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Bibliometric Analysis and Systematic Review of Neuroscientific Studies in Fashion Design Literature[1]

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Abstract

With the development of technology, neuroscience tools have facilitated the processes of understanding and predicting human behavior in different sectors within the scope of marketing strategies. The aim of this study is to explicate the neurofashion concept examining the current studies conducted in fashion design with neuroscience tools. Thus, it aims to evaluate the methods and results of applied studies effectuated in fashion industry and to offer novel perspectives. Accordingly, the study data was obtained in two stages. In the first, the publications in the Scopus (Elsevier) database were analyzed with the R-based Biblioshiny package program considering year, country, keyword, author and citations using the bibliometric analysis method. In the second stage, the systematic literature review method was used with the Google Scholar scientific search engine. Of the searches made with keywords on the search engine, those related to the subject were selected and examined. The study is one of the first in the field to examine the relationship between fashion design and neuroscience and is therefore important.

According to the information obtained from the research; use of neuroscience tools in fashion design allows fashion design and production processes to be carried out in-depth and with a more scientific perspective, contributing to sectoral sustainability and efficiency. It reveals that the predictions made using neuroscience tools have a much higher accuracy rate than those based on personal reports. These results indicate that use of neuroscience tools will directly reduce declines in product renewal and product marketing in the fashion design step.

Keywords: Neuromarketing, Neuroscience, Fashion Design, Bibliometric Analysis, Systematic Literature Review.

JEL Codes: D87, L67, M3

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[1]"This study was prepared based on the data obtained to provide a foundation for the ongoing doctoral dissertation titled 'Analysis of the Garment Prototyping Phase through Neuroscientific Tools' conducted within the Department of Fashion Design at the Graduate School of Ankara Hacı Bayram Veli University."

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Introduction

Factors such as the advancement of technology, intensification of competition, social changes and increased consumer awareness have changed the behavior and preferences of consumers. With this change, consumer decision-making processes have evolved into a more complex and in-depth structure. Consumers' preferences are no longer shaped only by logical considerations; their emotional reactions are also becoming an important factor affecting their purchasing decisions (Yücel & Çubuk, 2014:133). While traditional marketing approaches focused on the product, today marketing has shifted its focus towards consumers. With this change, identifying consumers' wants and needs and understanding the factors affecting their purchasing behavior have become of great significance for marketing. Use of neuromarketing techniques in marketing research has also developed with this changing understanding. Neuromarketing techniques are used to reveal consumers' true feelings and true thoughts concerning the products or services at both conscious and subconscious levels (Bağçı, 2022:30).

The neuromarketing concept is defined as a discipline studying and investigating the changes that occur in the brains of individuals in decision-making processes and behaviors in areas such as market research, product and service design, brand positioning, communication and pricing (Tejada-Escobar, Fajardo-Vaca, & Vásquez-Fajardo, 2015). From another perspective, it is a tool that endeavors to understand what goes through the minds of consumers when they come into contact with a product or brand (Lindstrom, 2008:14). In traditional research methods, the results obtained in these methods are limited since the participants convey their behaviors, perceptions and attitudes at the conscious level, that is, they present subjective data, whereas neuromarketing increases the reliability of the research since it allows obtaining objective data from the subconscious level (Manas-Viniegra, Nunez-Gomez, & Tur-Vines, 2020:2). Generated from the combination of neuroscience and marketing, neuromarketing is based on analysis of brain responses triggering marketing and communication stimuli in consumers (Ju´arez-Var´on, Mengual-Recuerda, Capatina, & Nú˜nez Cansado, 2023:2). As a new way of understanding the consumer, this concept was introduced by Dr. Ale Smidts in 2002 (Hubert & Kenning, 2008).

Also known as emotional marketing, Neuromarketing is an important step in opening and understanding the black box in the human mind (Emül & Yücel, 2021:10; Yücel & Çubuk, 2014:223). Neuromarketing findings offer powerful new perspectives to the field of consumer research by revealing that the average consumer does not always make conscious and deliberate decisions, rather he/she is influenced by subconsciously formed preferences. This reaction is a result of the functioning of the human brain which tries to save energy and produce quick and effective actions. Since most purchase decisions take place at a subconscious level, consumers often have insufficient awareness regarding the reasons behind their decisions and choices (Lee, 2021:185).

Neuromarketing is prioritized in research conducted in many sectors such as industrial production. Employees' emotions are of high importance for the operational efficiency of businesses and working performance of the staff. The way to understand the emotions of individuals is through study of their neural activity (Li, Wang, & Wang, 2017:370).

Especially, fast-moving consumer goods, telecommunications, banking and tourism sectors are among the most prominent areas of research. On the other hand, the successful results obtained despite the lack of sufficient theoretical basis, numerous repeated scientific experiments, ethical issues and various procedures have increased the interest in applied fields such as fashion industry, product design, gastronomy and automotive sector in neuromarketing studies (Kurtoğlu & Ferman, 2020:74). Significance of neuromarketing studies is remarkable for the fashion industry which is full of brands, trends and visual images (Touchette & Lee, 2017:4).

Today, fashion industry is one of the most polluting sectors in the world. For this reason, in recent years many apparel companies, including fast fashion brands, have committed to producing sustainable fashion products, using recyclable textile materials, or have taken various steps to eliminate textile waste as part of their business operations (Marko & Kusa, 2023:87). In this context, consumer forecasting studies with neuromarketing tools can make significant contributions to the development of the sustainable fashion industry. Thanks to these tools, consumers' emotional and cognitive responses to sustainable fashion products and brands can be perceived.

Studies to predict consumers' consumption behavior can guide brands in developing sustainable product and marketing strategies. For instance, neuromarketing tools such as EEG (Electroencephalography) and fMRI (functional Magnetic Resonance Imaging) can help identify how consumers visually process sustainable fashion products and what emotional responses they have to these products, as well as guide fashion brands in developing sustainable product and marketing strategies.

Studies using neuromarketing tools indicate that unconscious perceptions are more common than conscious perceptions. The perception that we often make choices based on emotions or ideas beyond our rational control has played a key role in the development of modern theories of consumption (Feghali, 2010:91). Therefore, it shows how valuab-

le neuromarketing tools are in gaining a more profound understanding and more reliable prediction of consumer behavior.

Lack of awareness of neuromarketing activities by companies in the fashion industry has several financial implications and leads to losses rather than profits. Therefore, in addition to traditional market research, businesses need to be familiar with neuroscience techniques and the new trends involved in this field (Tejada-Escobar, 2015:33). In 2005, in the US alone, companies spent over 7.3 billion dollars on market research. In 2007, this amounted to $12 billion, not including additional costs such as product marketing, packaging, TV commercials, outdoor advertising, celebrity and top model fees. This shows that traditional practices have lost their effectiveness today and it is very important to adopt and implement up-to-date technological practices as soon as possible (Feghali, 2010:92).

