Exploring the trend of scientific research of eye-tracking for digital advertising insight – A Bibliometric Analysis

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Abstract. *Eye-tracking technology continues to evolve, playing an increasingly significant role in digital advertising. As a result, scientists have been motivated to explore this topic further. In this paper, desk research was conducted to analyze publications related to eye-tracking usage in digital advertising, using data from the WoS database. The analysis includes standard bibliometric indicators, examining research productivity, paper and source types, language of publications, distribution by countries, active affiliations, authorship, keywords, and citation analysis. The data reveal that eye-tracking technology in the digital advertising context has been researched since 1994, with a notable increase in research activity since 2020. A total of 49 publications related to eye-tracking in digital advertising are visible in the WoS database. All these papers are published in English, and most of them are original research articles, authored by 120 researchers from 20 different countries and 90 affiliations. Notably, this paper represents one of the few attempts to explore eye-tracking as a future trend using bibliometric analysis, particularly leveraging the VOSviewer software.*

Keywords. eye-tracking, digital marketing, research, bibliometric analysis, VOSviewer

1 Introduction

Following the adage that "seeing is believing" and "believing is buying" (Maslowska et al., 2020) marketing can benefit from a better understanding of how consumers use sight in purchase situations. Therefore, eye-tracking technology plays an important role in marketing as it enables precise estimation of eye movement patterns and provides insights into consumers' attention (Maslowska et al., 2020; Schmidt & Maier, 2022). By utilizing eye-tracking technology, eye movements and fixation patterns can be accurately and discreetly observed (Russell et al., 2017). Furthermore, eye-tracking can offer a fresh and unique perspective to researchers and marketers to understand how online consumers make purchasing decisions (Maslowska et al., 2020).

Over time, eye-tracking technology's ability to evaluate attention without drawing focus to the stimuli being analyzed provides new, fresh insights into the "black box", or inner mechanisms of product placements and advertising messages (Russell et al., 2017).

Eye-tracking is increasingly used particularly in print ads, to capture both individual occurrences and the overall context of the ad (Fox et al., 1998). By tracking visual attention of users this technology can be used to help determine one's focus on an ad (Fox et al., 1998) as well as brand placement disclosure (Boerman et al., 2015). Smit et al. (2015) highlighted that eye-tracking can be challenging for research participants, but can offer crucial information which can enhance marketing campaigns' strategic planning.

Over time, eye-tracking technologies significantly improved. In 2013 a study by Hartmann et al. was carried out, and it showed the differences in analyzing eye-tracking data obtained through automated tabulation, registration, and tracking of eye-fixation. The authors divided the data into picture and text areas within experimental ads using Tobii T60 eye-tracking technology. The goal was to determine the number of visits to each area. They concluded that viewers are more drawn to text-based advertising messaging than to the image itself (Hartmann et al., 2013). Three years later, a new technology emerged, it was electroencephalography–eye-tracking (EEG/ET). This innovative technique allows precise identification of both the emotional valence (from the EEG) and the source of a reaction (from the ET) (Matukin et al., 2016). With the help of this technique, marketers can gain insights into the emotional responses and attention patterns of consumers according to which they can create more visually appealing brochures, internet ads, packaging, outdoor ads, and booklets (Matukin et al., 2016).

The upcoming chapter outlines the research methodology. Subsequently, the third chapter presents the research findings, encompassing descriptive statistical results, visualization analyses, research

implications and limitations. Finally, the paper ends with a summary of the conducted research.

