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Review

Eye Tracking as an Instrument in Consumer Research to Investigate Food from A Marketing Perspective: A Bibliometric and Visual Analysis

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Abstract: Eye tracking plays a crucial role in consumer research. The aim of this work is to present the statuses of studies that used eye tracking as an instrument in consumer research to investigate food from a marketing perspective. For this purpose, a bibliometric review of 118 articles from the Business Source Premier and Web of Science Core Collection database was compiled. The bibliometric review provides information on publication trends, leading authors, collaborative networks, journals, institutions, countries, articles, keywords, and themes investigated. Publications in the research field have appeared since 2011, primarily in Europe, the United States, and Uruguay. Three areas of research streams were identified: (1) how consumers became aware of and chose food, (2) nutritional information and its impact, and (3) how food information and its visual attention led to certain consumer behavior. The bibliographic review summarized past research directions and, thus, identified possibilities for future research streams.

Keywords: bibliometric analysis; eye tracking; consumer research; food; nutrition; marketing

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1. Introduction

The United Nations data show that consumer spending by private households on food varies widely from 6.23 to 89.23% [1]. Despite this wide range of household spending on food, food is of great importance to private households, and in consumer research, it is important to understand what factors ultimately lead to consumer decisions [2]. Various studies in consumer research have, therefore, investigated relationships between marketing activities and customer acceptance. Marketing activities can influence consumers, for example, through different product positions on the shelf [3], the number of shelf spaces [4,5], the visual design [6–8], or the psychological interpretation of product quality [9,10]. Studies examining consumer acceptance show that consumers' purchasing behavior and, thus, their decisions depend on the mental resources that they are willing to invest in the purchase decision [11,12]. Other studies question these results as they show that in many situations, consumers tend to simplify their information-seeking and information-processing behavior, meaning that preferences are often constructed and not always disclosed by consumers [5,13–15]. To improve understanding of consumers' sub-conscious behavior and bypass consumer secrecy when confronted with seemingly "real" food-related choices [16], marketing researchers gradually adopted eye tracking as an evaluation instrument [17] to find out what factors (both bottom-up and top-down) ultimately lead to consumers' responses [2]. Since then, the use of eye tracking as an instrument in consumer research to investigate food from a marketing perspective has been growing steadily [2,16,18].

Eye tracking has been around since 1879, when the French ophthalmologist Louise Èmile Javal first discovered that the movement of the eye while reading was not continuous but consisted of quick movements (saccades) mixed with short pauses (fixations) [19]. In 1908, Edmund Huey built the first eye tracker, a device with which eye movements could

be tracked during the reading process [20]. Over the years, eye tracking technology and methods evolved, and they are now used in almost all areas of life. Research institutions and businesses have specialized in using eye tracking in the food sector to investigate consumer behavior [2,16,18]. To obtain an overview of studies that used eye tracking as an instrument in consumer research to investigate food from a marketing perspective, a bibliometric review was carried out while asking the following five research questions: Which authors published in the outlined research field and were cited most frequently (RQ 1)? With whom did the authors collaborate (RQ 2)? Which scientific publications, journals, countries, and institutions contributed to the growth of the research field (RQ 3)? What were the major keyword clusters in the research field (RQ 4)? What were the primary themes in the research field between 2008 and 2023 (RQ 5)?

To investigate the research questions and consider the sixteen-year period with numerous publications in consumer research with eye tracking as an instrument to investigate food from a marketing perspective, it seemed appropriate to examine the literature corpus through a bibliometric review. A bibliometric review can be used to investigate metadata in a literature corpus [21] to obtain information about developments in a field of research and provide a universal overview of what has been published [22]. In bibliometric reviews, a large number of articles can be analyzed by examining the effects of different similarity measures and displaying them through a bibliometric mapping technique [23]. In the present study, VOSviewer software (version 1.6.20) developed by van Eck and Waltman [24] was used, because with this software tool, bibliographic networks can be created and visualized with authors, co-authors, citations, journals, countries, or institutions based on co-authorship, bibliographic coupling, co-citations, co-occurrence, or co-word analysis [25,26]. Furthermore, this software is freely available to the bibliometric research community.

This bibliometric review aims to present the statuses of studies that used eye tracking as an instrument in consumer research to investigate food from a marketing perspective. For this purpose, 118 articles were compiled from the Business Source Premier (BSP) and Web of Science (WoS) Core Collection database. This bibliometric review contributes to the literature by first examining the contributions of researchers to the research field with performance analysis and identifying and presenting leading institutions, countries, and journals. Second, by identifying the most present and cited authors and highly referenced articles using co-authorship, bibliographic, and co-citation analysis, the research field's underlying knowledge base and collaborative networks are highlighted. Third, the most popular keywords and co-word networks are shown using co-occurrence and text data analysis. Finally, bibliographic coupling analysis was used to identify three themes in the research field from 2008 to 2023 and provide recommendations for future research.

The remainder of the bibliometric review is structured as follows: Section 2 explains the bibliometric method and materials, while in Section 3, the analysis and findings of the bibliometric analysis are presented. Section 4 elaborates on key findings and future research directions, while Section 5 concludes this study.

2. Bibliometric Method and Materials

In 1934, Paul Otlet was the first author to define "bibliometrics" as a tool for measuring all aspects related to book publishing and reading [27]. However, the concept of bibliometrics experienced worldwide spread through the work of Pritchard in 1969 [21]. Bibliometric methods use bibliographic data from public databases such as WoS, Scopus, and PubMed to quantitatively investigate research and publication performance via performance analysis using publication-related metrics focusing mainly on authors, journals, countries, and institutions [22,28,29]. They also visually represent, with science mapping, bibliometric maps that describe how certain research disciplines or fields are conceptually, intellectually, and socially structured [22,28,29]. Following Donthu et al. [22] (p. 294), the four steps for conducting a bibliometric analysis were applied in this paper: (1) define the aims and

scope, (2) choose the techniques, (3) collect the data, and (4) run the bibliometric analysis and report the findings.

2.1. Bibliometric Data Collection

The data collected for the bibliometric analysis were retrieved from two scientific databases, BSP and WoS. These two databases were chosen because they provide a wealth of information (such as authors, titles, journals, keywords, institutions, citations, etc.) for a bibliometric analysis [25], are commonly used scientific databases in bibliometric studies [22], and are among the leading databases in this field of research [18,30]. The final search was conducted on 15 January 2024 with the following four categories: (1) eye tracking, (2) consumer/nutrition, (3) food, and (4) marketing. The following search function was constructed from these four categories and applied to the following scientific databases: (eye-track* OR eye track OR eye movement* OR eye gaze OR visuali* OR visual attention) AND (consumer behave* OR purchase decision OR purchase intention OR shop* OR consumer OR buy* OR nutrition* OR diet OR health) AND (food OR food* OR grocer* OR beverage OR eat* OR drink*) AND (organic OR product* OR sustainab* OR price OR supermarket OR retail* OR e-commerce OR ecommerce OR online* OR electronic commerce OR package* OR label* OR marketing). The wildcard (*) was used to include spelling variations and reduce the number of phrases while still providing comprehensive search results.