Since neuromarketing measures the reaction of consumers' brains to marketing stimuli in real time, it allows for an unbiased and unfiltered understanding of consumers' purchasing decisions. TJ Maxx, an apparel company, collaborated with Mindlab International, a neuromarketing research company, to analyze consumers' brain responses while shopping using brain activity monitoring technologies such as EEG. Research has found increased brain activity associated with surprise, satisfaction and reward when customers encounter luxury brands. Such findings provide companies with valuable insights to inform store organization and product placement. For example, a company like TJ Maxx can design store layouts to increase the feeling of a treasure hunt among customers, which in turn encourages the mobilization of positive emotions, spurring more sales (Touchette & Lee, 2017:3-4).

Techniques Used in Neuromarketing

Neuromarketing techniques are generally known for brain imaging systems. Neuromarketing utilizes brain (neurometric) and physiological (biometric) measurement techniques to understand consumers' conscious and subconscious responses, and these two techniques should support each other (Erdemir, 2015). We can classify the techniques used in neuromarketing as techniques that measure metabolic activities in the brain, techniques measuring electrical activities and techniques that measure activity outside the brain (Bercea, 2012:2).

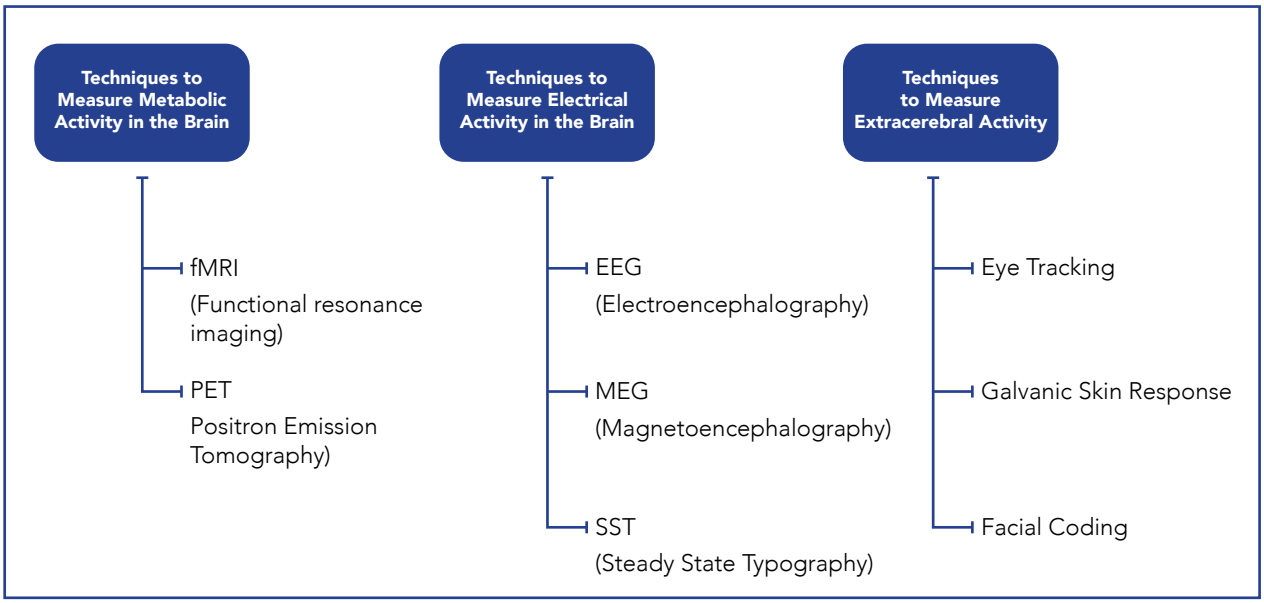


Figure 1. Techniques Used in Neuromarketing

Source: (Bağçı & Bostan, 2022)

In this context, the literature review was conducted on the use of neuromarketing tools in the field of fashion design in Scopus (Elsevier) and Google Scholar databases identified publications in different fields. It was observed that the publications were mainly in the fields of "Business, Marketing, Economics, Social Sciences, Arts and Humanities". Regarding the scope of the subject, it is revealed that the publications are mainly dealt with titles such as "Fashion Industry, Neuromarketing, Brand Image, Sustainability, Fashion Psychology, Consumer Behavior".

The aim of this study is to explicate the concept of "neurofashion" by examining the current status of studies conducted in the field of fashion design with neuroscience tools. Thus, it is aimed to offer new perspectives for future research by evaluating the methods and results of applied studies conducted in the fashion industry. It also provides an important contribution to understanding the effects of fashion on the brain and behavior by revealing the scope

and development of research at the intersection of the two disciplines. Furthermore, by identifying gaps in the literature regarding the integration of neuroscientific approaches into fashion design, it aims to provide direction for future research in this field. This study, which examines the psychological and neurological dimensions of fashion design in more depth, has the potential to be an important reference point for both academic circles and practical applications by contributing to the knowledge of the field.

Accordingly, the study data were obtained in two stages: bibliometric analysis and systematic literature review. The research questions are presented in Table 1.

Table 1. Research Questions

Analysis Type	Research Question
Bibliometric Analysis	What is the distribution of publications on fashion design with neuroscience tools according to years?
	How are the number of documents and citation scores of the top five journals according to the number of citations?
	What was the distribution of the authors who contributed to these studies by country and how was the collaboration realized?
	What are the top 10 most cited publications?
	What are the keyword phrases used in studies on fashion design with neuroscience tools?
	What was the relationship between the keywords of these studies?
Systematic Literature Review	What are the main research trends in neuroscience in relation to the field of fashion design?
	In the field of fashion design, studies in the field of neuroscience have been carried out in which areas the most.

Method

In this study, descriptive research method was used to delve into the current status of studies conducted in the field of fashion design with neuroscience tools. A descriptive review is a methodology used to obtain generalizable results in a field of research by screening and analyzing the most relevant articles and begins with a systematic screening strategy (Koçak Usluel et al., 2013:55). A topic makes progress when it is logically integrated on the basis of the findings of previous studies. Having been applied as a research methodology, literature reviews contribute significantly to the conceptual, methodological and thematic development of different fields (Paul & Criado, 2020:1). In order to shed light on the concept of neuromoda and to put forward new ideas for future research, the data obtained were carried out in two stages: bibliometric analysis and systematic literature review.

Constituting the first stage of the research, Bibliometric analysis is a systematic method extensively used to research and analyze large volumes of scientific data. This method allows to uncover information on how a particular field or a concept has developed, while explaining emerging issues in that field (Gerçek, 2022:207). Bibliometric research is an important tool that provides guidance for future scientific studies by identifying the most influential studies, researchers and countries in the field under study. These studies elucidate developments in the scientific literature by revealing interactions between researchers and countries (Gülmez, Oğuz, & Yalçıntaş, 2020:91).