2 Methodology

A review of the literature published until April 24th, 2024, which dealt with the research of eye-tracking usage in digital advertising is the main aim of this paper. Desk research was conducted to fulfill the set research goal. A bibliometric analysis was made on the collected secondary data to summarize the existing literature in the Web of Science core collection database. Usual bibliometric analysis with descriptive statistics helps to identify authors, keywords, citations, journals, organizations, countries, all their links, and other criteria to reveal their connection at the scientific level (Lacković Vincek et al., 2023). Data for bibliometric analysis can be obtained using various databases. Most often, it includes relevant ones such as Scopus and Web of Science (WoS) and the authors decided to use the Web of Science core collection database based on several facts. WoS was selected due to its reputation as the most discerning database, boasting high impact factors and comprehensive citation analysis. It stands as one of the world's foremost relevant databases (Pavlić, 2024) so the reason for choosing WoS database is evident. According to the author's knowledge, so far in the WoS database, bibliometric analysis has been done on topics related to this research, such as those that cover neuromarketing research (Alsharif et al., 2021), usage of eye-tracking technologies for vision screening (Ali et al., 2021) and eye-tracking technologies in marketing in general (Munoz Leiva et al., 2022). However, in the case of those papers, the same search query was not used to search the WoS and also VOSviever as a visualization tool was used in two of them (Alsharif et al., 2021; Ali et al., 2021), but not directly connected with the aim of this paper. Also, it should be pointed out that database Alsharif et al. (2021) used the Scopus database for their research. Given that this specific type of paper is not currently present in the mentioned database, the significance of this paper's contribution becomes apparent.

The research process of bibliometric analysis consisted of the following stages:

1. Research design – During their research in the field of digital marketing, the authors constantly encountered the term "eye-tracking", which is often associated with the field of digital advertising. Considering the significant increase in digital sales after the Covid-19 pandemic and the projected future growth of the same (Statista, 2024), it has become obvious that the analysis of existing papers on eye-tracking technology is essential for companies operating in the digital environment. Additionally, the authors noticed a lack of bibliometric analysis papers covering this topic, which indicated the need for further research, so they decided to fill that gap and make a bibliometric analysis of existing papers visible in the WoS database.

2. Search strategy definition and selection of the appropriate database – After connecting several keywords (synonyms) and phrases that are associated with the idea of the paper itself, it was determined which are the primary keywords for literature search ("eye-tracking" OR "eye movement" OR "eye monitoring" OR "eye motion"). By selecting keywords (search query), several scientific databases were searched, including the two most relevant - Scopus and WoS and it was decided, as stated earlier, that the bibliometric analysis would be done on papers published in the WoS database. Based on the search query 52 235 papers were obtained in all research areas in the entire WoS database until April 24th, 2024. The search query included variations of all terms in all fields. However, a more detailed filtering of the "Business Economics" research area 712 papers was obtained. Additional filtering of that research area to the area that only covers "Communication" which is connected the most with digital advertising which is the main topic of this paper, resulted in 49 papers.

3. Refining the initial search results – In this phase, all 49 papers were scanned to filter the data according to the given criteria, which were that the papers investigating eye-tracking technology are related to digital advertising. By reviewing the titles, abstracts and primary texts of each article, it was determined that all the papers meet the given criteria. Information for documents that met the threshold included year of publication, language, journal, title, author, affiliation, keywords, document type, and number of citations, all of which were exported in plain text format for the purpose of the next phase – data analysis.

4. Data analysis – In this phase, descriptive statistics in WoS bibliometric mapping in the VOSviewer software (version 1.6.10) was used to perform and to visualize the obtained results, i.e. a network of papers co-occurrences, co-citations, and bibliographic matching.

3 Research results

3.1 Results of descriptive statistics

The main goal of this paper is to give a detailed review of the literature published until April 24th, 2024 within the Web of Science core collection database. The focus of this research is on eye-tracking usage in the context of digital advertising. The paper achieved its goal through conducted desk research.