The first search of articles resulted in a total number of 2273 records. An article was included if it was (1) written in the English language, (2) a full-text article published in a peer-reviewed journal, (3) a primary source (i.e., neither a conceptual paper, conference paper, or a review), (4) published in the period from 2008 to 2023, and (5) a study that used eye tracking as an instrument in consumer research to investigate food from a marketing perspective (see Table 1).

Table 1. Criteria for the inclusion and exclusion of an article for eligibility screening.

Inclusion Criteria
• Obtainable in the BSP or WoS database; • Written in the English language; • Full-text article published in a peer-reviewed journal; • Primary source; • Published in the period from 2008 to 2023; • Used eye tracking as an instrument in consumer research to investigate food from a marketing perspective.
Exclusion criteria
• Not a primary source (i.e., conceptual paper, conference paper, review); • No eye tracking applied; • Not related to consumer research; • No food investigated; • Articles focusing on developing eye tracking techniques rather than applying them; • No full record and tab-delimited cited reference text format obtainable for the identified article in WoS.

The identification of studies was conducted by both authors to ensure that all qualified articles that focused on the use of eye tracking as an instrument in consumer research to investigate food from a marketing perspective were included and that all selected papers met the inclusion and exclusion criteria. According to Edward et al. [31], no studies would be missed by a two-person screening. The detailed identification of studies via the databases

and further filtering processes (see Figure 1) resulted in 118 articles from multiple journals for the final analysis of the sample, with the earliest article being from 2011 and the most recent one being from 2023.

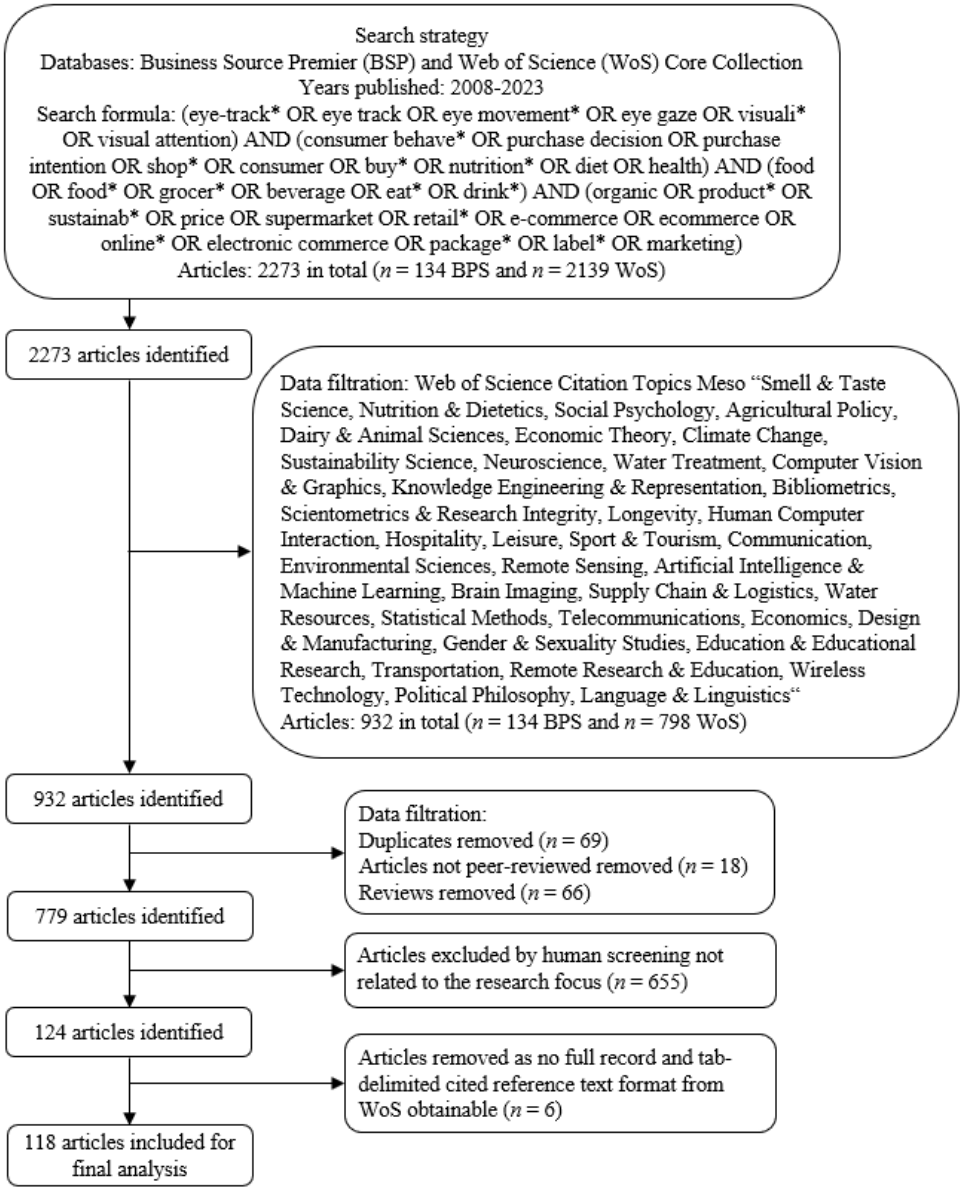

Figure 1. Search strategy and data filtering process.

2.2. Data Analysis and Visualization

Data were obtained from the BSP and WoS databases. Full records and cited references were downloaded for all articles from WoS in a tab-delimited text format. For six articles identified in BSP, the full records and cited references in a tab-delimited text format could not be obtained from WoS and, therefore, were excluded (see Figure 1). Performance, co-authorship, bibliographic, and co-citation analysis were used to identify leading authors, journals, countries, and institutions [22,28,32,33] and answer research questions one, two, and three. To answer the fourth research question, keyword co-occurrence and text data (co-word) analysis were used to classify and map salient keywords [22,34,35]. The bibliographic coupling analysis was used to identify primary themes in the research field and answer the fifth research question [28,32,36]. For the analyses, VOSviewer software was used to display the results in a graphical format and an easy-to-understand manner [26,37]. VOSviewer is

designed for constructing and visualizing bibliometric networks [25]. Since VOSviewer can combine the literature and enables the identification of similarities and important themes between the articles [24,25,33], VOSviewer (version 1.6.20) was used for the extraction and statistical analysis of the data. The tab-delimited text format data were uploaded into VOSviewer and then analyzed. Microsoft Excel 2021 was used to supplement VOSviewer's data statistics.

3. Analysis and Findings

3.1. General Characteristics of the Bibliometric Analysis

A total of 118 articles from BSP and WoS were identified from 2008 to 2023. Moreover, 363 authors from 37 countries and 162 institutions contributed to the literature corpus. The articles were published in 58 different journals. Table 2 provides an overview of the main information regarding the bibliometric data collection retrieved from BSP and WoS.

Table 2. Descriptive analysis: main information regarding the bibliometric data collection.