The bibliometric analysis of the data obtained through databases such as Clarivate Analytics Web of Science, Scopus, Google Scholar and Science Direct provides researchers with detailed information on the topics they are researching and provides guidance for new research to be conducted. At this stage, Scopus was preferred as a database for it contains a richer collection of publications focused on the field of fashion design, offering a more comprehensive resource to researchers than other databases. In the first stage of the study, a bibliometric analysis of the studies on the concepts of "neuromarketing" and "fashion design" in the Schopus (Elsevier) database was conducted.

Concurrently, the systematic literature review, which constitutes the second stage of the research, is a special type of literature review and provides additional advantages. This type of review uses systematic and explicit methods to identify, select and critically evaluate relevant research. It also scrutinizes a specific problem by clearly formulating it and collects and analyzes data from included studies (Siddaway, Wood, & Hedges, 2019:751). A systematic literature review is the process of finding, evaluating and summarizing the most relevant studies available to answer a specific research question. It is also recognized as an effective research methodology for synthesizing and presenting the results and findings of a detailed review of studies in an organized, clear and reproducible manner (Yıldız, 2022:367).

This part of the study was conducted by Yıldız et al according to the stages adapted from Tranfield. The process followed is illustrated in Figure 2.

The process followed for the Systematic Literature Review was carried out in 3 steps and the research was conducted on Google Scholar search engine. The reason why Google Scholar was preferred is that more directly relevant publications can be accessed on this platform compared to searches in other databases.

The Process Followed in Systematic Literature Review

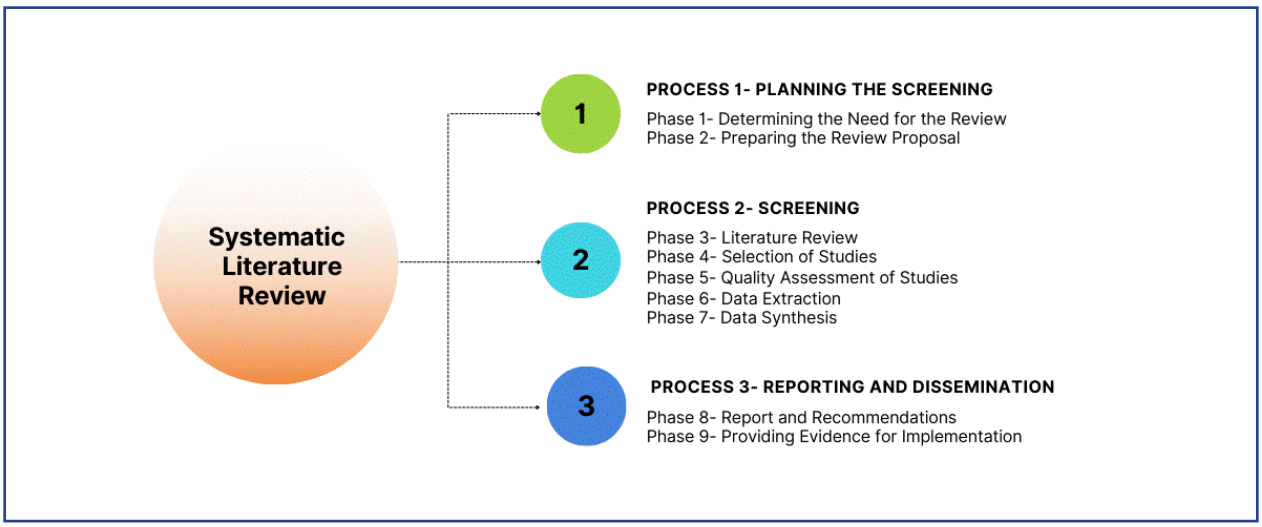


Figure 2. Systematic Literature Review
Source: (Yıldız, 2022:372)

Process-1 Planning the Screening

The first process of the Systematic Literature Review consists of "Determining the Need for the Review" and "Preparing the Review Proposal".

In the first phase, we frame the research questions according to the observed research gaps. The main aim is to examine the current state of research in the field of fashion design with neuroscience tools. It is also to clarify the concept of neuromoda and to address the advantages and disadvantages of studies with neuroscience tools.

In the second stage of the process, creation of the Screening proposal, the research question is first defined. Then, inclusion and exclusion criteria are determined in accordance with the purpose of the review. This stage is very important for the study to be carried out in an objective manner (Yıldız, 2022:371).

In this part of the study, answers were sought to the following questions:

- What are the main research trends in neuroscience in relation to the field of fashion design?
- In the field of fashion design, in which areas the studies in the field of neuroscience have been mainly carried out?

Process-2 Screening

The third stage of the process consists of "Literature Review", "Selection of Studies", "Quality Assessment of Studies", "Data Extraction" and "Data Synthesis". In this process, the search query is defined by combining the terms or keywords obtained from the research questions. Accordingly, on 05.10.2024, the keywords "neuromarketing and fashion" were typed into the Google Scholar search engine and the relevant results were listed. In the initial screening, 3,600 data were listed. In line with the inclusion criteria, only articles were included in the review and the number of data was reduced to 235. As for the time period, the year range 2013-2024 was chosen as it provides the most relevant results within the scope of the subject in the Schopus database. In line with the filtering based on the inclusion and exclusion criteria, 205 relevant publications were listed and reviewed.

Process-3 Reporting and Dissemination

TThe last step of the process consists of "Report and Recommendations" and "Providing Evidence for Implementation". In the last step, the results of the analysis are reported in two separate sections.