In the WoS database, according to the research results after the second phase of the analysis, 49 papers covering the research topic were filtered. Of the 49 papers published in the WoS database between 1994 and 2024, all papers were published in English by 120 authors from 20 different countries and 90 affiliations. These publications included 44 original research articles, 6 proceeding articles, 1 book chapter, 1 review article and 1 early access article. The first scientific paper on this topic was published in 1994 and it was a paper entitled "Do Adolescents Attend to Warnings in Cigarette Advertising - An Eye-Tracking Approach" written by the authors Krugman, D.M., Fox, R.J., Fletcher, J.E., Fischer, P.M. and Rojas, T.H. and published in Journal of Advertising Research. From then until April 24th, 2024, 49 papers on this topic were published and 44 of them have been cited, and the total number of citations of all papers is 1 142 (without self-citations 1 089) of average 40,79 per item and H-index 18. The highest number of analyzed papers was published in 2017 and 2019, 7 of them. The highest level of citations was achieved in 2022, when the number of citations reached 178. The most cited paper entitled "Consumer eye movement patterns on yellow pages advertising" by Lohse, G.L. was published in year 1997. Its number of citations is 212 (average per year is 17,57). However, it is important to point out that in 2017 there was a noticeable increase in the number of published papers on this topic. Namely, since 2020, 21 papers have been published. This increase in research results can probably be attributed to the impact of the Covid-19 pandemic, as well as the increasing interest of scientists in researching this area due to the increase in digital sales. Table 1. shows the ten most cited papers in the WoS database that dealt with the research of eye-tracking usage in digital advertising. And, the distribution of the number of all published papers as well as the number of citations and the total number of citations in the period from 1994 to 2024 is shown graphically in Figure 1.
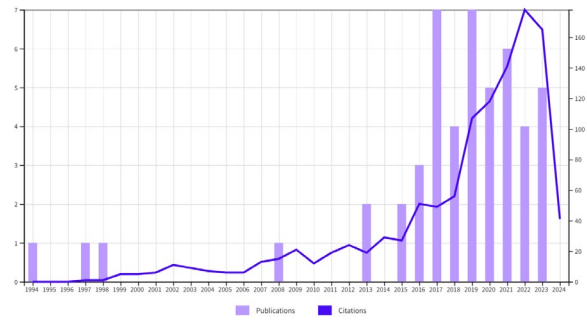

Figure 1. Distribution of the number of published papers and citations by year (Source: Authors's work based on Clarivate Web of Science, April 24th, 2024)

Most papers, 13 of them are published in the International Journal of Advertising, 12 in the Journal of Advertising, 12 in the Journal of Advertising Research, and 4 in the Journal of Current Issues and Research in Advertising. Two papers each were published in the journals European Advertising Academy, Marketing Identity and Public Relations Review. In other journals is published one paper (Advances in Advertising Research, Elgar Handbooks in Political Science, International Journal of Business Communication, Marketing Identity Online Rules Pt I and II and Research Handbook on Visual Politics). 40 published papers are indexed in journals with the Social Sciences Citation Index (SSCI), 6 in the Conference Proceedings Citation Index – Social Science & Humanities (CPCI-SSH) category, 4 of them in the Emerging Sources Citation Index (ESCI) and 1 in Book Citation Index – Social Sciences & Humanities (BKCI-SSH) category. Based on the research area, and bearing in mind the set search query, the results show that all scientific papers are related to business economics and communication (49 papers) and one in government law. It should be noted that this one is included in the other two mentioned research areas as well.

Table 1. The ten most cited papers in the WoS database that dealt with the research of eye-tracking usage in digital advertising

RANK	PAPER	AUTHOR(S)	JOURNAL	YEAR	Total WoS citations
1	Consumer eye movement patterns on yellow pages advertising	Lohse G.L.	Journal of Advertising	1997	212
2	Do Adolescents Attend to Warnings in Cigarette Advertising - An Eye-Tracking Approach	Krugman et al.	Journal of Advertising Research	1994	116
3	Using Eye Tracking to Understand the Effects of Brand Placement Disclosure Types in Television Programs	Boerman et al.	Journal of Advertising	2015	108
4	Adolescents' attention to beer and cigarette print ads and associated product warnings	Fox et al.	Journal of Advertising	1998	94
5	Nature imagery in advertising Attention restoration and memory effects	Hartmann et al.	International Journal of Advertising	2013	58
6	Understanding which cues people use to identify influencer marketing on Instagram: an eye tracking study and experiment	Boerman & Muller	International Journal of Advertising	2022	41
7	Face Presence and Gaze Direction In Print Advertisements How They Influence Consumer Responses-An Eye-Tracking Study	Adil et al.	Journal of Advertising Research	2018	30
8	How consumers attend to online reviews: an eye-tracking and network analysis approach	Maslowska et al.	International Journal of Advertising	2020	28
9	The Development and Testing of a Child-inspired Advertising Disclosure to Alert Children to Digital and Embedded Advertising	De Jans et al.	Journal of Advertising	2018	28
10	Toward a Better Understanding of Advertising Stimuli Processing Exploring the Link between Consumers' Eye Fixation and Their Subconscious Responses	Matukin et al.	Journal of Advertising Research	2016	27