Description	Results
Articles	118
Journals	58
Countries	37
Institutions	162
Period	2008–2023
Average citations per article	29.16
Authors	363
Authors appearances	463
Authors of single-authored articles	311
Authors of multi-authored articles	152
Single-authored articles	311
Multi-authored articles	52
Articles per author	0.325
Authors per article	3.08
All keywords	664
Author keywords	353
Keyword plus	370
References	4546
Co-Author per articles	3.92
Collaboration index	2.92

Note: Collaboration index: total authors of multi-authored articles/total multi-authored articles.

3.2. Annual Publications and Publication Trend

The annual publications and the publication trend are shown in Figure 2. Although the period for the BSP and WoS search started in 2008, the first article related to the research field was published in 2011 by Bialkova and van Trijp [38]. While in the first six years (2011–2016), the number of publications increased from one to eleven, the number of publications in 2017 and 2018 fell to nine. In 2019, the highest number of publications was recorded, with twenty publications. In the following two years (2020–2021), the number of publications fell to seventeen and then to nine. In 2022, the publications rose again to twelve, only to stagnate in 2023 at eleven publications. Despite these fluctuations, the linear trend in publication numbers shows a steady increase. Accordingly, studies using eye tracking as an instrument in the research field are experiencing growing research interest, which is also confirmed by other reviews [2,16,18].

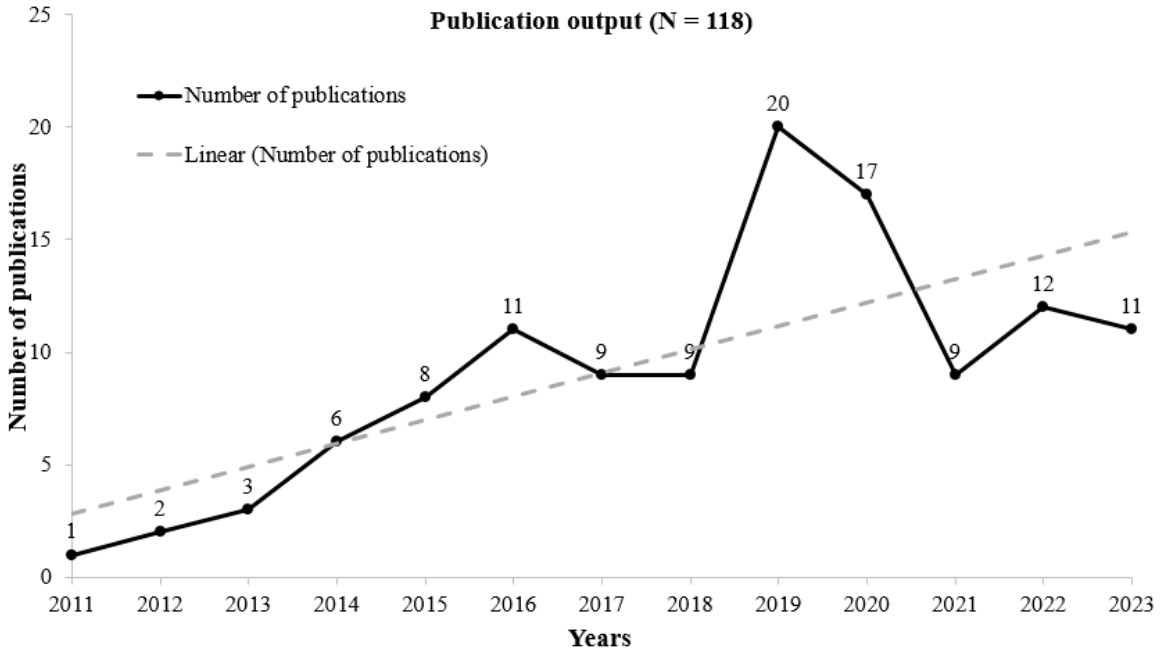

Figure 2. Number of publications by year and publication trend (N = 118).

3.3. Publication by Country and Institution

The countries were determined based on the institutional affiliation of the corresponding authors. Thirty-seven countries contributed to the research field. From these thirty-seven countries, twelve countries met the inclusion criteria of a minimum number of five articles from a country. The co-authorship analysis with the number of co-authored articles was calculated by selecting the top twelve countries. The countries were grouped into four clusters with 22 links and a total link strength (TLS) of 36 (see the overlay visualization map in Figure 3).

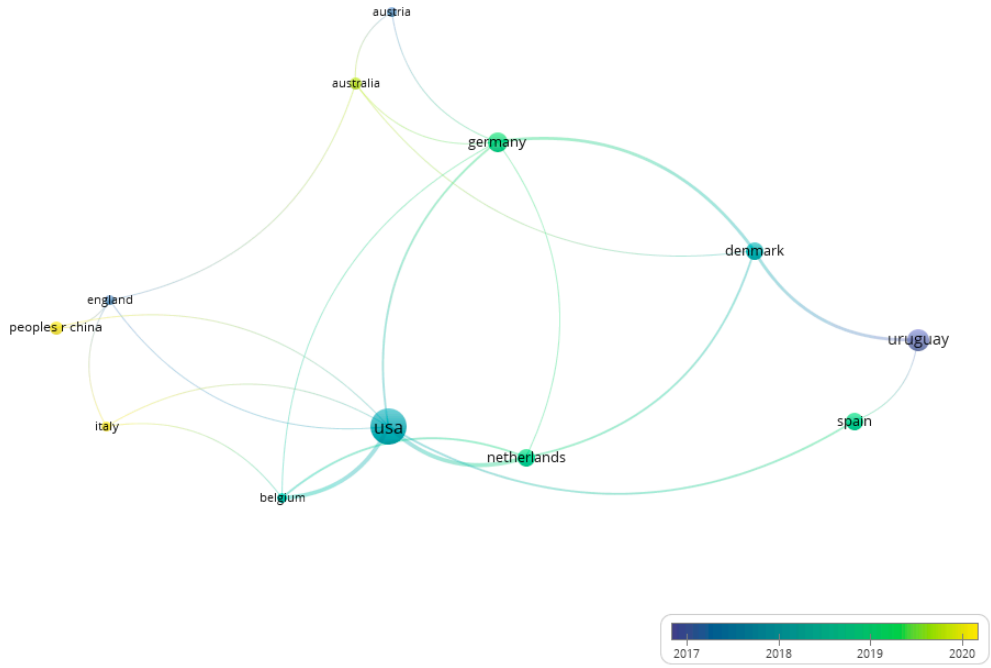

Figure 3. Overlay visualization map of the top twelve countries from 2008 to 2023.

The overlay visualization map shows the countries weighted after the number of articles involved in the research field in terms of the average publication years. The colors of the circles indicate the years. Accordingly, countries such as Australia, China, and Italy have the most recent publications in the research field, while those from countries such as Austria, England (UK), and Uruguay were published earlier. The United States and Uruguay were the most productive contributors in the research field, as shown by the sizes of the circles that represent the number of publications. The connecting lines between the countries represent the cooperation. The length of the connecting lines between the countries indicates the relative strength and similarity of the research themes. The shorter the distance of the connecting line between the countries, the stronger the relationship. As mentioned before, four clusters were identified. The first cluster consisted of Denmark, Spain, and Uruguay; the second cluster consisted of Austria, Australia, and Germany; the third cluster consisted of China, England (UK), and Italy; and the last cluster consisted of Belgium, the Netherlands, and the United States. These clusters showed close co-operation and similarities in the research themes.