Figure 3 shows the stages of data analysis with Bib-

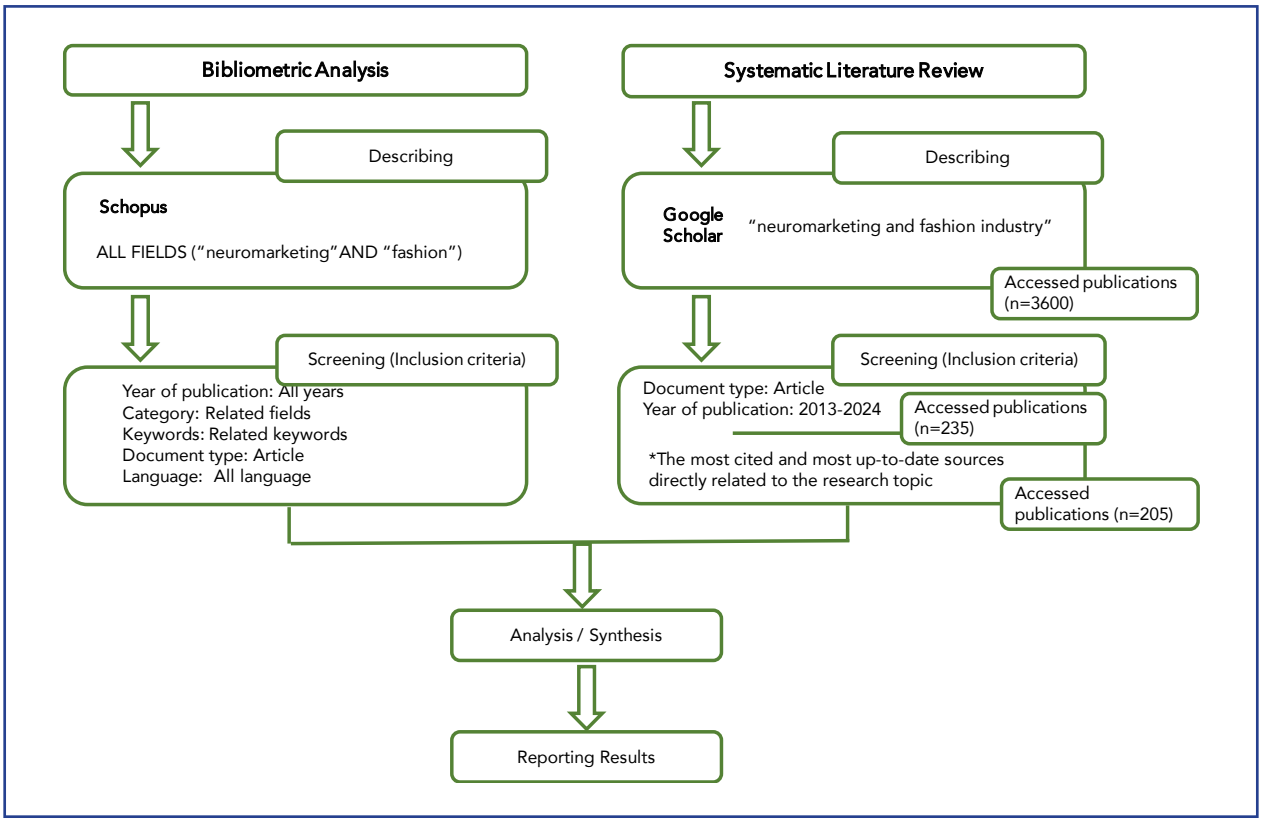


Figure 3. Bibliometric Analysis and Systematic Literature Review Stages

Source: (Jain, et. al., 2022:1532)

liometric Analysis and Systematic Literature Review.

On 05.10.2024, 409 results were obtained from the Scopus database by selecting "all fields" with the words "neuromarketing" AND "fashion" for the years 2007-2024. Then, the subject areas (Social Sciences, Arts and Humanities, Multidisciplinary, Psychology, Business Administration, Management and Accounting), which were predicted to be suitable for the scope of the research, were selected from all fields and the total number of data obtained in the scanning made by filtering the keywords related to the subject was 159. Table 2 shows the publication distribution of the results obtained regarding the specified restrictions in the Schopus database. Only articles were included in the scope of the research and 138 studies were analyzed.

Publication Type	Number of Publications
Article	138
Book	4
Declaration	9
Conference	8
Total	159

Table 2. Publication Distribution in Scopus (Elsevier) Database

The files downloaded from the Schopus database in BibTeX format were transferred to the R-based Biblioshiny package program, were examined and interpreted by visualization.

In the second stage of the study, the systematic literature review (SLR) method is used. For the articles that could not be accessed in Schopus databases, the 10 most closely related publications were accessed via Google Scholar search engine with the keywords "neuromarketing in fashion design" and analyzed with this method.

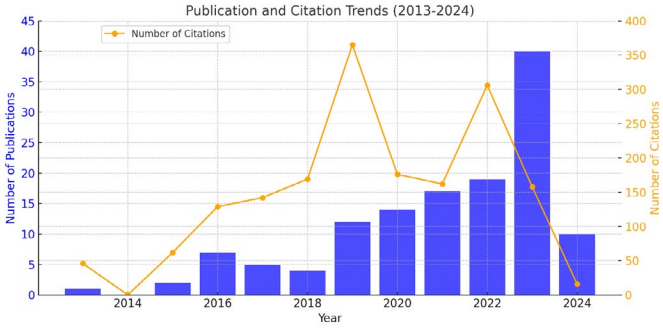
Findings

The findings regarding the documents analyzed within the scope of the research questions of the study are presented below.

Bibliometric Analysis Findings

Figure 4 shows the publications containing the keywords "neuromarketing" and "fashion" and the distribution of citations received by these publications according to years. When the table is analyzed, it is found that the oldest publication was made in 2013 and the newest in 2024. The highest number of publications was recorded in 2023 with 40 publications. Especially after 2016, there has been a signifi-

cant increase in the number of publications dealing with the concept of fashion in the field of neuromarketing, while looking at the number of citations, 12 different publications made in 2019 attract attention



with 365 citations.

Figure 4. Relationship between Number of Publications and Number of Citations by Year

The number of documents and citation scores of the top five journals according to the number of citations are given in Table 3. Analyzing the table, it is seen that "Journal of Retailing and Consumer Services" ranks first with 20808 citations and 16.1 citation points. The journal is an international and interdisciplinary forum for research and debate in the rapidly evolving and transforming fields of retailing and service studies. It is a peer-reviewed, open access journal with a particular focus on consumer behavior, policy and managerial decisions.

No	Journal Name	Number of Documents	Number of Citation	Citation Score (2022*)
1	Journal of Retailing and Consumer Services	5	20.808	16,1
2	Physiology and Behavior	1	8.010	6,3
3	Tourism Review	1	4.359	12,8
4	Journal of Business Research	7	51.538	16
5	Journal of Fashion Marketing and Management	1	1.243	7,9

Table 3. Top Five Most Cited Journals in the Subject
(* The Scopus database includes data for 2022 as the current citation score.)

Figure 5 illustrates the distribution of the number of publications accessed with the relevant keyword group according to countries. It is seen that there are 47 countries in total, including Turkey. Italy, which ranks first among the 138 publications reached in the review, stands out with 52 publications. After Italy, Spain ranks second with 35 publications. These countries are followed by China with 31 publications, the USA with 25 publications, India with 24 publications and South Korea with 18 publications. Turkey has 1 publication.

When the cooperation network between the countries of the 138 publications accessed with the relevant keyword group is analyzed, it is seen that Italy and the USA, Spain and Portugal, India and the United Kingdom, and the USA and France are among the countries that work together the most.

