were linked to time travel and episodic memory, with additional connections to Alzheimer's disease and pharmaceutical use. Conversely, the term "hotel" primarily pertained to lodging arrangements within the context of neuroscience or neuropsychology events. Excluded from consideration were papers related to technology (including virtual reality and machine learning), neurology, brain function, and brain regions.

Finally, the database was later exported to R Bibliometrix 4.3.1, which was used for the network analysis, as previously done by Cardoso's *et al.* (2021; 2022). The final database includes 45 articles, published from 2009 to September 2023. As mentioned by Paul *et al.* (2021), if a small volume of articles is found and they do not include any systematic literature review, the domain is suitable to the subjected to such analysis. Therefore, the results of the screening process indicate that the topic is indeed suitable for this analysis.

2.1.2. SPAR-4-SLR protocol - Stage 2: Arranging

In the first sub-stage of Stage 2, organisation, the 45 articles of the database were homogenized, and an excel file was created. Moreover, the Scival topic prominence and prominence percentile (SciPP) data were retrieved manually from Scopus database as previously done by Cardoso's *et al.* (2021; 2022) and Lima Santos's, *et al.* (2020), as Scopus does not provide this data in the output. In the second sub-stage of Stage 2, Purification, analysis method criteria were defined for each of the research objectives within the hybrid review approach, following the method proposed by Cardoso *et al.* (2022).

2.1.3. SPAR-4-SLR protocol - Stage 3: Accessing

Regarding the first sub-stage of Stage 3, evaluation, the procedures employed to achieve each specific objective are summarised in Figure 3. The two first objectives were achieved through the authors' keyword analysis, in which their network structure was performed considering 5-419 nodes with a minimum of two edges. To fulfil the third objective, to determine the structure and dynamics of

neurotourism, neuroscience, and neuromarketing applied to tourism and travel, a qualitative approach was adopted, which involved carefully and integrally reading each of the 27 articles within the database. Analogous to previous studies (Cardoso et al., 2022; Mudarra-Fernández et al., 2018; Snyder, 2019), a variable-oriented literature review with nine indicators was employed. This technique was selected because, as argued by Snyder (2019, p.334), “it aims to identify all empirical evidence that fits pre-specified inclusion criteria to answer a particular research question or hypothesis”, which fits the purposes of the present study. The nine variables used in the variable-oriented literature review were based on the study carried out by Cardoso et al. (2022), which aimed to map the scientific performance of neuromarketing and identifying research gaps and emerging topics within the field.