The top twelve countries that investigated the research field with a minimum number of five articles are listed in Table 3. The United States was the most productive country, with a percentage contribution of 25.78% to the research field during the study period from 2008 to 2023. Uruguay was second, with a percentage contribution of 12.50%, and Germany was third, with a percentage contribution of 10.16%. Among the twelve leading countries were eight European countries, which together contributed more than fifty percent (51.56%) of the growth of the research field in terms of the number of articles.

Table 3. Top twelve countries that contributed to the growth of the research field by article.

Rank	Country	Articles	Percentage	Citations	TLS
1	United States	33	25.78	1134	15
2	Uruguay	16	12.50	691	4
3	Germany	13	10.16	305	9
4	Denmark	11	8.59	449	9
5	Netherlands	11	8.59	461	9
6	Spain	11	8.59	315	3
7	China	7	5.47	98	2
8	Australia	6	4.69	144	4
9	England (UK)	5	3.91	313	4
10	Austria	5	3.91	158	2
11	Belgium	5	3.91	79	8
12	Italy	5	3.91	61	3

Of the 162 institutions, 8 institutions contributed to the growth of the research field by providing at least four articles. The Universidad de la República in Uruguay was the most productive institution with sixteen articles, followed by Aarhus University in Denmark in second place with seven articles and Wageningen University in the Netherlands in third place with six articles (see Table 4).

Table 4. The top eight institutions that contributed to the growth of the research field by article.

Rank	Institution	Country Location	Articles	Citations	TLS
1	Universidad de la República	Uruguay	16	691	3
2	Aarhus University	Denmark	7	341	5
3	Wageningen University	Netherlands	6	392	7
4	Ghent University	Belgium	5	313	6
5	University of Arkansas	United States	4	292	2
6	Colorado State University	United States	4	141	0

Table 4. *Cont.*

Rank	Institution	Country Location	Articles	Citations	TLS
7	Copenhagen Business School	Denmark	4	108	0
8	Arizona State University	United States	4	69	5

Three clusters with six links and a TLS of 14 were obtained (see Figure 4). The three clusters show the relatedness of the institutions based on the number of co-authored documents. The first cluster (in green) consisted of the University of Arkansas and Ghent University. The second cluster (in red) was formed by Arizona State University and Wageningen University. The third cluster (in blue) comprised Aarhus University and the Universidad de la República. Colorado State University and Copenhagen Business School showed no relatedness with the other six institutions. Of the eight leading institutions, four were from Europe, which together contributed significantly to the growth of the research field, with 44.00% of articles.

Figure 4. Relatedness of the eight institutions in the research field.

3.4. Publications by Journal

All articles were published in fifty-eight journals. *Food Quality and Preference* was the journal that contributed the most to the research field, with twenty-three articles. With a much smaller number of articles, the journal *Appetite* followed with eight articles, then the journal *Food Research International* with seven articles and the *Journal of Business Research* with six articles (see Table 5).

Table 5. Top journals with at least three publications in the research field.

Journal	Country	Articles	Citations	H-Index	JCR
Food Quality and Preference	United Kingdom	23	810	144	Q1
Appetite	Netherlands	8	340	168	Q1
Food Research International	United Kingdom	7	254	195	Q1
Journal of Business Research	United States	6	140	236	Q1
Frontiers in Psychology	Switzerland	4	38	157	Q2
Public Health Nutrition	United Kingdom	3	104	156	Q1
Journal of Nutrition Education and Behavior	United States	3	94	90	Q2
Journal of Retail and Consumer Services	United Kingdom	3	76	120	Q1
International Journal of Consumer Studies	United Kingdom	3	59	88	Q1

3.5. Publication Activity by Authors, Co-Authorship, and Author Collaboration

In total, 363 authors contributed to the research field, 311 (85.67%) of them with one (single-authored) article and the remaining 52 authors (14.33%) with multi-authored articles, e.g., [39–74]. The eight most productive authors contributed to almost 40% of all publications. Ares, G., e.g., [75–80] was the most productive author in the research field, with sixteen articles (10.53%), followed by the authors Machín, L. e.g., [81–84], with nine articles (5.92%), and Giménez, A., e.g., [85,86], with eight articles (5.26%) (see Table 6).

Table 6. The top eight most productive authors from 2008 to 2023 in the research field.

Rank	Author	Country	Articles	Percentage
1	Ares, Gastón	Uruguay	16	10.53
2	Machín, Leandro	Uruguay	9	5.92
3	Giménez, Ana	Uruguay	8	5.26
4	Antúnez, Lucía	Uruguay	7	4.61
5	Grebitus, Carola	United States	5	3.29
6	van Loo, Ellen J.	Netherlands	5	3.29
7	Graham, Dan J.	United States	4	2.63
8	Maiche, Alejandro	Uruguay	4	2.63

3.6. Co-Authorship Analysis

In the co-authorship analysis, the relatedness of authors was determined based on the author's number of co-authored articles [87]. This examined the interaction between the authors in the research field [22], i.e., it was shown how they interacted with each other (including their disciplines). Of the 363 authors, 52 authors met the threshold of a minimum number of at least two articles, e.g., [88–111]. The larger the circle and the font of the author's name, the greater the research achievement of the respective author. The colors of the circles represent the author's networks with topics, working groups, etc. [25]. The connecting lines indicate the authors' corresponding networks. In this study, there were sixteen author networks with 83 connection lines and a TLS of 166. Figure 5 shows the network visualization map, which depicts the authors' collaboration in the context of the research field from 2008 to 2023 in sixteen networks, while there is a limited connection to publications among the author networks. It turns out that the authors of a publication in a network come from interdisciplinary fields, e.g., marketing, consumer studies, food science, and psychology.