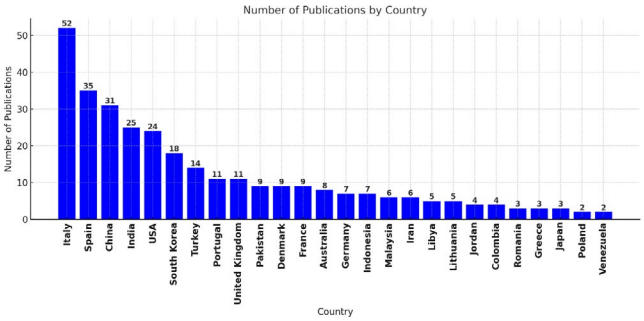


Figure 5. Distribution of the Number of Publications Accessed with the Related Keyword Group by Country

Table 4 presents information on the top 10 most cited studies on the subject. Accordingly, the first ranked study by Roh, T., Seok, J., Kim, Y. titled "Unveiling ways to reach organic purchase: Green perceived value, perceived knowledge, attitude, subjective norm, and trust" received 120 citations in the Schopus database. Among the top 10 most cited articles, the United Kingdom and South Korea stand

Table 4. Information on the Top 10 Most Cited Studies on the Subject

No	Title	Author	Magazine	Institution	Country	Year	Number of Citation
1	Unveiling ways to reach organic purchase: Green perceived value, perceived knowledge, attitude, subjective norm, and trust	Roh, T. Seok, J. Kim, Y.	Journal of Retailing and Consumer Services, 67, 102988	Soonchunhyang University, Global Business School KT Economics and Management Research Institute Seoul Women's University, Department of Data Science	South Korea	2022	120
2	The application of EEG power for the prediction and interpretation of consumer decision-making: A neuromarketing study	Golnar-Nik, P. Farashi, S. Safari, M.-S.	Physiology and Behavior, 207, pp. 90–98	Neuroscience Research Center, Shahid Beheshti University of Medical Sciences Deputy of Research and Technology, Hamadan University of Medical Sciences Brain Future Institute	Iraq	2019	102
3	Electronic word of mouth in tourism and hospitality consumer behaviour: state of the art	Pourfakhimi, S. Duncan, T. Coetzee, W.J.L.	Tourism Review, 75(4), pp. 637–661	University of the Sunshine Coast, Sunshine Coast, Australia Hogskolan Dalarna, Falun, Sweden Department of Tourism, University of Otago, Dunedin, New Zealand	Australia, Sweden, New Zealand	2020	72
4	How to "Nudge" your consumers toward sustainable fashion consumption: An fMRI investigation	Lee, E.-J. Choi, H. Han, J. Dong Hyun, K. Eunju, K. Kyung Hoon, K.	Journal of Business Research, 117, pp. 642–651	Sungkyunkwan Üniversitesi, Seul, Güney Kore Pekin Moda Teknolojisi Enstitüsü, Pekin, Çin Yonsei Üniversitesi, Seul, Güney Kore Changwon Ulusal Üniversitesi, Changwon, Güney Kore	South Korea, China	2020	69
5	Omnichannel fashion retailing: examining the customer decision-making journey	Lynch, S. Barnes, L.	Journal of Fashion Marketing and Management, 24(3), pp. 471–493	Cirencester, United Kingdom Manchester Fashion Institute, Manchester Metropolitan University, Manchester, United Kingdom	United Kingdom	2020	65
6	Neuroscience-Inspired Design: From Academic Neuromarketing to Commercially Relevant Research	Spence, C.	Organizational Research Methods, 22(1), pp. 275–298	Crossmodal Research Laboratory, Oxford University, Oxford, United Kingdom	United Kingdom	2019	55
7	Using EEG to examine the role of attention, working memory, emotion, and imagination in narrative transportation	Gordon, R. Ciorciari, J. van Laer, T.	European Journal of Marketing, 52(1-2), pp. 92–117	Faculty of Business and Economics, Macquarie University, North Ryde, Australia Department of Psychological Sciences, Swinburne University of Technology, Hawthorn, Australia Cass Business School, University of London, London, United Kingdom	Australia, United Kingdom	2018	54

8	Empathy can increase customer equity related to pro-social brands	Lee, E.-J.	Journal of Business Research, 69(9), pp. 3748–3754	Business School, Sungkyunkwan University, 53 Myeongnyun-dong 3-ga, Jongno-gu, Seoul, 110-745, South Korea	South Korea	2016	54
9	Better branding: Brand names can influence consumer choice	Hillenbrand, P. Alcauter, S. Cervantes, J. Barrios, F.	Journal of Product and Brand Management, 22(4), pp. 300–308	Faculty of Business Administration and Accounting, Universidad Nacional Autónoma de México, Mexico City, Mexico National Institute of Psychiatry Ramón de la Fuente Muñiz/Institute for Neurobiology, Universidad Nacional Autónoma de México, Juriquilla, Querétaro, Mexico Institute for Neurobiology, Universidad Nacional Autónoma de México, Juriquilla, Querétaro, Mexico	Mexico	2013	46
10	Trust me if you can – neurophysiological insights on the influence of	Hubert, M. Hubert, M. Linzmajer, M. Riedl, R. Kenning, P.	European Journal of Marketing, 52(1-2), pp. 118–146	Department of Management, Aarhus University, Aarhus, Denmark Independent Researcher, Berlin, Germany Institute of Retail Management, University Sankt Gallen, Sankt Gallen, Switzerland University of Applied Sciences, Upper Austria, Austria	Denmark, Germany, Switzerland, Australia	2018	44

527 keywords were used in 138 articles that included the concepts of "Neuromarketing" and "Fashion Design" within the scope of the constraints determined in the research. The word cloud created according to the intensity of the related keywords used in the studies is shown in Figure 6. In the word cloud created using R Studio software, letter sizes and thicknesses are arranged proportionally according to usage intensity. It is seen that the words consumer, neuromarketing, behavior, and brand are used much more frequently than other words in the publications scanned within the scope of the subject. In addition, it is noteworthy that keywords such as fashion, sustainable, purchase and influence are also prominent words in studies in the field of neuromarketing.

Figure 6. Word Cloud Created with Related Keyword Group

Findings of the Systematic Literature Review

Firstly, the title, keywords and abstract were analyzed and the publications directly related to the research topic were selected. In this direction, general information about the 10 articles selected among the publications accessed and considered to be the closest to the subject scope is given in Table 5.