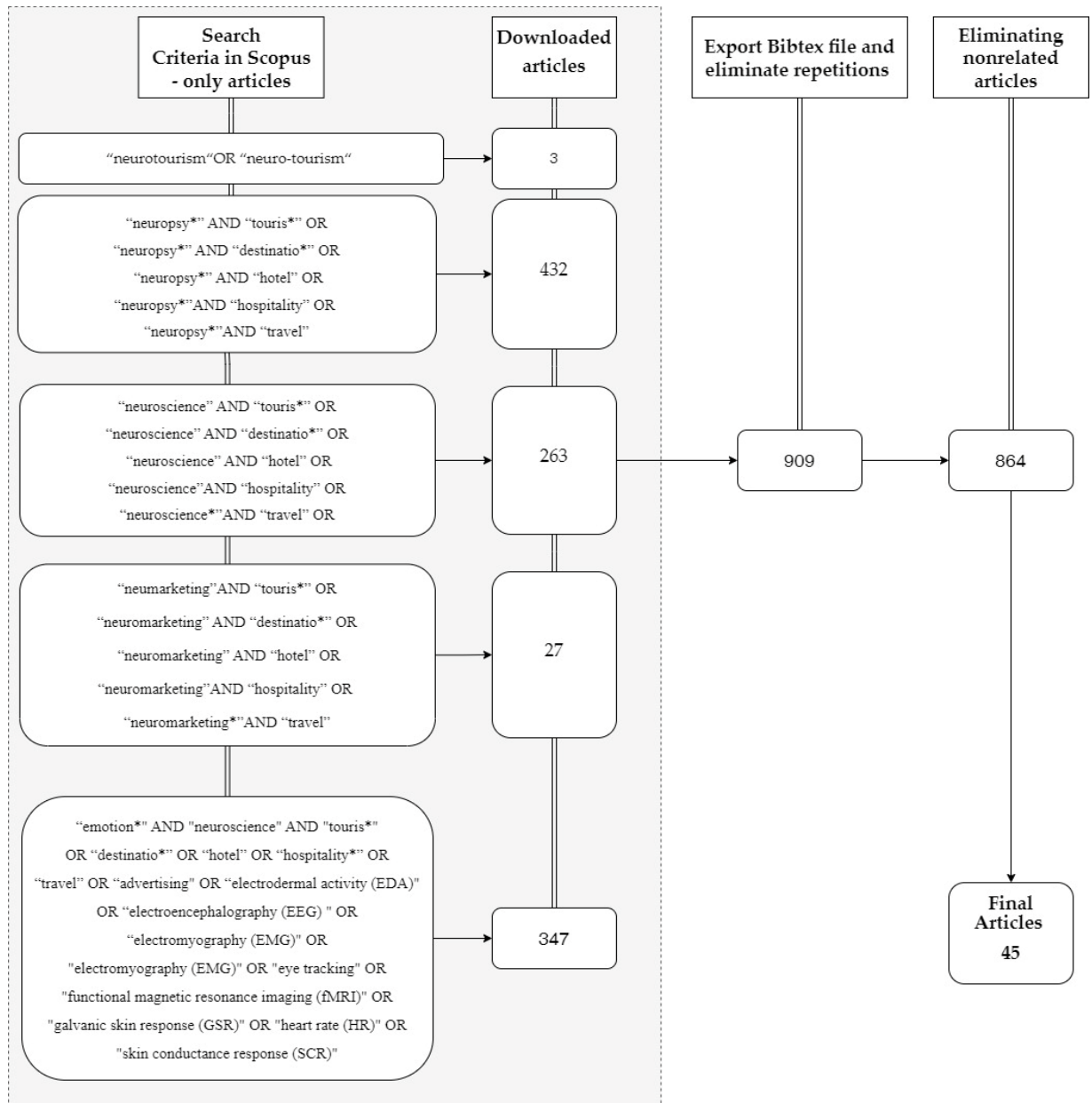


Figure 2. Summary of Assembly SPAR-4-SLR protocol

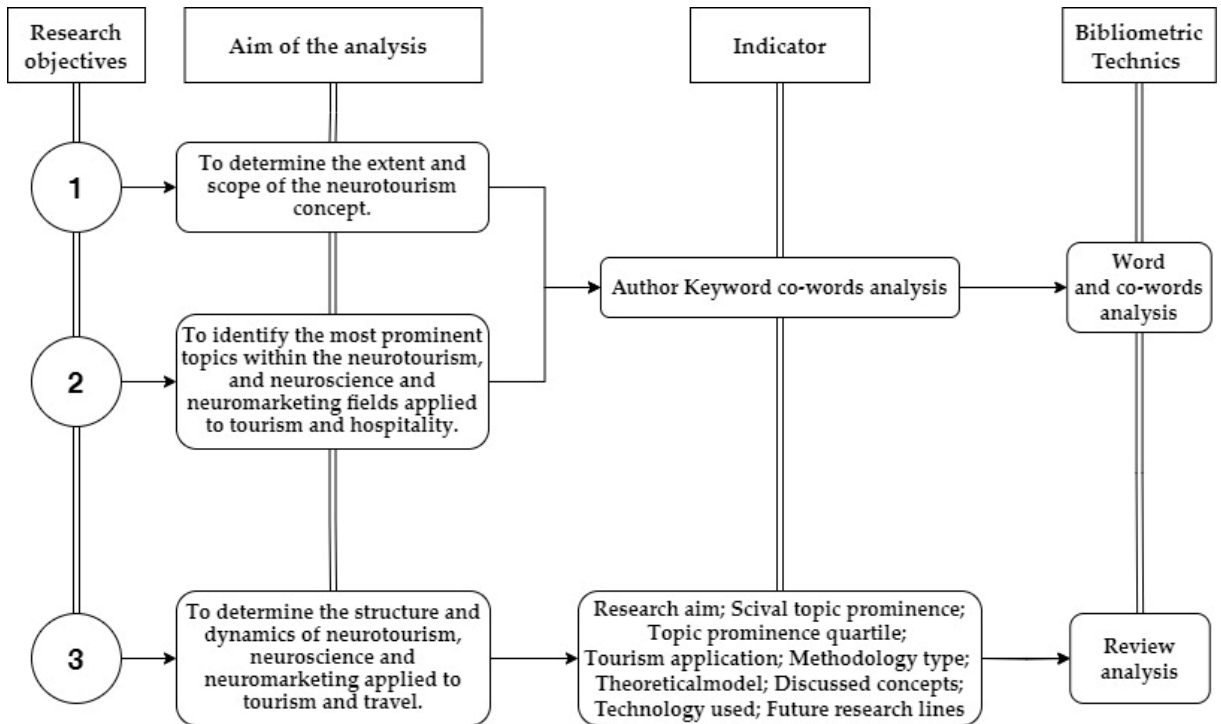


Figure 3. Summary of research objectives, indicators and bibliometric technics used

Regarding the reporting, presentation and discussion sub-stage, the authors' key-word analysis is graphically represented in Figure 4, and the results of the variable-oriented literature review are exhaustively described in Appendix A. In the next section, these results are discussed in detail.

3. Results and discussion

3.1. Neurotourism's scope, prominent topics, and applications of neuroscience and neuromarketing

To determine the extent and scope of the key areas of interest in the domain of neuroscience and neuromarketing as applied to research in tourism, hospitality, and travel spanning from 2009 to October 2023, an analysis of the author-keywords network structure was conducted. This analysis involved the consideration of 50 words, clustering them into 5 groups, and applying 3 labels with a label size of 0.3, utilizing the Louvain Clustering Algorithm.

In relation to the initial and second aims of this study, which involve identifying the prevailing themes in the realms of neurotourism, neuroscience, and neuromarketing as they relate to tourism, hospitality, and travel, the analysis reveals the emergence of two primary clusters linked to the field of tourism, as illustrated in Figure 4.

The cluster with the most substantial presence is "neuromarketing", which is linked to "neuroscience". This is followed by "psychology", which is associated with "eye tracking". Notably, both the "neuromarketing" and "neuroscience" clusters exhibit direct connections with the field of tourism. The "neuromarketing" cluster is directly linked to consumer neuroscience, eye-tracking, electroencephalography, psychology, consumer behaviour, attention, and advertising. The "psychology" cluster establishes a direct connection with "neuroscience", encompassing concepts such as the "prospect theory" and the "decoy effect", both rooted in the fields of marketing and the psychology of pricing. These theories were introduced by Boz *et al.* (2017) and subsequently applied to the domains of

tourism and hospitality. Specifically, they utilized "eye tracking" to assess the pricing of tourism-related products. The "prospect theory" is associated with considerations of profits and losses, often referred to as the "loss-aversion" theory. Meanwhile, the "decoy effect", also known as the "attraction effect", explores how tourists exhibit a distinct change in preference between two options when a third option is introduced asymmetrically.



Figure 4. Author keywords – co-word analysis

The cluster with the highest betweenness centrality (53.95) in connection to tourism is "emotions", which is also intertwined with hospitality, affection, and emotional aspects. Additionally, two other clusters are linked to "neuromarketing" applied within the domains of tourism and hospitality: "advertising" and "advertising effectiveness", both having connections with EEG. Noteworthy studies in the realm of advertising include the work of De-Frutos-Arranz and Blasco López (2022), which conducts a bibliometric analysis on the influence of emotions in advertising tourism destinations. Li *et al.* (2023b) explore arousal in destination advertising through EEG, while Baraybar Fernández *et al.* (2023) investigate the impacts of emotional stimuli using measurements such as heart rate, EEG, and electrodermal responses. Furthermore, Flores *et al.* (2022) delved into the role of Eye Tracking in advertising.

Lastly, within the "neuroscience" cluster, there is a notable presence of "consumer neuroscience" linked to EEG and ERP- Event Related Potential (often referred to as a time-locked EEG signal). This aspect has been extensively explored by McInnes and Hooshmand (2023), shedding light on neural responses to marketing stimuli.

3.2. The structure and dynamics of neurotourism, neuroscience and neuromarketing applied to tourism

The structure and dynamics of neurotourism, neuroscience and neuromarketing applied to tourism (including hospitality and travel) was determined by the systematic literature review guided by nine indicators that are identified in Appendix A. The two following sub-sections present a discussion on these results.

3.2.1. Research purpose, discussed concepts and application

The articles' research aim discussed concepts and application to tourism vary according to the methods employed, generally fall into one of three categories: literature reviews and systematic reviews, survey-based studies and neuroscience experimental studies. Notably, literature reviews and systematic reviews constitute a significant portion, making up 42% of the scientific output in this area. Among these systematic reviews, it is important to highlight that the term "neurotourism" is only introduced in Al-Nafjan *et al.*'s (2023) paper. Reinforce, that the Kasperuniene and Zydziunaite (2019) paper, a systematic review on professional identity construction in social media, does not have any direct application to tourism. The remaining literature reviews and systematic review are classified into three general categories: those aiming to apply cognitive psychology theories to tourism, those that integrate cognitive psychology to tourists' choice processes, those that discuss the integration of cognitive neuroscience to tourism. Examples of the first category are Scott (2020), who provides a personal perspective on the application of psychology theory in tourism studies; Pearce (2020), who discusses tourists' perception of time and the temporal features of their social episodes; Skavronskaya *et al.* (2020), who critically assesses the relationship between novelty and memorable tourism experiences; and studies like Godovykh and Tasci (2021); Bastiaansen *et al.* (2019) which reviews the literature triangulating EEG, heart rate variability (HRV), skin conductance (SCR) and, facial EMG technique to study the emotions of the tourist experience; Koc and Boz (2014), which all address topics related to emotions in tourists' experiences.