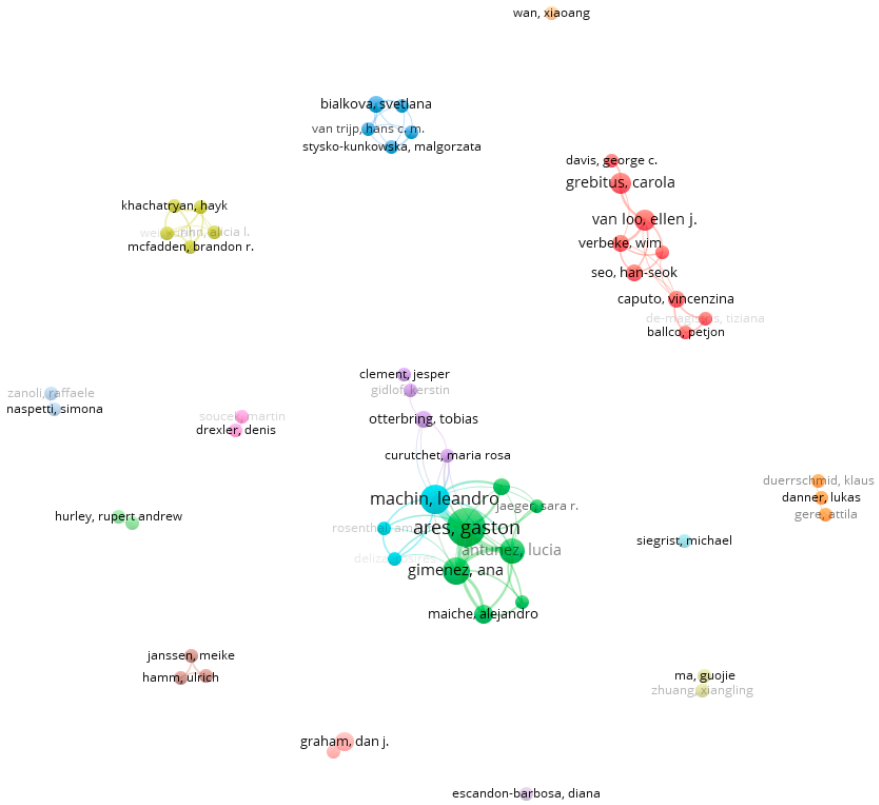

Figure 5. Network visualization map of author collaborations from 2008 to 2023.

3.7. Co-Citation Analysis

A co-citation analysis was used to determine the relatedness of authors based on the number of citations they shared [87,112] and, thus, identify the most cited authors. It is assumed that publications that are frequently cited together are thematically similar [22]. The colors indicate these thematic connections. In total, 3330 authors were identified, of which the 20 most frequently cited authors had at least twenty citations, e.g., [113–119]. The most cited and co-cited authors were Bialkova, S., with 115 citations, followed by Ares, G., with 97 citations, and Grunert, K. G., with 95 citations (see Figure 6 and Table 7).

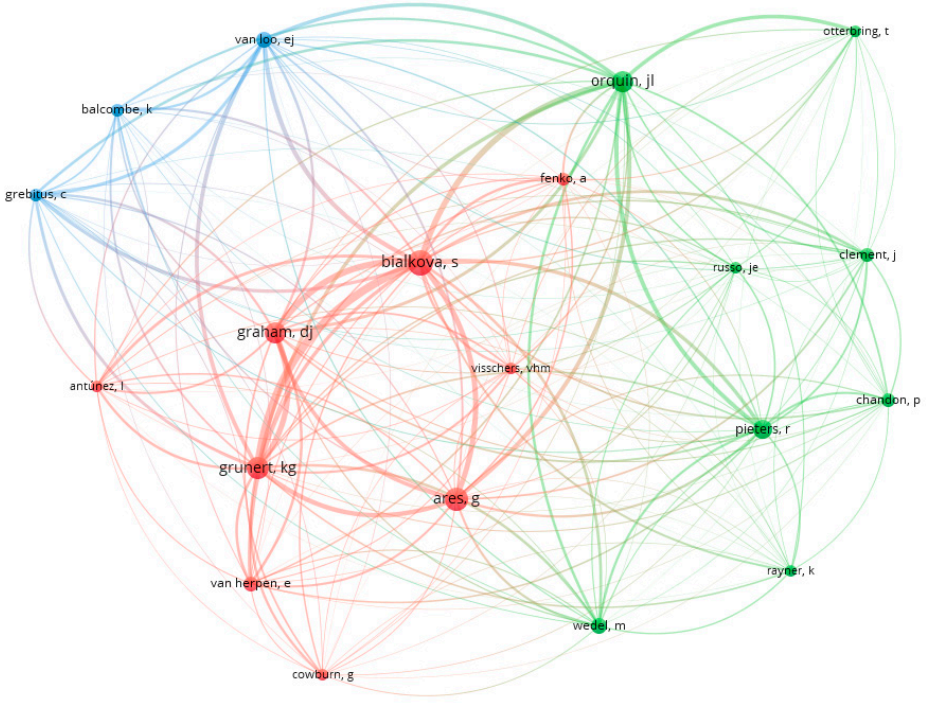

Figure 6. The top twenty most cited authors.

Table 7. The top twenty most cited authors from 2008 to 2023 in the research field.

Rank	Author	Citations	Rank	Author	Citations
1	Bialkova, Svetlana	116	11	Clement, Jesper	35
2	Ares, Gastón	97	12	Grebitus, Carola	28
3	Grunert, Klaus G.	95	13	Balcombe, Kevin	27
4	Orquin, Jacob L.	82	14	Fenko, Anna	25
5	Graham, Dan J.	78	15	Antúnez, Lucia	24
6	Pieters, Rik	62	16	Cowburn, Gill	23
7	van Loo, Ellen J.	45	17	Visschers, Vivianne H.M.	23
8	Wedel, Michel	41	18	Russo, J. Edward	22
9	van Herpen, Erica	40	19	Rayner, Keith	22
10	Chandon, Pierre	35	20	Otterbring, Tobias	22

A total of 4546 references were cited in the 118 articles included in this study. To identify the most cited references, the co-citation analysis with the cited references was used as the unit of analysis. Of the 4546 cited references, 14 meet the threshold of at least twenty citations of a cited reference. Table 8 lists the top eight most cited references from 2008 to 2023 in the research field.

Table 8. The top eight most cited references from 2008 to 2023 in the research field.

Rank	Reference	First Author	Citations	TLS	Journal	Country	JCR
1	Attention and choice: A review on eye movements in decision making	Orquin, J. L. [11]	41	122	*Acta Psychologica*	Netherlands	Q1
2	An efficient methodology for assessing attention to and effect of nutrition information displayed front-of-pack	Bilakova, S. [38]	36	167	*Food Quality and Preference*	United Kingdom	Q1
3	Eye tracking and nutrition label use: A review of the literature and recommendations for label enhancement	Graham, D. [120]	36	163	*Food Policy*	United Kingdom	Q1
4	What determines consumer attention to nutrition labels?	Bilakova, S. [121]	30	128	*Food Quality and Preference*	United Kingdom	Q1
5	A review of European research on consumer response to nutrition information on food labels	Grunert, K. G. [122]	30	125	*Journal of Public Health*	United Kingdom	Q1
6	Consumer visual processing food labels: Results from an eye-tracking study	Ares, G. [123]	30	105	*Journal of Sensory Studies*	United States	Q3
7	Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints	Van Herpen, E. [124]	28	132	*Appetite*	United States	Q1
8	Attention mediates the effect of nutrition label information on consumers' choice. Evidence from a choice experiment involving eye-tracking	Bialkova, S. [125]	25	121	*Appetite*	United States	Q1

3.8. Bibliographic Coupling Analysis

Bibliographic coupling analysis was used to identify the major themes in the research field between 2008 and 2023. Through bibliographic coupling analysis, the relatedness of articles is determined based on the number of references that they share [36]. Bibliographic coupling is generally used to better understand the research field and uncover specific themes that developed in the research field [126], and it is best used within a certain timeframe [28]. Accordingly, thematic clusters were identified that reflected the current state of research in the study period. For the bibliographic analysis, the article was used as the unit of analysis, and the inclusion criteria were set at fifty citations. Three clusters with twenty-four articles were identified (see Figure 7 and Table 9). The cluster "Nutritional information and impact" is displayed with the color red, the cluster "Labeling, visual attention, and decision" with the color blue, and the cluster "Customer attention, choice, and preference" with the color green.