No	Author *	Year	Publication Name	Area	Data Collection Tool	Subject Area
1	Kurtoğlu, A.L. & Ferman A.M	2020	An exploratory research among fashion business leaders and neuromarketing company executives on the perception of applied neuro-marketing	Business, Marketing	Semi-structured interview form	Fashion Industry, Neuromarketing
2	Baldo, D.vd.	2015	Brain waves predict success of new fashion products: a practical application for the footwear retailing industry	Business	Survey and EEG	Brand Image, Neuromarketing
3	Balconi, M.vd.	2019	A neuroscientific approach to explore consumers' intentions towards sustainability within the luxury fashion industry	Social Sciences, Environment	Survey and EEG	Luxury Fashion Consumption, Sustainability
4	Lee, S.E.	2021	Teaching neuromarketing to fashion students: an application of Kirkpatrick's model	Arts and Humanities	Survey	Fashion, Education, Neuromarketing
5	Lee, E.-J.vd.	2020	How to "Nudge" your consumers toward sustainable fashion consumption: An fMRI investigation	Business	fMRI	Fashion, Sustainability, Neuromarketing
6	Martyniuk, O. & Poplavska, T.	2021	Neuromarketing in the Context of Sustainable Development Philosophy	Economy	Compiled data from primary and secondary sources	Sustainable Development, Neuromarketing
7	Li, B.R. Vd.	2017	A novel method for the evaluation of fashion product design based	Business, Economics	EEG and Eye Tracking	Fashion Product Design, Neuromarketing
8	Andrade, N.A. Vd.	2022	Neuromarketing and Eye Tracking in Women's Fashion Buying Decision Making	Marketing	Eye Tracking	Neuromarketing, Fashion Psychology
9	Ju´arez-Var´on, D. Vd.	2023	Footwear consumer behavior: The influence of stimuli on emotions and decision making	Business	Eye tracking and galvanic skin response, semi-structured interview form	Neuromarketing, Consumer Behavior
10	Marko, M. & Kusa, A.	2023	Greenwashing and the Nature of Education in Relation to Consumer Trust in Fashion Marketing Communication	Business, Social Sciences	Galvanic skin response, survey	Neuromarketing,

* Studies with more than two authors are cited as first author's information, et al.

In the study titled *"An exploratory research among fashion business and neuromarketing company executives on the perception of applied neuromarketing"* by **Kurtoğlu and Ferman (2020),** listed first in the table, the aim is to shed light on the neuromarketing literature and explore the perceptions of neuromarketing and fashion managers regarding applied neuromarketing in the global and Turkish fashion industry. Following a review of current literature on theoretical and applied neuromarketing, in-depth interviews were conducted with 3 Turkish neuromarketing managers and 5 fashion leaders using a semi-structured interview form. The findings demonstrate that there are differences and similarities between the use of applied neuromarketing in the world and in Turkey. The in-depth interview findings reveal that the perceptions of Turkish fashion managers regarding neuromarketing differ from the previous literature and that there are different priorities for applying neuromarketing in fashion industry (Kurtoğlu & Ferman, 2020).

In the study titled "*Brain Waves Predict Success of New Fashion Products: A Practical Application for the Footwear Retail Industry"* by **Baldo et al. (2015),** importance of pre-market forecasting in the footwear retail sector is emphasized. The aim of the study is to propose a novel approach based on brain data to predict product success performance. Traditional methods have been found to be unreliable in forecasting consumer preferences, as demonstrated in

social and psychological market research studies. Therefore, use of brainwaves is proposed as a more accurate method for predicting the success in new fashion products. The significance of the study lies in the fact that the success rates of the numerous new products launched by retailers each year have a direct impact on retailers' gross profit, customer loyalty, and brand image. In this regard, application of a new forecasting method based on brain data is proposed, and the potential benefits of this method are discussed. The methodology of the study was carried out in two phases: Firstly, a quantitative method was employed with 40 female participants aged between 19 and 53. In this phase, participants were asked to complete a survey using a 5-point Likert scale. In the second phase, an experimental method using an EEG device was applied to measure the participants' brain responses to each pair of shoes. Participants evaluated the shoes in a simulated shoe store, rating them from 1 to 5, and then proceeded to the EEG experiment. In this phase, the participants were shown images of 30 pairs of shoes for 3 seconds and were asked whether they would purchase each pair. According to the findings of the study, using the brain data resulted in a prediction accuracy of 80%, and the brainwave-based predictions led to a 36.4% increase in profit (Baldo, Parikh, Piu, & Müller, 2015).

In the article titled *"A Neuroscientific Approach to Explore Consumers' Intentions Towards Sustainability within the Luxury Fashion Industry"* by **Balconi et al. (2019)**, a neuroscientific method was used to understand the implicit intentions of consumers regarding sustainability in the luxury fashion sector. The focus of the study is to analyze the implicit responses of consumers to sustainability issues in the context of luxury fashion while they are browsing in a store. In the study, an experimental method using EEG devices was adopted. Sixteen luxury consumers were divided into two groups: those sensitive to sustainability and those indifferent to it. After observing the store stimuli, participants interacted with a sales consultant who explained the brand's sustainability policy. The study suggests that luxury consumers focused on sustainability exhibit greater cognitive and emotional activity when exposed to sustainability-related cues, compared to non-sustainability-related topics. Furthermore, it was confirmed that an increased level of knowledge about sustainability leads consumers to perceive the stimuli more accurately and shows a significant delta power when interacting with the sales consultant explaining the brand's sustainability policy (Balconi, Sebastiani, & Angioletti, 2019).

Lee's (2021) article titled "*Teaching neuromarketing to fashion students: an application of Kirkpatrick's model*" has two main objectives. The former is to identify potential neuromarketing topics in order to enhance fashion students' understanding of marketing and consumer behavior. The latter is to assess how students experience and learn about neuromarketing topics. The study was conducted with the participation of 92 students enrolled in three different courses, after identifying content related to fashion consumption and neuromarketing. To teach students the fundamental concepts and applications of neuromarketing, 13 modules were developed, and an online neuromarketing workshop was organized. Finally, a learning assessment based on the Kirkpatrick model was conducted. The research concluded that fashion students had a positive experience learning about neuromarketing, and their understanding of fashion consumers was enriched with new knowledge and ideas. The results of the study suggest a broad range of neuromarketing topics that can be used in fashion design, marketing, and retail courses. These topics include subjects such as the brain and mind, emotions, attention levels, neuroaesthetics, and the relationship between the brain and shopping (Lee S.-E. , 2021).

In the article by **Lee et al. (2021)**, titled " How to "Nudge" your consumers toward sustainable fashion consumption: An fMRI investigation" a significant difference is observed between consumers' attitudes toward sustainability and their green purchasing behaviors, which creates a psychological imbalance. Based on this, the study investigates how to enhance consumers' preferences for fashion products with green labels. In the experimental study, 16 participants were shown two videos containing educational animations: one with a preparatory message addressing "environmental issues" and another with an explicit intervention message explaining the concept of "sustainability. In the study, data obtained while participants were watching the videos were collected using the neuroscientific tool, fMRI. The results supported the hypothesis that seeing a green logo increases consumer preference. Additionally, the findings indicate that when environmental incentive messages are presented before shopping for a product, consumers' preferences for sustainable fashion products increase (Lee, ve diğerleri, 2020).