Examples of the second category, studies that integrate cognitive psychology to tourists' choice processes, include Walls *et al.* (2011), which propose a framework for the tourists' destination decision-making process based on the cognition and affect interplay; Fennell (2009), a literature review on pleasure, incorporating knowledge from many knowledge fields; and Bastiaansen *et al.* (2019), who discusses what constitutes an experience and how it should be measured.

Finally, studies examples of the third category, studies that discuss the integration of cognitive neuroscience to tourism, are Parrinello (2012), whose main purpose is to argue that tourism studies should consider recent developments in neuroscience; Lew (2020), which discusses tourism' role as a vector of global sustainability awareness in an increasing integrated "shrinking world"; and Koc and Boz (2014), who use neuromarketing examples to illustrate how tourists perceive prices; Li *et al.*, (2022), who discuss the use of electroencephalography (EEG) in tourism and hospitality research; and Tham *et al.* (2021) which discusses the ethical issues of applying electrodermal activity (EDA) to ethnographic studies of tourism.

Survey-based studies also include three main categories: those that employ surveys to the study of tourists' behaviour and perceptions, those that measure the emotional dimension of tourist experiences, and those that employ surveys to measure the potential or effectiveness of neuromarketing strategies in tourism businesses. With the first category, examples are Morar *et al.* (2021), which employed surveys to collect self-reported data on the psychological factors that influenced tourists' behaviour during the Covid-19 crisis; Pozharliev *et al.* (2021) and who employed surveys to collect data on tourists' emotional response, to interactions with service robots in hotels.

Examples of the second category, that measure the emotional dimension of tourist experiences, include Goggin *et al.* (2017), which measured the experience dimension and place attachment of visitors to a National Park; and Pearce (2012), which attempts to explain peoples' experiences of visiting places of previous significance. The experience of visiting home and familiar places and familiarity in their lives. The last category includes works such as Mojahedi and Hassanpour (2016), who demonstrated, through data collected via questionnaires with a travel agency chain's personnel, that neuromarketing strategies have a significant impact on the company's competitive advantage.

Finally, within the realm of neurotourism research, about 31% of the studies utilize neuroscientific methods. These studies can be classified into five distinct categories, each with its unique application to the field of tourism:

- 1) Investigations pertaining to the application of neuroscience methods in the context of hotels and restaurants – As an example, Chark and McCartney (2023) conducted a study in which they employed neuroimaging to examine the cognitive processes of hotel employees. Likewise, Pozharliev *et al.* (2021) utilized neuroimaging techniques within the realm of robot services. In a similar vein, Hsu and Chen (2020) applied EEG technology in the hospitality sector, measuring participants' brain activity to gain insights into how hotel videos, featuring a smiling face emoji as a subliminal message, impact consumers' choices in selecting hotels.
- 2) Studies that focus on understanding the impact of neuroscience on consumers' intention to purchase tourism products – Gunawan *et al.* (2023) employ EEG technology to investigate purchase intention. Additionally, Boz *et al.* (2017) expand upon existing research in neuroscience and neuromarketing to delve into tourists' perceptions of prices and pricing matters. Their study utilizes EEG, GSR – Galvanic skin response, HR –Heart rate, and ET- Eye tracking in the context of a price psychology model for tourism products, further contributing to the field of neuroscience and neuromarketing.
- 3) Research examining the role of emotions from a neurological perspective within the tourism sector – Mengual-Recuerda *et al.* (2021), which employ neuromarketing biometrics – assessed through galvanic skin response, eye-tracking and electroencephalography – to analyse tourists' response to the presentation and tasting of dishes and wines in haute cuisine restaurant, and Zhou *et al.* (2023) - studying emotion and the dynamic functional connectivity of brain regions to perform EEGs.
- 4) Analyses of how advertising stimuli affect the communication in tourism and hospitality tourism – López (2020), which employed eye-tracking to compare the perceived level of visual attractiveness of different hotel websites; Hsu and Chen (2020) compared both participant's choices and their brain waves to assess the impact of subliminal messages in destination promotional videos. Muñoz-Leiva *et al.* (2019), who crossed eye-tracking and self-report data to analyse advertising effectiveness in social media in terms of customers' visual attention and memory recall. Bastiaansen *et al.* (2018), the first study to effectively apply neuroscience techniques to tourism research. The authors used EEG to measure Event-related potentials (ERPs) triggered by viewing scenes of destination promotional videos. Lazo *et al.* (2023) employ eye-tracking (ET) technology to examine the communication related to tourism on the internet. Ramsoy *et al.* (2019), employed eye-tracking and electroencephalography (EEG) brain monitoring to test the effect of viewing of images and videos about places on tourists' destination choice. Meanwhile, Li *et al.* (2023b) employed EEG to assess the spillover effects of negative commercials on destination advertising.
- 5) Studies exploring the neurological factors influencing competitiveness and the choice of tourist destinations – Royo Vela and Garzón Paredes (2023) employ EEG to examine the competitiveness of a destination's image. In a similar vein, Ramsoy *et al.* (2019) analyse emotional and cognitive reactions associated with destination choices, while Michael *et al.* (2019) utilize both eye-tracking (ET) and EEG technologies to investigate the same aspect. Savelli *et al.* (2022) conducted a study where they utilized both EEG and ET to investigate the impact of communication signals on tourism destinations' attractiveness.

The Scival topic prominence and prominence percentile were analysed using a combination of qualitative and qualitative variables (see Appendix A). The most relevant result is that 84% of all scientific production on neuroscience and neuromarketing applied to tourism, hospitality and travel is clustered above the 90th Scival prominence percentile, which means it is in the top 10% of all topics in

the world. The results also reveal a high level of CiteScore, citation and view counts. This means this is a popular topic amongst researchers, which are both reading and citing works addressing it in significant rates, which in turn, makes it an emerging domain with great funding potential.

The results also demonstrate that the distribution of themes is quite diversified in terms of positioning in the Scival topic prominence clusters, amongst which the most relevant is “Neuromarketing | Neurosciences | Community Participation”. Namely, this clusters include the study of Li *et al.* (2022b), which focuses on the prospects of using electroencephalography (EEG) in tourism and hospitality research.

3.2.2. *The application of theoretical models in the selected papers*

The analysed papers employ or propose a variety of theoretical models. Amongst survey-based and experimental studies, Pozharliev *et al.* (2021) presents a conceptual model of human versus robot type service. Namely, the authors observe how working model differences – in terms in of social behaviour – among consumers affect their automatic emotional reactions when interacting with robots in a hospitality context. Within the literature reviews, Bastiaansen *et al.* (2019) proposes a conceptual model of the experience construct. Namely, the authors’ framework seeks to explain how memorable experiences are formed, viewing emotions as their building blocks. Still in this group, Walls *et al.* (2011) presents an affective-cognitive model of vacation decision making, and Fennell (2009) adapts of model of the temporal frames of pleasure to theoretically discuss the concept building on knowledge fields such as philosophy, psychology, marketing and tourism.

3.2.3. *Neuroscience and neuromarketing technologies employed*

The neuroscientific technologies (also called neurotechnology, neuroscientific methods, or biometric technologies, in the neuromarketing domain) applied to tourism, vary according to the studies’ objectives. However, they can be generally classified into those the record neural activity in the brain and outsider the brain.