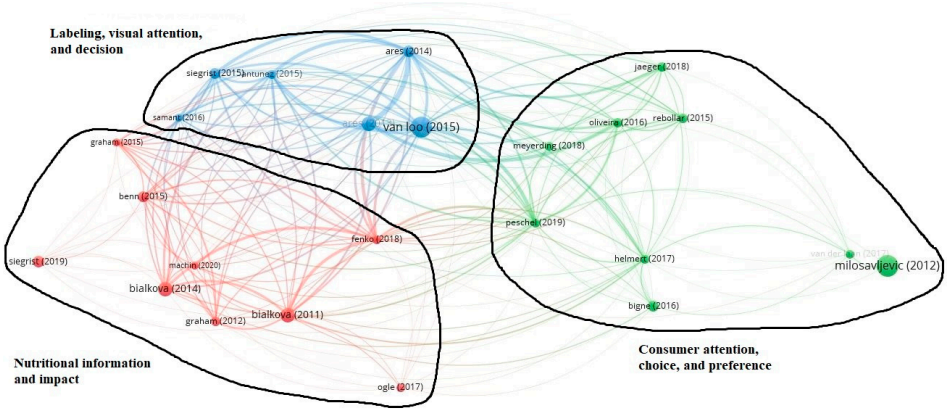

Figure 7. Bibliographic coupling of the articles with more than 50 citations.

Table 9. Thematic clusters identified through bibliographic coupling.

Clusters Identified	Sources	Brief Description
Nutritional information and impact (red)	Benn et al. [127] Bialkova and van Trijp [38] Bialkova et al. [125] Fenko et al. [128] Graham and Jeffery [120] Graham et al. [129] Machín et al. [130] Ogle et al. [131] Siegrist et al. [132] Antúnez et al. [85]	The studies mainly examined nutritional information on foods related to health, attention, choice, awareness, information-seeking behavior, and decision-making.
Labeling, visual attention, and decision (blue)	Ares et al. [123] Ares et al. [133] Samant and Seo [9] Siegrist et al. [134] van Loo et al. [135]	How the high-quality attributes (certain labels) and (label) designs of food products improve visual attention, thinking, and processing time.
Consumer attention, choice, and preference (green)	Bigné et al. [136] Milosavljevic et al. [6] Jaeger et al. [137] Oliveira et al. [86] Rebollar et al. [138] van der Laan et al. [139] Helmert et al. [140] Meyerding and Merz [14] Peschel et al. [8]	Labels, design, priming, brand, brand aspects, etc., are investigated to find out what attracts visual attention and leads to food choice.

3.8.1. Red Cluster: Nutritional Information and Impact

Bialkova and van Trijp [38], Bialkova et al. [125], Fenko et al. [128], Graham and Jeffery [120], Graham et al. [129], Machín et al. [130], and Siegrist et al. [132] explored the attention, impact, information processing, and purchases of nutritional information. Benn et al. [127] investigated what information consumers were looking for. Ogle et al. [131]

examined whether children's attention to and preference for media characters increased regardless of nutritional quality.

3.8.2. Blue Cluster: Labeling, Visual Attention, and Decision

Ares et al. [123,133] and van Loo et al. [135] investigated the importance of visual attention in food labeling, as well as the impact of thinking styles on food decisions. Antúnez et al. [85] and Siegrist et al. [134] examined the effectiveness of different labeling formats and visual attentional capture. Samant and Seo [9] explored the impact of label education on consumers' purchasing behavior, as measured by their visual attention to product labeling.

3.8.3. Green Cluster: Consumer Attention, Choice, and Preference

Meyerding and Merz [14] and Milosavljevic et al. [6] examined visual attention and consumer preferences, while Helmert et al. [140] and Jaeger et al. [137] demonstrated that damage of food products rapidly attracted consumers' attention. Bigné et al. [136] found out that the key driver of additional brand choices was the time spent on the first choice and that allocating less time to the first choice triggered additional purchases within product categories. Oliveira et al. [86] studied consumer attention and evaluated differences between food products. Peschel et al. [8] and Rebollar et al. [138] investigated patterns when looking at packaging and attention capture. Van der Laan et al. [139] studied how goal priming affected food choice.

3.9. Keyword and Co-Occurrence Analysis

Co-occurrence analysis was used to determine the relatedness of keywords based on the number of articles in which the keywords appeared together [112]. In addition, the keywords were identified in different colored clusters using VOSviewer's graphical representation [112]. Analyzing the co-occurrence of keywords is a useful tool for understanding the knowledge structure of a research field by assessing the association between keywords in a particular research field [141]. Each co-occurrence of a pair of words is represented as a link between the keywords [126]. The links between the circles show the strength of the relationship between each keyword [142]. The building network represents the cumulative knowledge and helps us to understand the knowledge components and structure of the research field [126]. A color-coded cluster represents circles with common attributes [126]. In total, 664 keywords were found, and 21 met the threshold based on the inclusion criteria of a minimum of eleven co-occurrences. Figure 8 shows the keyword co-occurrence network analysis map.

The co-occurrence analysis revealed three major clusters with 197 links and a TLS of 1046. The clusters were titled "Nutritional information and impact" (blue cluster), "Visual attention and food choice" (red cluster), and "Food information and decision" (green cluster). The keywords mapped in the blue cluster were mainly related to nutritional information and attracting consumers' attention as they searched for food and made their choices. The red cluster included keywords such as visual attention, perception, preferences, health, willingness-to-pay, and food choice. The green cluster comprised keywords that were related to food information such as quality, design, and labels and helped with decision-making. The clusters and the keywords assigned to each cluster are listed in Table 10.