In the article by **Martyniuk and Poplavska (2021)**, titled *"Neuromarketing in the Context of Sustainable Development Philosophy"*, a literature review was conducted to identify the evolution and research trends in the fields of neuromarketing and marketing ethics. The researchers focused on the dominant consumer ideology in the modern world. Among the products of this ideology, fashion is characterized by elements such as wastefulness and profit-orientedness. Consumption is defined as the act of acquiring goods or services. Excessive consumption, which is widespread on a global scale, refers to acquiring more goods and services than needed. This situation is driving the entire system into a deep crisis. Some scholars believe that the way out of the crisis may lie in the interaction

between neuroscience and economics. Others view the solution as the development of a new way of thinking and a new paradigm. This paradigm must be introduced to the masses through education, thereby raising individuals' levels of consciousness and expanding their potential. The study emphasizes that the most objective responses are obtained from consumers, and it discusses the applications of neuromarketing in areas such as branding, product design and innovation, advertising effectiveness, behavioral triggers affecting purchasing decisions, digitalization, and the entertainment sector. It also includes global companies that use neuromarketing methods to achieve their goals. In conclusion, it can be argued that neuromarketing is a pioneering and promising technology in influencing society in the modern era. While its potential has not yet been fully realized or explored, these studies are among the high-budget expenditures in large corporations (Martyniuk & Poplavska, 2021).

In the study conducted by **Li et al. (2017)**, titled *"A Novel Method for the Evaluating of Fashion Product Design Based on Data Mining"* it is stated that predictions made using neuroscience tools are much more objective compared to traditional methods in the fashion design process. It is emphasized that a new scientific method is needed to evaluate the appearance of fashion products in order to improve traditional evaluation approaches. In this context, beauty is one of the fundamental standards in fashion product design. However, evaluating the beauty of a fashion product is a complex process. This process consists of three stages: comparing fashion products, evaluating various objects, and selecting the most beautiful one. In the fashion design process, an effective evaluation of the appearance of fashion products not only enhances design efficiency but also helps reduce wasted resources. According to the Stimulus-Organism-Response (S-O-R) model, human behaviors can be divided into stages of perception, evaluation, decision-making, and action. Among various product options, individuals frequently determine their preferences. Therefore, an individual's preference behavior involves an evaluation of the product design. 15 female participants took part in this study which employed an experimental method and aimed to develop quantitative evaluation factors related to product appearance, EEG and Eye-Tracking devices were used to collect the data. The women's shirts visually used in the study were divided into seven categories based on technical features, and the participants' preference levels were identified. This method not only scientifically evaluates the product's appeal but also provides an objective reference for improving product appearance design (Li, Wang, & Wang, 2017).

In the study titled *"Neuromarketing and Eye-Tracking in Women's Fashion Buying Decision Making"* conducted by **Andrade, N.A. et al. (2022)**, the research presents an overview of studies related to the use of eye-tracking in consumer research on women's fashion preferences. The study emphasizes that understanding what consumers want is one of the most critical elements of retail success. According to the data obtained in the study, the importance of understanding the cognitive aspects of the customer decision-making process is appreciated by various industries. Leaders of international e-commerce giants and other e-commerce retailers are adopting advanced applications, such as brainwave-based thermal mapping and eye-tracking data, to maintain emotional connections with various market segments, replacing traditional surveys. The researchers highlight that despite numerous studies using neuroscience tools, there are still many unexplored topics in the fashion industry. The study mentions that using eye-tracking devices can help determine "which information consumers pay attention to and in what order" and "which information or visual elements are noticed and which are ignored." Furthermore, it is suggested that this technology can also identify which products on a store mannequin are perceived, which brands attract the most attention, and which information formats or designs capture consumers' attention most effectively (Andrade, Raqinatto, & Cohen, 2022).

In the article by **Juárez-Varon et al. (2023)**, titled *"Footwear Consumer Behavior: The İnfluence of Stimuli on Emotions and Decision Making"* the effectiveness of stimuli used to guide consumer purchasing decisions in a fashion footwear store is experimentally analyzed. The study focuses on the analysis of consumer behavior and how brain activation is influenced through stimuli created by the brand in retail settings. The researchers stated that the decision-making process is influenced by four main factors: cultural factors, social factors, personal factors, profession, and economic status. The research sample consisted of 20 female and 10 male consumers who had purchased at least one product from the brand, in accordance with the target consumer profile specified by the brand. Special stimuli were placed within the store to enhance the brand's value. After participants were informed about the customer journey map, they experienced the shopping process with various stimuli within the store. According to the results of the study, the most attention-grabbing element in the store windows was the entrance, while the least attention-grabbing element was the brand. Areas that generated the highest emotional intensity included the store entrance, women's footwear section, central accessory area, and checkout area, all of which involved product or social interaction. The cashier area, the attention of the cashier, and the payment process resulted in the highest level of emotional intensity. Qualitative interviews revealed that the consumers' primary focus was on the products, though they also valued the store's decor and

the attention of the staff. As a result, one of the key findings was that the product's placement attracted more visual attention and engagement than stimuli based solely on decoration. The major contribution of this research is that it shows how stimuli related to special resting and leisure areas, moments when consumers touch products, and the attention of employees are key moments at the emotional and memory level (Ju´arez-Var´on, Mengual-Recuerda, Capatina, & Nú˜nez Cansado, 2023).

In the article titled *"Greenwashing and the Nature of Education in Relation to Consumer Trust in Fast Fashion Marketing Communication"* by **Marko and Kusa (2023)**, a neuromarketing study was conducted on fast fashion brands. The study describes how a sample of Generation Y and Z consumers, both knowledgeable and unaware of greenwashing, is influenced by fast fashion brands' marketing communication in terms of customer loyalty. The study focuses on Generation Y's resistance and emotional responses to deceptive advertising messages showing greenwashing from the fashion brand H&M. A sustainability-themed commercial from H&M was shown to both conscious and unconscious participants regarding sustainability. The results indicate that the consumer group lacking sustainability awareness had a more positive perception of the messages in the film. Consumers with insufficient knowledge cannot assess the advertisement messages accurately and rationally, and the brand may appear more valuable in their eyes. The study emphasizes that environmental education is the key to eliminating deception and ensuring consumers evaluate the messages correctly (Marko & Kusa, 2023).

Conclusion

This study elucidates field research by examining the current status of studies conducted in fashion design with neuroscience tools through the years 2013 and 2024. According to the data obtained in two stages; application of neuroscience tools in fashion design has attracted more and more attention in recent years. Today's intense competitive environment has had a direct impact on the marketing strategies of businesses, which has led to elate the importance of marketing approaches that enable direct interaction with the consumer, allow the consumer to be monitored in every aspect, aim to create large customer portfolios and aim to be constantly in the minds of the consumer (Bayır, Yücel & Yücel, 2018:253). In this context, neuromarketing stands out as a versatile tool for brands in the fashion industry to achieve these strategic goals. Especially after 2016, there has been a significant increase in the number of publications in the field, and by 2023, the number of publications has increased significantly compared to the previous year, indicating that the integration of neuroscientific methods into the fashion design process is becoming increasingly adopted.