Amongst the methods that record brain activities inside the brain, the most common is electroencephalography (EEG). The method is favoured, for instance, to assess potential tourists’ emotional reactions to promotional films. For instance, by Hsu and Chen (2020) use it to examine the role of subliminal messaging (namely, their impact on hotel choice) in promotional films. EEG is also employed in conjunction with techniques that measure activity outside the brain, such as galvanic skin response (GSR) and eye tracking, also with the purpose of assessing the effectiveness of marketing content through in images and videos, as done by Flores *et al.* (2022) discussing the role of Eye Tracking in advertising.

As an example of the combination of EEG and GSR, Bastiaansen *et al.* (2019) employ it to assess the effectiveness of tourist destination marketing content in films. As an example of combining EEG and eye tracking, Ramsøy *et al.* (2019) employed these two neuroscience methods to test whether direct emotional and cognitive responses to travel destination (through the viewing of images and videos) is indicative of subsequent stated destination preference. Eye tracking on its own is also employed. Muñoz-Leiva *et al.* (2019), for instance, crossed it with self-report data to analyse advertising effectiveness in social media in terms of customers’ visual attention and memory recall. Baraybar Fernández *et al.* (2023) combined EEG with heart rate and electrodermal response to study the effects of emotional stimuli in advertising.

Finally, a trend in the application of neuroscience techniques in recent years is its triangulation with self-report data. The mentioned works of Ramsøy *et al.* (2019), Muñoz-Leiva *et al.* (2019), and Hsu and

Chen (2020) all used this method to test whether participants' statements about their preferences or decisions coincide with what their brain activities suggest.

3.3. *Research agenda highlighted within the body of scientific output in the fields of neuroscience, neuroscientific methods, neuromarketing, and tourism domain*

As detailed in Appendix A, most literature reviews on neurotourism and neuroscience and neuromarketing applied to tourism hospitality and travel urge future studies to integrate more specific psychological concepts, definitions and theoretical relationships from cognitive psychology and neuroscience. Namely, Skavronskaya *et al.* (2020), who analyses the role of novelty in the creation of memorable tourism experiences through psychology theories, suggests further studies on the connection of novelty with emotions and memories. Other topics suggested for future studies are tourists' perception of time (Pearce, 2020) and the relationships between tourists' emotions, feelings, and moods (Godovykh & Tasci, 2021). These studies also suggest the use of specific neuromarketing technologies by future studies, such as EEG combined with other techniques (Li *et al.*, 2022; Bastiaansen *et al.*, 2019).

Regarding empirical studies employing neuroscience techniques to tourism investigation, these present a valuable contribution to tourism scholars, as well as businesses and destination managers. For decades, consumer research on tourism relied almost exclusively on self-report studies. Although insightful, those studies have clear limitations, especially when attempting to address subjective and, to a great extent, unconscious variables, such as emotions. Therefore, they have a clear potential to help better understand phenomena such as tourists' destination decision-making process and image formation process. They can also help tourism businesses of many types understand what works and what does not when trying to create a pleasant and transformative experience to tourists. Accordingly, they can help destinations communicate more effectively and convey the intended affective image.

Naturally, since this research trend is still very recent, there are several limitations to be tackled by future studies. Before discussing items in the future research agenda for neurotourism, however, one issue must be addressed. As neuroscience technologies assess emotional responses that might be unconscious, and thus, unknown to respondents, the ethics of such procedures becomes a topic of discussion. This problem is addressed by Tham *et al.* (2021), who argues that ethics must be embedded through increased collaboration and co-creation in the context of applying, preparing and approving research procedures. Therefore, such suggestion must be considered within all further tourism research employing neuroscience techniques.

Regarding specific research objectives that should be pursued, previous studies' limitations point to some possibilities. For instance, studies measuring brain responses to images and videos, like Bastiaansen *et al.* (2018), only measure short-term changes in emotional responses. Measuring long-term responses is, therefore, an important challenge for future studies in the field. Accordingly, studies analysing tourists' decision-making process are based on evidence from participants' prefrontal cortex. According to Hsu & Chen (2020), while this region is considered the decision-making centre of the brain, neural activities in other regions should also be explored. Moreover, while Ramsay *et al.* (2019) found that although emotional responses partially explain tourists' travel preferences, they are not identical to their subjective stated preference, which suggest that other mechanisms might also affect it. Those should also be explored by future studies.

Some empirical studies also suggest specific concepts to be addressed. For instance, Pozharliev *et al.* (2021) calls for further studies on the emotional dynamics of human-robot interaction in hospitality services. Meanwhile, and Goggin *et al.* (2017), calls for studies on how tourists' experiences change

according to the context. Regardless of the specific context or phenomenon being explored, Michael *et al.* (2019) summarises the main aspect of the research agenda for neurosciences in tourism: considering it as not a special branch, but as a set of tools embedded as a natural part of tourism research.

4. Conclusions

Given how recent neurotourism and the application of neuroscience to tourism is, as well as the consequent research gaps in this domain, the present paper aimed to assess the state-of-the-art of neurotourism and the application of neuroscience and neuromarketing to tourism research. Namely, the study sought to answer the following research questions:

1. "What is the extent and scope of the concept of neurotourism?"
2. "What is its relationship with neuroscience and neuromarketing?"

The stated questions were answered through a systematic literature review carried out through a combination of bibliometric and framework-based analysis, to which the Scopus database was adopted as a main database. The results show that neurotourism and the application of neuroscience and neuromarketing to tourism research is a popular emerging domain. This is evidenced by the results of the Scival topic prominence and prominence percentile, analyses, which show that the domain is above the 90th percentile and have a high CiteScore.

In terms of the specific research questions, the full extent and scope of the neurotourism concept are still in their early stages of development. Nevertheless, the existing body of literature, although relatively limited, portrays neurotourism as an emerging research domain within the tourism context. While certain studies, exemplified by Pourfakhimi *et al.* (2023) and Chark *et al.* (2023), contend that neurotourism encompasses the application of neuroscientific methods to both tourism and hospitality, the prevailing consensus among researchers defines it primarily as the application of neuroscience within the field of tourism. This perspective is shared by scholars such as Al-Nafjan *et al.* (2023), Ma *et al.* (2014), and Li *et al.* (2023).

Certainly, the thematic network analysis conducted in this study highlights a strong interconnection among neuromarketing, neuroscience, and the field of tourism. As Cardoso *et al.* (2022) have asserted, neuromarketing is situated within the broader realm of neuroscience, encompassing elements of psychology, and it primarily seeks to comprehend various facets of consumer behaviour, motivations, preferences, expectations, and the efficacy of advertising strategies. Furthermore, the dominant themes in this research, which encompass neurotourism, neuroscience, including the neuroscientific methods, and the application of neuromarketing principles to tourism, hospitality, and travel, are prominently represented within the "neuromarketing" cluster. This cluster exhibits close associations with both "neuroscience" and "psychology". Additionally, other notable clusters include "emotions", "advertising", "consumer neuroscience", "EEG (electroencephalography)", "eye-tracking", "behaviour", "attention", and "advertising". These topics are predominantly explored through literature reviews, survey-based studies, and experimental studies, as evidenced by the findings related to the structure and dynamics of the research domain. Among these study types, experimental studies stand out as the ones that truly employ neuroscientific methods and techniques as integral components of their research designs. On the other hand, survey-based studies typically rely on self-report data to measure constructs rooted in psychological and neuroscientific theories. These topics are addressed mostly through literature reviews, survey-based studies and experimental studies as evidenced by the results on the structure and dynamics of the domain. Amongst those, experimental studies are the ones which indeed employ neuroscientific methods/techniques within the research design. Survey-based studies mostly rely on self-report data that measure constructs built on psychology and neuroscience theory.