Source: Authors's work based on Clarivate Web of Science, April 24th, 2024

A total of 20 countries were involved in the publications of the researched topic of this paper. The most active country with 20 publications is USA. It is followed by the Netherlands (6 publications), Australia (5 publications), France (4 publications), Belgium, PRC and Spain with 3 publications. Austria, Czech Republic, Denmark, Germany, Greece, India, New Zealand, Oman, Poland, Slovakia, South Africa, Taiwan and United Arab Emirates have one publication on the topic of eye-tracking in connection with digital advertising. The most active academic affiliations are the University of Amsterdam with 6 publications, and Ghent University, Texas Tech University, Texas Tech University System, University of Georgia and University System of Georgia with 3 publications. American University, Macquarie University, Northwestern University, Uniformed Services University of the Health Sciences USA, University of Minnesota System, University of Minnesota Twin Cities and the University of South Australia have 2 papers visible in WoS database, and other 77 institutions had one publication until April 24th, 2024.

3.2 Visualization of bibliometric analysis

This section describes the bibliometric analysis of keyword co-occurrence, bibliographic coupling of documents to see the links between published papers and their authors, as well as citation metrics.

A total of 12 keywords, in the papers included in the bibliometric analysis on the topic of eye-tracking in connection with digital advertising, that occurred more than five times in the WoS database are distributed in 2 clusters of different colors (red and green) with 50 links and total link strength of 116 (see Figure 2). The first cluster, colored in red, includes 7 keywords (attention, eye-tracking, impact, memory, persuasion knowledge, recall and responses). The second cluster, which is colored green, includes 5 keywords (brand, information, model, movements and pictorial). The most frequent keyword, also the core keyword related to search queries, was "eye-tracking" with 15 occurrences, 10 links and a total link strength of 29. This keyword is followed by keyword "attention" with an occurrence level of 13, 11 links between other keywords and a total link strength of 30. "Brand" as the third most frequently used keyword (12 occurrences) has 9 links and a total link strength of 29. "Information" and "impact" are the fourth keyword with 10. It is followed by the keywords "memory" with 9 occurrences, "movements" with 7 occurrences, "recall", "responses", "persuasion knowledge", "model" with 6 occurrences and "pictorial" with 5 occurrences. All of them have a lower level of occurrence, links with other keywords and link strength than the three main ones (eye-tracking, attention and brand).
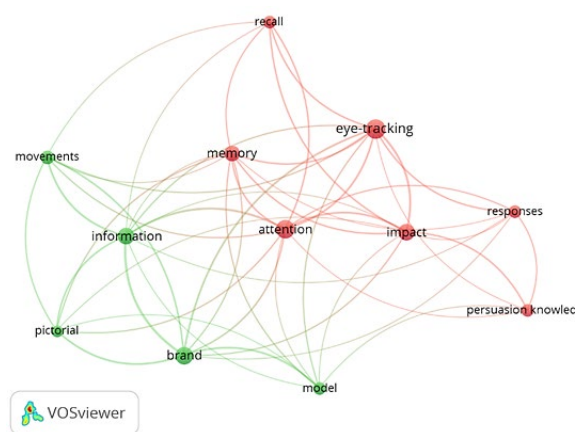

Figure 2. Visualization map of keywords co-occurrence (Source: Author's work based on collected data, April 24th, 2024)