Based on systematic literature review, it is worth mentioning that the publications on "neuromarketing" and "fashion design industry" were more limited compared to other fields, but there has been a significant increase in the number of studies on these subjects in the last 10 years. Rapidly evolving industries, especially telecommunications, banking and tourism, have been the prime beneficiaries of these insights, while the fashion industry has increasingly benefited from the in-depth consumer understanding provided by neuromarketing (Kurtoğlu & Ferman, 2020:73). The fashion design industry potential to create more informed and emotionally-based consumer experiences by utilizing neuromarketing techniques plays a significant role in increasing research in this field. Furthermore, the growing interest in the applicability of neuromarketing to the fashion design industry is developing in parallel with the advances in technology and innovation. In recent years, the development of neural and biological data collection methods has made it possible for fashion brands to analyze consumer perceptions thoroughly, leading to a rapid increase in research. This trend reveals that the fashion industry should be driven not only by aesthetic considerations, but also by psychological and neuroscientific factors.

Unlike traditional marketing methods, studies conducted using neuroscience tools have shown more objective results and higher prediction accuracy. According to Baldo et al.'s study, the capacity of self-report-based methods to accurately predict success is limited, and the use of brain data can reach up to 80% prediction accuracy. We also compared how both methods would affect the company's gross profit. Simulations based on sales data indicated that the self-report-based forecast would lead to a 12.1% increase in profits, while the brain scan-based forecast would increase profits by 36.4%. These findings demonstrate the potential of neuroscientific approaches to improve the performance of brands. concurrently, creating significant value for organizations, shareholders and consumers, this innovative method strengthens brand image using brain data significantly (Baldo, et al., 2015:61).

Among the topics addressed in neuromarketing studies, consumer preferences and sustainability concepts stand out. Despite the laborious process involved in designing and selecting products for production, a large portion of these products fail because they do not meet consumer expectations and needs, resulting in failure. Products that do not meet consumer desires and expectations lead to a large amount of unsold stock. As a result, customers are unable to find the products they want in the store, reducing their satisfaction. At this point, creating brand value, producers need to provide clear responds to questions such as "why should the

consumer prefer this brand and why should they be loyal to this brand?". For the consumer, this explains the value creation process more clearly (Yücel & Çubuk, 2014:223). Seeking answers to these questions, neuromarketing allows them to accurately understand consumers' expectations and offer products accordingly. Thereby, brand value is shaped more clearly for the consumer and a strong bond can be established between the brand and the consumer.

Discounts make products attractive, nonetheless, it can have a negative impact on brand image. Fashion retailers can fail due to designs not capable of meeting consumer expectations, leading to the accumulation of unsold stock. The main reasons for these failures include incorrect pricing, lack of design and incorrect packaging (Baldo, et al., 2015:62). As a result, customers may lose trust in the brand, making rebuilding the brand's reputation a long and costly process. Therefore, accurately predicting consumer preferences is of great economic and environmental importance for manufacturers.

According to Tejada-Escobar et al., many large and small apparel businesses lack knowledge about the effects of neuromarketing on sales management. This deficiency negatively affects financial performance and leads to losses, especially due to increased and inefficient advertising expenditures. In this context, businesses' knowledge of neuroscientific research methods and new marketing trends such as neuromarketing will allow them to accurately analyze consumer mental processes (2015:38).

Neuroscience tools used in marketing activities are regarded as an effective way to reduce the failure probability because these tools allow brands to develop more accurate strategies by analyzing consumer behavior in depth. A product becomes fashionable when it is sold and adopted by consumers in the market. Fashion is ultimately shaped by the consumer, because the consumer preferences who buys and adopts the product, defining fashion. In this context, neither designers nor businesses determine fashion, the real determining power is the customer. Therefore, in contemporary marketing strategies, brands adopt a consumer-oriented approach and try to accurately understand the needs and expectations of consumers and thus aim to create a loyal customer base. Neuroscientific tools become an important part of this process, helping brands meet customer expectations more accurately and efficiently (Öndoğan & Öndoğan, 2021:76).

Touchette and Lee conducted an experimental study with an EEG device to measure consumers' response to the attractiveness of clothes. Accordingly, while the subjects viewed the clothes, the data obtained from the left and right frontal regions of the brain were compared with their self-reported responses. Supporting Davidson's theory, the researchers found that there was a statistically significant difference in frontal asymmetry between attractive and unattractive clothing products. The findings of this study suggest that the frontal asymmetry score may be an alternative method for measuring consumers' unconscious responses to the attractiveness of clothing products (2017:3).

According to Neuromarketing (Marketing 4.0); when consumers make purchasing behavior decisions, they make decisions not only according to the rational part of the brain, that is the logical part of the brain, but also with the irrational, i.e. the emotional part. Neuromarketing is mainly concerned with this emotional, i.e. irrational, part of the brain (Yücel & Çubuk, 2014:223).

The fact that purchasing activities are shaped not only by needs but also by emotional ties forces marketing strategists to balance more rational and emotional factors. Accordingly, neuromarketing offers important guidance to strategists in balancing emotion and rationality in understanding consumer behavior (Bağçı, 2023:160). The insights that neuromarketing offers, especially in understanding emotional factors, are gaining increasing attention in the marketing world. Studies demonstrate that neuromarketing methods are used by global brands in different sectors and that these methods reinforce customer trust in competitive markets. The fashion industry also benefits from these methods, enabling brands to accurately analyze consumer emotional responses and develop effective marketing strategies. Therefore, the increase in publications on neuromarketing and the fashion design industry allows for more profound research at the intersection of these two fields, paving the ground for the future studies.

Suggestion

Making neuromarketing techniques more widespread in the fashion industry will assist brands gain a deeper understanding of consumer behavior and develop more targeted marketing strategies. The integration of neuromarketing methods will increase competitive advantages in the industry. With new technologies such as neural and biological data collection methods, fashion brands can better understand consumer perceptions and make informed decisions.

A great part of failure in brands arises from misjudgment of consumer expectations. Neuromarketing enables brands to improve their product design and marketing strategies by accurately predicting these expectations. In addition, brand image can be strengthened and customer loyalty can be increased with strategies to create emotional bonds.

Given the interest in sustainable fashion design, neuromarketing can help develop strategies for brands offering environmentally responsible pro-

ducts. Pricing strategies optimization can be done based on consumer perceptions of price thanks to neuromarketing, preventing losses due to overstocking.

Neuroscience tools can make significant contributions in the textile industry in various areas such as understanding consumer behavior, improving product design, offering personalized fashion, optimizing the store experience and health. The integration of technology and neuroscientific analysis will help the industry to produce more efficient, customer-oriented and innovative products and solutions. Finally, in-depth research on the knowledge and practices in the field of neuromarketing in the fashion sector and the creation of expert staff will enable professionals in the sector to implement these techniques effectively. By increasing the effective use of neuromarketing in the fashion industry, these recommendations will help brands develop more successful marketing strategies.

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