Furthermore, when considering their applications within the tourism context, neuroscientific methods are predominantly utilized to gain insights into tourists' emotions. These applications encompass understanding how positive emotions contribute to the creation of memorable experiences, examining tourists' emotional responses to interactions with service robots, and evaluating the effectiveness of marketing content for tourism destinations or services, such as hotels. Additionally, these methods are employed to assess the effectiveness of advertising efforts and their impact on destination choices and destination products. Emphasizing the interdisciplinary nature of tourism studies, it's worth reinforcing that the commonly used neuroscientific methods such as EEG, ET, GSR, and HR play a pivotal role. EEG, dedicated to measuring brain electroactivity, and ET, GSR, and HR, dedicated to capturing psychological responses within the body, facilitate a profound connection between the fields of neuroscience and neuropsychology (a branch of neuroscience) within this context. Just as the intersection of neuroscience and psychology gave rise to a new research domain known as neuromarketing, it is evident that the fusion of neuroscience and neuromarketing within the realm of tourism is giving birth to a nascent field of study: neurotourism. Therefore, the findings of this study clearly indicate that "neurotourism" is an expanding research domain that incorporates principles from neuroscience, neuromarketing, and applies neuroscientific methods within the sphere of tourism.

The Scival topic prominence analysis conducted in this study illuminates the nascent stage of neurotourism research, as evidenced by its high topic prominence percentile scores, consistently exceeding the 90th percentile in Scival prominence rankings. This emerging area appears to be dispersed across multiple topic clusters, with its primary association being within the neuromarketing cluster. "Topic Prominence" in Scival serves as a valuable metric in this context, as it quantifies the significance and recognition of research topics within specific fields or disciplines. This metric helps researchers and institutions identify which topics are gaining substantial attention and prominence in the academic and research community. Recognizing the importance of neurotourism growth, it is essential to establish a dedicated cluster for "neurotourism" within Scival. By doing so, we can formally acknowledge and track the development of this emerging research area, enabling researchers and institutions to better understand its evolution and significance in the broader landscape of research and academia.

4.1. The study's contributions

For researchers in the field of tourism, this study demonstrates that the application of neuroscience, neuroscientific methods, and neuromarketing to the domains of tourism, hospitality, and travel, also known as "neurotourism", is an emerging and promising area that offers significant potential for publications, citations, and research funding. These results deconstruct the preconceived idea that neuromarketing applied to tourism is an expensive and inaccessible research area and encourage researchers to pursue it. Namely, as demonstrated by the described research agenda, researchers interested in pursuing this area should focus on specific psychological concepts, definitions, and theoretical relationships from cognitive psychology and neuroscience applied to tourism. Concepts like novelty (ad its connection with emotions and memory), tourists' perception of time, feelings and moods are all fertile paths for future research. Accordingly, experimental studies involving specific neuroscientific methods, such as EEG, are also advisable.

Our paper makes several noteworthy contributions to the field of neurotourism. First and foremost, it provides a comprehensive review of the existing literature, amalgamating insights from various sources and fields. This synthesis enhances our comprehension of the interplay among neuroscience, neuroscientific methods, neuromarketing, and tourism, lending neurotourism a distinct interdisciplinary nature. Secondly, the pioneering methodological approach, combining Scival topic prominence and hybrid systematic review techniques, introduces a novel way of assessing research

trends and identifying knowledge gaps. Thirdly, by highlighting the substantial research gap we uncovered, our paper provides a roadmap for future investigations, stimulating further research endeavors in neurotourism. Lastly, our discussions on current trends and future research directions offer valuable guidance for scholars and practitioners interested in advancing this burgeoning field.

4.2. The study's limitations and implications

While this paper contributes valuable insights, it is essential to acknowledge certain limitations. Firstly, the focus on Scopus as the primary source for paper selection may introduce a potential bias, as it excludes papers from other databases. Additionally, this research is contingent on the availability and inclusion of relevant papers in Scopus, which may not encompass the entirety of neurotourism literature. Secondly, the study is not necessarily cross-sectional as the database was acquired using a set of keywords that may not fully encompass the entirety of scientific output in the fields of neuroscience, neuroscientific methods and neuromarketing applied to tourism. For future studies employing a similar methodology, it is advisable to incorporate the concepts and theoretical models outlined in the appendix table of this research as part of the search keywords in Scopus or another database. Thirdly, the hybrid systematic review approach we employed, while innovative, is not immune to subjectivity during the selection and evaluation of papers. Lastly, the concept of neurotourism is still evolving, and the framework we present may require adaptation as the field matures.

The limitations presented by the extant literature also point to additional research paths. These include measuring long-term (rather than only short-term) changes in emotional responses to marketing stimuli, considering neural activity in regions of the brain other than the prefrontal cortex, and considering factors other than emotional responses to explain tourists' stated choices. The most assertive suggestion, however, is increasingly embedding neuroscientific methods as tools for tourism research, rather than considering investigations using them as a special branch.

The implications of this extend to multiple stakeholders. Academically, our paper sets the stage for a more structured and rigorous exploration of neurotourism, encouraging scholars to delve deeper into this interdisciplinary domain. Practically, it offers insights to professionals in the tourism industry by elucidating how neuroscience and neuromarketing approaches can be harnessed to enhance tourism experiences and marketing strategies. Policymakers and destination managers can benefit from our findings by understanding the potential of neurotourism to drive tourism growth and its associated economic implications. Furthermore, our identification of knowledge gaps and emerging areas provides a valuable resource for researchers seeking to address unanswered questions in neurotourism, ultimately contributing to the advancement of knowledge and the potential for practical applications in the tourism sector.

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Appendix A. Neurotourism, neuroscience and neuromarketing application to tourism, hospitality, and travel