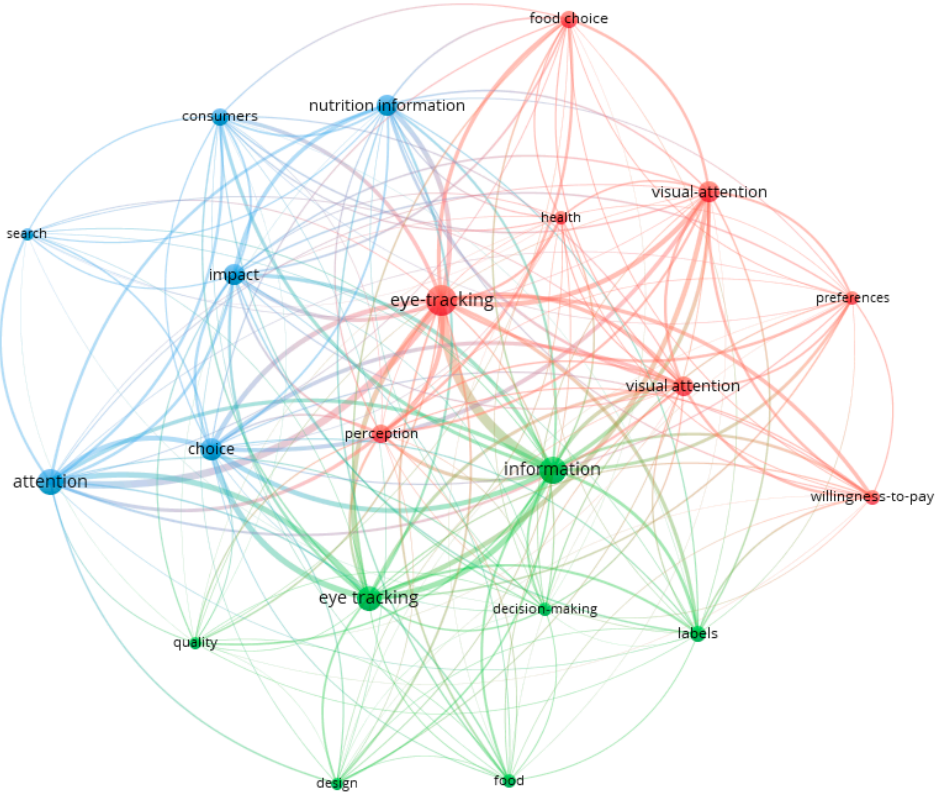

Figure 8. All keyword co-occurrences network analysis map.

Table 10. Keyword clusters identified using keyword co-occurrence analysis.

Nutritional Information and Impact (Blue)	Visual Attention and Food Choice (Red)	Food Information and Decision (Green)
Attention (41)	Eye-tracking (59)	Information (45)
Choice (31)	Visual attention (28)	Eye tracking (40)
Impact (27)	Visual attention (25)	Labels (18)
Nutrition information (27)	Perception (23)	Decision-making (12)
Consumers (20)	Food choice (19)	Food (12)
Search (11)	Willingness-to-pay (14)	Design (12)
	Preferences (13)	Quality (11)
	Health (12)	

3.10. Text Data Analysis (Co-Word Analysis) of Title and Abstract

Text data analysis was used to identify existing and predict future relationships between key themes in the research field [35]. It was based on relevant words that appeared in the titles and abstracts of the articles [35]. Thus, in contrast to co-occurrence and bibliographic coupling analysis, with text data analysis, the actual content of the article was used, and frequently occurring terms, insofar as they were thematically related, were identified [22]. In total, there were 2849 terms in the title and abstract fields. Structured abstract labels and copyright statements were ignored, which meant that no terms were extracted from them. The twenty most frequently occurring terms were set as the inclusion criteria. Figure 9 shows the text data analysis map.

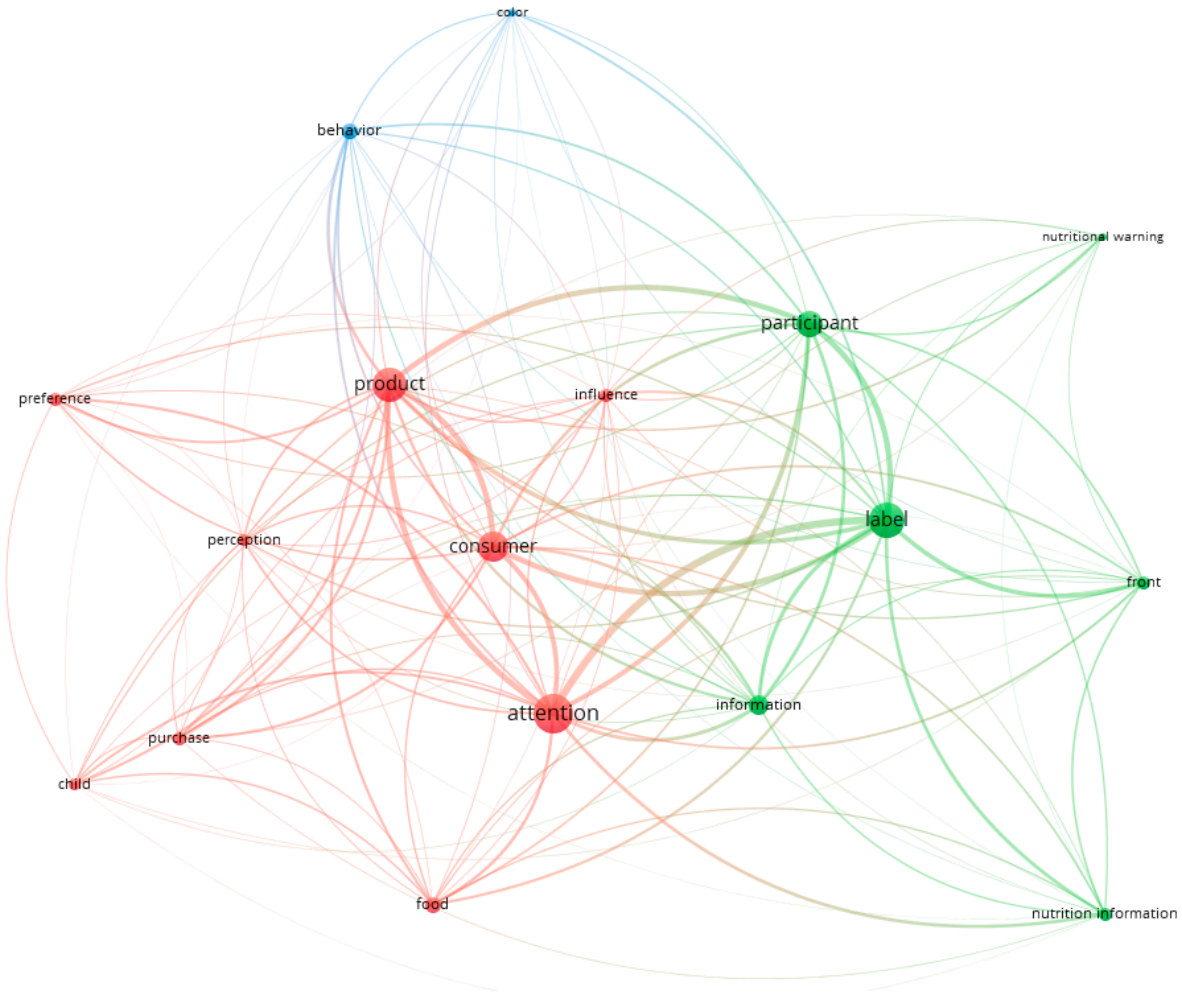

Figure 9. Text data analysis map.