From Figure 3, it can be seen that when matching the available papers 7 clusters exist. In the first cluster, colored in red, 11 papers were found. All papers in this cluster are published between 2017 and 2023. In the second cluster, which is colored green, 8 papers were found. They are all papers published in the last five years (from 2019 to 2024). The third cluster, which includes 8 papers, is marked in blue. The fourth cluster, colored yellow, consists of 7 papers. Within this cluster are the oldest papers, published in the years 1994, 1997, and 1998. Papers from this cluster are also in the five most cited papers, the papers from authors Lohse (1997), Krugman, et al. (1994) and Hartmann et al. (2013). 7 papers are in the fifth cluster, colored purple. Boerman et al. (2015) and Boerman and Muller (2022) are the authors of the papers that are in five most cited papers of this research field. Those papers are in the sixed cluster which has 5 papers and is marked in light blue. The last and the smallest one, which is colored orange, consists of 3 papers. This visualization shows that the paper "Consumer eye movement patterns on yellow pages advertising" written by Lohse and published in 1997 represents a research base for all other papers published in the field of research on eye-tracking as a trend in digital advertising together with paper "Do adolescents attend to warnings in cigarette advertising - An eye-tracking approach" from the author Krugman and his associates (1994).
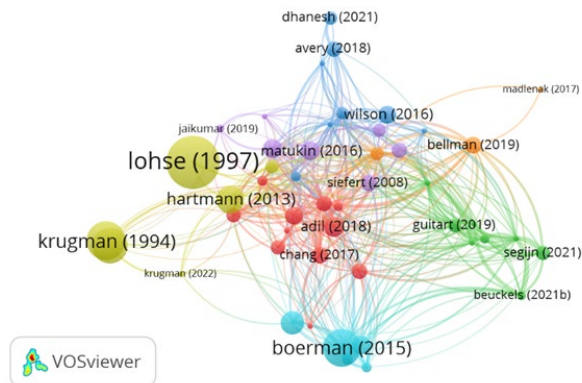
Figure 3. Visualization map of bibliographic coupling of documents (fractional counting) (Source: Author's work based on collected data, April 24th, 2024)

3.3 Research discussion and limitations

Eye-tracking has an undisputable role in today's digital advertising which can be seen from the theoretical background of this paper as well as from bibliometric analysis that was made for the purpose of achieving the main goal set before research was conducted. After all phases of the research process, which is listed in the methodological part of this paper, have been produced it is evident that according to keywords occurrence the link between eye-tracking technology and digital advertising is strong and very important. According to the papers published since 2020, it can be concluded that this field is gaining in importance each day. Perhaps the reasons for this are the development of digital technology or the increase in sales in the digital environment during the lockdown caused by the Covid-19 pandemic, but perhaps the reasons are something else, time will certainly show. Currently, only a limited number of papers, authors, institutions, and countries are actively researching the mentioned field. However, there is an expectation that this situation will evolve in the future. Until then, the scientific impact of this paper remains unquestionable.

Nevertheless, the conducted research has certain limitations. Firstly, the fundamental limitation lies in the fact that the bibliometric analysis relies solely on the WoS database. While WoS is considered a very comprehensive database, future studies should broaden their scope by incorporating additional scientific databases. This would enable a more comprehensive analysis and facilitate comparisons across different databases. Additionally, the research's limitations extend to used search query, as it inherently restricts the authors. In response to the initial query according to which a substantial number of papers, specifically 52 235 of them, the authors set criteria that they considered the most appropriate for the topic of the paper, eye-tracking technology in digital advertising. This approach potentially resulted in fewer papers for bibliometric analysis which can be considered as a research limitation. However, upon reviewing all 49 selected papers, it was confirmed that the established

conditions were appropriate and that each paper corresponded to the researched topic.

4 Conclusion

As this article shows, eye-tracking is gaining popularity as a crucial technology for measuring and capturing the attention of consumers, yet it is still not reaching its full potential. However, the development of eye-tracking technology has created a wealth of new opportunities for study and growth in the area of digital advertising, which was the primary subject of this paper. And with the daily development of eye-tracking technology, in the future digital advertising, regardless of web or mobile version, could gain more and more importance.

Apart from providing a theoretical overview of the term "eye-tracking" technology in the digital advertising context, this paper presents the results collected from the WoS database by conducting desk research. The use of a bibliometric analysis, which includes a data set of 49 publications, reveals the strong and significant relationship between eye-tracking technology and digital advertising based on keyword occurrence. Considering the theoretical overview of the term "eye-tracking" from its inception in 1994 to 2024 (the most ancient and most recent article from the observed data set), the previously mentioned outcome was predicted. So, a greater increase in scientific papers on this topic can be expected.

However, it is crucial to remember that the success of bibliometric analysis done for the purpose of writing this paper is primarily the result of high-quality data preparation, which consists of four stages: research design, search strategy definition and selection of the appropriate database, refining the initial search results and data analysis.

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