Authors	Methodology type	Research aim	Discussed concepts	Theoretical model	Tourism application	Future research lines/study limitations	NTech	Scial topic prominence	SciPP
Al-Nafjan et al. (2023)	Systematic Review	Future direction of neurotourism research.	Neuromarketing methods and theories.	-	Neuromarketing methods applied in tourism.	Neuro-tourism modalities for documenting the emotional responses and assessing the decision-making of tourists.	-	Neuromarketing Neurosciences Community Participation	95.878
Li et al. (2023a)	Literature review	To stimulate the use of neuroscience within tourism research.	Neuroscience Social science Neuromarketing Neuroeconomics Neuromanagement Neuroimaging Marketing	-	Building new interactions allowing for a broader and deeper understanding.	Development of areas such as tourism marketing, neuroscience applied to the well-being of tourism, tourism, and other areas.	EDA EEG ET fMRI	Neuromarketing Neurosciences Community Participation	95.878
Liu et al. (2023b)	Bibliometric review	To discuss the prospects for applying neuroscience to sustainable consumption.	Consumer neuroscience Sustainable Consumption Marketing	Future consumption Traditional decision models.	---	Using Prisma in Bibliometric review.	EEG ERPs fMRI fNIRS	Neuromarketing Neurosciences Community Participation	95.878
McInnes et al. (2023)	Comprehensive / practical review	To provide guidelines for using EEG in consumer and marketing research.	Consumer neuroscience Neuroimaging	---	---	---	EEG fMRI ERPs	Neuromarketing Neurosciences Community Participation	95.878
De-Frutos-Aranz & López (2022)	Bibliometric	This bibliometric discussion about the role of emotional advertising in tourism and neuromarketing to assess to the advances in neuroscience.	Emotions Destination marketing Consumer neuroscience Neuromarketing	-	Understanding on how neuromarketing contributes to reveal tourists' implicit emotional responses.	Provide data to carry out more efficient campaigns increasing tourism competitiveness through neuromarketing.	-	Neuromarketing Neurosciences Community Participation	95.878
Lei et al. (2022)	Systematic review	To provide a critical review involving neurophysiological measures such as EEG, fMRI, and SC in tourism and hospitality.	Neurophysiological Tourism and hospitality Destination marketing Emotional dissonance theory Subliminal perception.	-	Use different brain areas correlate with cognitive processes. Neurophysiological techniques hold promise and help the managers.	Assessment of multi-sensory stimuli involving neuroscientific techniques. Limitations: small samples, high costs and complexities of the experiments.	EEG fMRI SC EDA	Neuromarketing Neurosciences Community Participation	95.878
Li et al. (2022)	Literature review	Investigate the prospects of using electroencephalography (EEG) in tourism and hospitality research.	Discussion about EEG technology application in tourism and hospitality.	-	Application of EEG to the emotions research applied to tourism and hospitality.	Challenges for the application of EEG technology mixing with other technologies.	-	Neuromarketing Neurosciences Community Participation	95.878

Authors	Methodology type	Research aim	Discussed concepts	Theoretical model	Tourism application	Future research lines/study limitations	NTech	Scial topic prominence	SciPP
Scott (2020)	Literature review	To provide a personal perspective on the application of psychological theory in tourism studies and the importance of cognitive science for future research.	Transfer of psychological paradigms to tourism.	-	Cognitive psychology and tourism Cognitive science.	Revisit what a social "science" means in the light of new data from neuroscience and cognitive psychology.	-	Marketing Consumer Culture Netnography	99,315
Lew (2020)	Literature Review	To achieve sustainable development in an integrated and rapidly shrinking world.	Perspective paper: neuroscience, philosophy, psychology, biology, quantum physics and spirituality disciplines. Psychology fundamentals; Tourists and social episodes; Time in tourism; Developing time-oriented design principles; Specifying duration; Managing and filling downtime; Preparing for tourist sequences; Encouraging engagement; Implicating time in memorability.	-	Sustainable tourism global consciousness path.	-	-	Causal Layered Analysis Education Foresight	95,417
Pearce (2020)	Literature review	Overview of two key topics - the cognitive psychology of perceiving time and then, the remembering, valuing, and structuring of malleable tourist episodes.	Novelty in behavioural and personality psychology; Novelty in cognitive psychology and neuropsychology. The taxonomy of novelty: short-term, long-term, and complete novelty; Primary and secondary novelty; Novelty and memory; Novelty in tourism experiences; Cognitive appraisal theory (CAT).	-	Tourists' perception of time	Specifying duration, encouraging emotional engagement, managing, and filling downtime, preparing for emergencies, tailoring tourist sequences, and implicating time in memorability.	-	Interval Timing Time Perception Young Adult	93,866
Skavronskaya et al. (2020)	Narrative literature review	Review and critically analyse novelty as a psychological concept and examine the interconnection between novelty and emotions, especially in the context of memorable tourism experience.	Novelty in behavioural and personality psychology; Novelty in cognitive psychology and neuropsychology. The taxonomy of novelty: short-term, long-term, and complete novelty; Primary and secondary novelty; Novelty and memory; Novelty in tourism experiences; Cognitive appraisal theory (CAT).	-	Tourism experiences.	Integrate more specific psychological concepts, definitions and theoretical relationships from cognitive psychology and neuroscience to the conceptual understanding of novelty for memorable tourism experiences. New specific focus on novelty connections with emotions and memories for novelty conceptualization in tourism.	-	Travel Motivation Music Festival Destination	98,762

Authors	Methodology type	Research aim	Discussed concepts	Theoretical model	Tourism application	Future research lines/study limitations	NTech	Scival topic prominence	SciPP
Bastiaansen et al. (2019)	Literature review – proposal of different methodologies to measure tourism experiences	Discussion in the fields of hospitality, tourism, and leisure on what exactly constitutes “a memorable experience” and how to measure.	Unpacking the experience construct Current quantitative approaches to measuring experiences. Validity issues in experience measurement.	Conceptual model of the experience construct.	Emotions and experience Hospitality, tourism, and leisure.	Studying if memorable experiences predict future revisit or recommendation decisions. Triangulating EEG, HRV, SCR and facial EMG techniques to study the emotions of the tourist experience.	-	Aesthetic Value Abstract Art Artwork	95-987
Kasperi-Zydzianaitis (2019)	Systematic Literature Review	Summarizing professional identity construction in social media research literature.	Predicting Virtual Behaviour Trusting Social Media; Helping to Maintain Physical; Psychological Balance.	-	Professional Identity Construction Social Media.	Apply more themes within the different disciplines on professional identity construction in social media.	-	Social Networking Sites social media Instagram	99-761
Pour-fakhimi et al. (2019)	Literature review	To evaluate e-Tourism technology acceptance literature to illustrate current gaps in the field and suggest two alternative perspectives that could be adopted.	Evaluative functional and normative beliefs, behavioural control beliefs, evaluative affective beliefs, personal traits, and characteristics.	-	e-Tourism technology.	To use a systematic literature review methodology to meta-analyse the results of a broader spectrum of research in this field systematically.	-	Technology Acceptance Model Mobile Payment E-Learning	99-977
Koc & Boz (2014)	Literature review	Approach to consumer/tourist behaviour called psychoneurobiochemistry and to explore the possible and potential influences of psychoneurobiochemical factors on tourism marketing.	Psychoneurobiochemistry of tourism marketing (Melatonin, circadian rhythm and photoperiod). Emotions and moods.	-	Psychoneurobiochemistry in tourism.	Further analysis and synthesis of research studies in above disciplines from the perspective of tourism and consumer behaviour. Potentially relevant studies in psychology, neurology, biology and chemistry to tourism marketing.	-	Impulse Buying Social Commerce Community Participation	97-638
Parrinello (2012)	Literature review	An attempt will be made to indicate formulations in neuroscience which potentially cast new light on various aspects of tourism.	Embodiment: a post-cartesian attitude Qualia Extended Mind Mirror Neurons Neuroethics Neuroimaging.	-	Tourism and neuroscience.	-	-	Place Heritage Tourism Tourist Experience	98-382