Three clusters with 128 links and a TLS of 11217 were detected. The following three themes were identified through text data analysis: (1) consumer attention and food choice, (2) nutritional information, and (3) behavior (see Table 11). The first theme corresponds to the green cluster "Consumer attention, choice, and preference" identified via the bibliographic analysis and the red cluster "Visual attention and food choice" identified via the keyword co-occurrence analysis. How consumers paid attention to and chose food (red theme of the text data analysis) was the central field of research in the articles examined when eye tracking technology was used. This should be seen as a research direction to be pursued further. The second theme of the text data analysis directly corresponds to the red cluster "Nutritional information and impact" identified via the bibliographic analysis and the blue cluster "Nutritional information and impact" identified via the keyword co-occurrence analysis. Accordingly, a focus in the research field was on studies related to the nutritional information about food and its impact, which should be considered a further future research stream. The third theme of the text data analysis is a sub-aspect of the blue cluster "Labeling, visual attention, and decision" identified via the bibliometric analysis and the green cluster "Food information and decision" of the keyword co-occurrence analysis. Food information, labeling, and visual attention lead to certain behavior that contributes to decision-making. These can be summarized under the future research field identified in the first theme.

Table 11. Clusters generated using text data analysis.

Consumer Attention and Food Choice (Red)	Nutritional Information (Green)	Behavior (Blue)
Attention (270)	Label (233)	Behavior (64)
Product (221)	Participant (151)	Color (24)
Consumer (181)	Information (96)	
Food (68)	Nutrition information (53)	
Preference (49)	Front (50)	
Purchase (49)	Nutritional warning (21)	
Influence (46)		
Perception (44)		
Child (39)		

4. Key Findings and Future Research Directions

The first paper that used eye tracking as an instrument in consumer research to investigate food from a marketing perspective was published in 2011 by Bialkova and van Trjip [38]. This article was the second most cited reference (see Table 8). It can be considered a starting point for eye tracking research as Bialkova and van Tjip [38] (p. 592) stated that eye tracking "seems to be a promising tool for answering puzzling questions in consumer attention and decision-making with straightforward potential extensions to enlarge its scope." This is also supported by the increase in the number of publications in the following years (see Figure 2), which shows that eye tracking as an instrument of investigation became increasingly important in consumer research [2,16,18].

The leading journal for publications within the field of research was the journal *Food Quality and Preference* (RQ 3; see Table 5). European countries contributed the most to the research field, followed by the United States and Uruguay (RQ 3; see Table 3), while Eastern European and Asian countries were under-represented. This could be an area of research for the future. One institution and country (Universidad de la República in Uruguay) was particularly noticeable. This one institution published all publications for Uruguay (RQ 3). In the network visualization map of the author collaboration, it can be seen that the Universidad de la República had the largest collaboration network of all authors (RQ 2; see the networks in green and light blue in the center of Figure 5). The Universidad de la República with the authors Ares, G.; Machín, L.; Giménez, A.; and Lucia A. collaborated primarily with Aarhus University in Denmark with the author Aschemann-Witzel, J. The second collaborative network was formed by Arizona State University in the United States with the author Grebitus, C., and Wageningen University in the Netherlands with the author van Loo, E. J. The third collaborative network was formed between the University of Arkansas in the United States with author Seo, H.-S. and Ghent University in Belgium with the authors van Loo, E. J. and Verbeke, W. (see Figure 4). Author networks were built from interdisciplinary areas, e.g., marketing, consumer studies, food science, and psychology. This close cooperation could enrich the research field in the future, especially if computer sciences are included even more. Aarhus University followed the Universidad de la República as the second highest contributing institution to the growth of the research field (RQ 3; see Table 4). In addition, the authors Ares, G.; Machín, L.; Giménez, A.; and Antúnes, L. of the Universidad de la República were the most productive in the research field (RQ 1; see Table 6).

When it comes to the co-citation analysis, a different picture than that in Table 6 emerged. Here, Bialkova, S. was the leading author in citations (RQ 1; see Table 7). She was cited by the authors Ares, G. and Grunert, K. G. from the two leading institutions contributing to the research field, but also by all other authors from other institutions (see Figure 6). This becomes apparent by the position of the author Bialkova, S. in the middle of Figure 6 with the largest circle and font size, as well as numerous connection lines to the twenty most cited authors (RQ 1). Bialkova, S. was also represented with three references among the top eight most cited references (see Table 8), which demonstrates her prominent

position in the field of research at the time of the bibliometric review. Other leading authors in citations were Graham, D. J. from the University of Colorado and van Loo, E. J. from Ghent University (now Wageningen University) (see Figure 6).

The keyword co-occurrence analysis (RQ 4) was used to decode the most prominent terms in the literature with eye tracking as an instrument in consumer research to investigate food from a marketing perspective. It was determined that the keyword "eye tracking" occurred most frequently. This is not surprising, as it was the method inclusion criteria to be used in all the studies examined. In addition, most of the research focused on attention, nutritional information, (food) choice, and decision-making. Further important terms were preferences, labels, and willingness-to-pay. These keywords are inevitably linked to consumer research.

Bibliographic coupling, co-occurrence, and text data analysis were used to identify primary clusters and research themes in the research field between 2008 and 2023 (RQ 5). The three clusters and themes identified in the analyses were similar. The first research stream with eye tracking aimed to investigate how consumers become aware of and choose food. For the second research stream, the focus was on nutritional information on foods and its impact. The third research stream dealt with food information, including labels and prices and their visual attention, which led to certain consumer behavior.

In terms of the practical implications of this research, we can state that packaging and label designs serve as an important source of information for consumers (see Table 9). This suggests that the way consumers perceive packaging and label design is a key success factor for the purchase of the food. Future marketing strategies should, therefore, focus even more on this and be examined for their effectiveness using eye tracking. In this context, price representations should also be given greater consideration, as prices are a key purchase criterion for consumers (see Table 10). Since research so far has focused on certain countries (see Table 3), this research needs to be expanded to other countries, for example, countries in Eastern Europe, Asia, or Africa. It would then be necessary to determine whether the marketing strategies identified above (see Table 9) are also successful in these countries, i.e., whether similar marketing strategies are effective worldwide or whether a different customer approach is required depending on the country or region.

5. Concluding Remarks

This bibliometric review answered five research questions to present the statuses of studies that used eye tracking as an instrument in consumer research to investigate food from a marketing perspective. It makes important contributions to the literature while first examining the contributions of researchers to the research field with performance analysis and by identifying and presenting leading institutions, countries, and journals. Second, by identifying the most cited authors and highly referenced articles, the research field's underlying knowledge base and collaborative networks are highlighted. Third, the authors' collaborative networks are presented. Fourth, the most popular keywords are shown. Finally, the three themes in the research field are identified, and recommendations for future research are provided.

This study has limitations. The selection of keywords was based on the authors' understanding of eye tracking, consumer/nutrition, food, and marketing. Other constellations of keywords could be added in the future. With a bibliometric review, only the tab-delimited cited data record at a specific point in time in the past can be accessed for a publication. In contrast to systematic literature reviews, if an author changed universities, this is not necessarily obvious. In the future, past research results could be bundled and presented in systematic literature reviews to advance research based on this information. The literature corpus could be expanded and a more comprehensive understanding enabled if publications related to the research field are searched for in other databases such as Scopus.

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