Authors	Methodology type	Research aim	Discussed concepts	Theoretical model	Tourism application	Future research lines/study limitations	NTech	Scial topic prominence	SciPP
Walls <i>et al.</i> (201)	Literature review	Present the decision-making choice models and offers a thinking about the tourist vacation-making intricacies. To check the interrelationship between affect and cognition in the tourist vacation decision-making process.	Traditional and Postmodern Theories—Vacation Decision Making, Affect, and Cognition Affect and Cognition—A Proposed Decision-Making Model.	Affective-Cognitive Model of Vacation Decision Making.	Cognition and affect interplay Tourist vacation. Decision-making process.	Applying the theoretical model to practice.	-	Cultural Competence Occupational Therapists Communication Barriers	23.802
Fennell (2009)	Literature review	Summarize work in the area of travel motivation as a basis from which to gain traction in contextualizing pleasure.	-	Types and Temporal Frames of Pleasure	Nature of Pleasure Pleasure Travel.	There is a gap about a model of pleasure, based on different states or types of pleasure, and contrasted with different periods that mirror the nature of the tourism experience itself.	-	Travel Motivation Music Festival Destination	98.762
Mengual-Recuerda <i>et al.</i> (2021)	Mixed construct type "experience"	Use of neuromarketing technology for the analysis of emotions in a gastronomic experience in a two Michelin star restaurant. To analyse the cognitive and emotional activities. Identification of stimuli that influence the brain (deeper knowledge), consumer behaviour, and decision making.	Emotional Impact of Dishes versus Wines on Restaurant Diners.	-	Emotional impact of dishes Wines on restaurant diners.	Apply to other gastronomic experiences.	GSR ET EEG	Neuromarketing Neurosciences Community Participation	95.878
Tham <i>et al.</i> (2021)	Collaborative ethnography: experimental design.	Significance of ethics on intrusive technologies for tourism researchers.	Intrusive technologies Ethical considerations of intrusive technologies on human subjects Ethics applied to tourism research.	Ethical framework for intrusive technologies in tourism experiments.	Ethics Intrusive technologies in tourism.	Examine if cross-cultural differences exist in terms of intrusive technologies for tourism and hospitality. Undertake a longitudinal approach of pre-, during, and post-project ethical challenges from academic researchers and ethics committee staff central to the research. Extend the study to other samples.	ET EDA	Research Ethics Ethical Review Ethnography	86.860

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Godoykh & Tasci (2021)	Research note	To discuss conceptual and methodological aspects related to using emotions, moods, feelings, and affect, provide comprehensive definitions, and outline opportunities to capture them comprehensively in tourism and hospitality research.	Emotions Feelings Moods.	-	Differences between emotions, feelings, and moods in tourism experience.	Future research needs to analyse the relationships between tourists' emotions, feelings, and moods, as well as their antecedents and outcomes.	-	Servicescape Customer Experience Community Participation	99,508
Baraybar Fernández <i>et al.</i> (2023)	Experimental study	To determine the relationship between the emotions induced in audiovisual public service advertising messages and memory recall.	Advertising Emotions Neuroscience Consumer behaviour Neuromarketing Autonomic nervous system (ASN) activity.	-	-	-	ECG EDA EEG	Neuromarketing Neuroscience Community Participation	95,878
Cardone et al. (2023)	Experimental study	To examine the presence of a distinct and clearly defined spatial pattern in the thermal distribution of the face during a resting state.	Facial thermography.	Novel method to the thermal IRI	-	-	fMRI IRI GSR	Infrared Imaging Emotion Nose Tips	78,133
Clark & McCartney (2023)	Experimental study	Neuroimaging approach to explore the individual differences in cognitive processing style in senior hotel executives' brain images.	Social cognition.	-	Cognitive processing style.	Cognitive processing style in senior hotel executives' brain images.	Neuroimaging	Emotional Intelligence Job Performance Emotion	99,054
Gunawan <i>et al.</i> (2023)	Experimental study	To understand how online travel agencies' logo design, a combination of shapes and colours, influences consumers' purchasing intentions using behavioural and neuroscientific data.	OTAs EEG Neuromarketing Purchase intention Neuroscientific interpretation.	Construal level theory.	OTAs use tourism marketing to attract customers and manage purchase intention.	Neuroscience applied to tourism marketing research. Consider factors that affect by accuracy of participants responses and more neuroscientific measurements.	EEG	Social Rejection Psychological Distance Abstractness	93,617
Zhou <i>et al.</i> (2023)	Experimental study	To propose a progressive graph convolution network for capturing the characteristic in EEG emotional signals and progressively learning the discriminative EEG features.	Neuroscience.	PGCN method.	Progressive graph convolution network model.	To investigate the hierarchical information of emotion and the dynamic functional connectivity of the brain regions to realize EEG emotion recognition with high accuracy and robustness.	EEG	Support Vector Machine Electroencephalography Brain Computer Interface	99,269

Demystifying neurotourism: An interdisciplinary approach and research agenda

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Flores <i>et al.</i> (2022)	Quasi-experimental study	To determine the level of persuasion that has a well-designed advertising against the feminine perfumery of the brands Lancome, Caroline Herrera, and Chanel.	Neuromarketing Processes of the consumer (perception, memory, learning, emotion, and reason) Human behaviour Persuasion Neuroscience Neuroadvertising Communication Communication persuasion.	Advertising-oriented neuromarketing for positioning.	---	Explore the application of neuromarketing and eye tracking in other industries or contexts.	ET	Community Participation Liking Hedonic Scales	94-969
Savelli <i>et al.</i> (2022)	Experimental study	To examine the influence of typical-local foods' communication signals on tourists' visual attention and engagement.	Attractiveness of destinations Gastronomic tourism Sustainability Geographical indications Healthiness Communication Marketing Neuroscience.	Signalling theory.	Communication signals affect the tourist destinations' attractiveness in food tourism.	Generalize results. Conducting studies in a real context. Comprehensive overview of the different methods and reconciling them.	EEG ET	Community Participation Farmers' Markets Willingness to Pay	99-418
Pozharliev <i>et al.</i> (2021)	Experimental study applying video stimuli/questionnaire	Access of customers' affective, attitudinal, and behavioural responses to a human (vs. frontline robot) service agent.	Responses to frontline service robots Attachment styles in interaction with service robots. Level of robot anthropomorphism on customer responses to service robots.	Conceptual model human versus robot type service.	Service robots in restaurants.	Future research should examine more nuances in terms of the outcomes of a service interaction. Explore different service settings (e.g., medical facilities, restaurants, homes, financial services) and the related stereotypes.	-	Human-Robot Interaction Robots Artificial Intelligence	99-349
Hsu & Chen (2020)	Experimental study	Determine whether consumers process emojis as subliminal stimuli. Understand how hotel videos embedded with a smiling face emoji as a subliminal message affect consumers' selection of hotels, with their brain activities measured and collected while they watched the videos.	Emojis; Consumer behaviour; Subliminal advertising Subliminal stimuli and brainwaves; Hotel Neuromarketing	-	Using EEG in the field of hospitality and tourism to gain more insights into the minds of consumers.	Future studies can increase the sample size and diversify their research's demographic and gender group to enhance its generalizability.	EEG	Neuromarketing Neurosciences Community Participation	95-878

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López (2020)	Experimental study Post-test survey	To test that the structure of a website and location of certain previously considered attributes directly influence the user's perception of the visual attractiveness of websites, as well as their evaluation in the millennial target audience.	Visual Attention. Eye-tracking. Eye-tracking studies.	-	Gaze direction on Hotel websites/ Perceived visual attractiveness level	Replicate the experience to other target audiences.	ET	Tourists Destination Tourism Services	89,634
Muñoz-Leiva et al. (2019)	Experimental groups	Advertising effectiveness analysis in social media in terms of customers' visual attention and self-reported memory (recall).	Cognitive neuroscience methodologies to measure ad effectiveness; visual attention and recall as measurements of ad effectiveness. Banner recognition memory.	-	Measuring advertising effectiveness in travel.	To replicate this design with a larger sample of individuals to measuring advertising effectiveness in travel.	ET	Tourists Destination Tourism Services	89,634
Bastiaanse et al. (2018)	Experimental study	An EEG-based neuromarketing experiment was performed to establish whether event-related potentials (ERPs). To examine how consumer-related differences in working models of social behaviour, specifically attachment styles, affect their automatic emotional reactions to service robots in hospitality settings.	Destination in your brain; Destination marketing; Marketing of destinations; Measuring emotions from the brain; Neuromarketing.	-	Neuromarketing: Movies induced tourism.	Verifying the temporal persistence of the influence of organic destination movies on emotional responses. To study how long, the positive emotional response remains in the brain after seeing a destination movie.	EEG	Human-Robot Interaction Robots Artificial Intelligence	99,349
Xie et al. (2022)	Case study	To demonstrate that the assessment of fluency, complexity, and naturalistic patterns of an architectural work of art is achieved through sensory-motor systems.	Neuroscience; Cultural psychology; Neuroaesthetics.	Stress reduction theory (SRT) and attention restoration theory (ART)	Create more engaging and culturally relevant experiences for guests. Give priority to cultural and ecological elements in architectural projects.	Impacting specific cultural and ecological elements and the role of technology in the guest experience.	-	Aesthetic Value Abstract Art Artwork	95,987
Boz et al. (2017)	Case Study	To provide insight into how tourists perceive prices and pricing issues. In particular, it provides neuromarketing examples to explain how tourists perceive prices in holiday advertisements in terms of design features, positioning and content	Destination pricing; Tourism pricing psychology; Decoy effect; Prospect theory.	-	Tourism pricing.	Apply the price psychology model to tourism products e.g., hotels, restaurants, entertainment.	EEG GSR HR ET	Neuromarketing Neurosciences Community Participation	95,878

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Goggin <i>et al.</i> (2017)	Case study - short interviews	To measure the emotional dimension of experience and place attachment.	Affects based on neuronal circuits concentrated in subcortical regions of all mammalian brains: Care, play, seeking, fear, grief, fear, rage and lust.	-	Emotional dimension of experience and place attachment	Research to discriminate the positive emotions associated with connection to place and spiritual experiences. Provide a model on place emotional.	-	Place Heritage Tourism Tourist Experience	98,382
Li <i>et al.</i> (2023b)	Survey	To examine the spillover effects of residual arousal produced by a prior advertisement on subsequent destination video advertising.	Emotion spillover; Destination marketing; Neuromarketing.	-	Increase the explanation power of excitation transfer theory. Integrate travellers' emotion spillover. Intensify the emotional experiences of viewing advertising.	Evaluate spillover effects of negative commercials on destination advertising. Gender analysis. Combination with fMRI.	EEG	Neuromarketing Neurosciences Community Participation	95,878
Morar <i>et al.</i> (2021)	Survey	Explore self-reported changes in travel behaviours and preferences in relation to psychological reactions to the COVID-19 pandemic and neuropsychological personality traits.	Risk Perception and Disease; Tourists' Fear; Resilience Factors; Personality and Travel.	-	Tourists' Fear and travel behaviour.	Incorporate observation and neuropsychological measures for behavioural inhibition and fun-seeking subsystems. Use larger samples and the same proportion female/male.	-	Tourist Destination Image Risk Perception	99,872
Mojahedi & Hassanpour (2016)	Questionnaire	To identify and prioritize neuromarketing strategies and investigate its effects on the company's competitive advantage on the basis of the marketing mix.	Exploration into the brain; Functions of the nervous system; Neurology and biometrics in marketing; Neurology for advertisements; Neuromarketing strategies; Home and familiar places; Return travel; Connections to VFR Travel Blogs. Social Representations. On Site Experiences. Time perception. Variability. Links to memory. Virtual VHPP Travel, Emotions.	-	Neuromarketing strategies effects in travel agencies.	Replicate the study to other tourism services.	-	Capitalism Personal Identity Historian	24,956
Pearce (2012)	Questionnaire	Explain the of individuals' experiences in returning to previous places of significance and familiarity in their lives applied to tourism.		-	Experience of visiting home and familiar places (Visual Flight Rules).	-	-	Visual Flight Rules Tourism Human Migration	75,709

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Lazo et al. (2023)	Cross-sectional descriptive study (web analytics tools and survey - Delphi)	To propose neuromarketing actions for the tourist promotion of the Cuba destination on the Cubatravel website.	Fundamentals of psychology and neuroscience Commercial strategies.	Visual hierarchy theory.	Neuromarketing actions applied to tourist promotion.	-	ET	Methodology Photogrammetry Information Modelling	99.024
González-Mena et al. (2023)	Cross-sectional experiment study	To achieve greater efficiency, attraction, and engagement on the part of the user.	Neuromarketing Design; User experience; Neuroscience.	-	Relation between Facial Expressions and Website Design.	-	ET FEA	Neuromarketing Neurosciences Community Participation	95.878
Royo Vela & Garzón Paredes (2023)	Multi-method quantitative approach applying surveys and neuromarketing	To test the effects of heritage on the TDI formation.	Destination image; Cognitive-emotional dimensions; Neuromarketing.	TDI model	Providing an authentic experience. implications for tourism management and marketing.	Relate cognitive-emotional factors that generate the image of the heritage destination. Use of more advanced neuromarketing techniques.	EEG	Destination Image Competitiveness Revisit Intention	98.855
Ramsøy et al. (2019)	Multi-modal approach including self-reported destination preference	Analyse future holiday travel choices. To test whether direct emotional and cognitive responses to travel destination would be indicative of subsequent stated destination choice.	-	-	Emotional and cognitive responses for destination choice.	Include destination choices that vary in the temporal dimension (e.g., comparing choices of planned travel in a year vs those that are spontaneous and instant) to better understand how subconscious and conscious processes contribute to actual destination choices.	EEG	Neuromarketing Neurosciences Community Participation	95.878
Michael et al. (2019)	Neuromarketing study on destination image investigating the third source of image formation, that is, the "demand side", the image receivers, applied to local citizens.	To understand how direct and unconscious emotional and cognitive responses underlie travel destination choice.	Destination image and arousal media; Bridging the gap in novel neuroscience methods; Unconscious emotional and cognitive responses to destination images.	Emotional arousal model applied by induced destination images.	Unconscious emotional and cognitive responses.	Application the model to other geographical and cultural contexts.	ET EEG	Destination Image Competitiveness Revisit Intention	98.855