# A Bibliometric Analysis on the state of the art of Neuromarketing research in Web of Science

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**Abstract**

Neuromarketing is an ever-evolving field and as such it is important to have an image on where we stand today regarding research about it. In order to study the state of the art of neuromarketing research in Web of Science, we carried out a bibliometric analysis with Vosviewer software. Using the keyword "neuromarketing" as the only search term, we retrieved 184 scientific articles from the Web of Science of Core Collection. We carried out all 5 possible types of analyses allowed on Vosviewer: co-authorship, co-occurrence, citation, bibliographic coupling, and co-citation. The results show that the United States is at the forefront of the field, having the most citations and published documents alongside being the most popular country for co-authored works, and also being the country most involved in citations. Most of the countries heavily involved in neuromarketing research are from Europe, with England being the most involved. Regarding the articles themselves, the most popular keywords are those related to research fields, other than neuromarketing, such as neuroscience, neuroeconomics, advertising, consumer decisions, among others. Likewise, the most popular journals for neuromarketing articles are those in the fields marketing, consumer behavior, psychology, neuroscience, etc. Other results show that the most popular cited journals are from the United States while the most popular cited authors are from Europe.

**Keywords:** Neuromarketing, Bibliometric Analysis, Vosviewer, Web of Science

## Introduction

The field of neuromarketing is a branch of the field of neuroscience that has gained a lot of popularity over the years and whose growth has been going strong for a while (Plassman et al. 2012). Ariely and Berns (2010) argue that this rise on popularity can be attributed to the possibility that it will become more accessible and efficient than other marketing methods and that it will be able to provide information that conventional marketing won't be able to. Neuromarketing can be defined as the application of neuroscientific methods to study human behavior in relation to market and marketing exchanges (Lee et al., 2017).

We felt that a bibliographic analysis would be the best tool to study the state of art of neuromarketing research. Bibliometric analyses are a type of study that have become more common each year due to the richness of information they provide and their relative simplicity. Nowadays its common to see them applied in several research fields such as economics, psychology, business, marketing, etc. (Pineda Escobar & Merigó, 2020), with the field of neuromarketing being no exception (Wannyn, 2017). These studies are often used to illustrate tables or graphs using metadata from various items, e. g. scientific articles, in order to study topics of interests, such as the most popular journals or research relationships between authors or countries.

One of the most popular types or bibliometric studies are citation analysis, which consists of the use of bibliometric data related to the citation data of scientific articles in a quantitative study. It is possible to measure the impact or quality of items such as articles, journals, or authors by using relevant information, for example, the number of times that an article or an author is cited, or the number of documents published by a scientific journal. (Moed, 2019).

Since the purpose of bibliometric analysis is to study the state of the art of research in a particular subject, the use of widely recognized databases like Scopus or Web of Science is common practice. For added convenience, these databases usually allow the user to download the metadata from their indexed articles which usually contain the references section needed for bibliometric analysis.

Based on the above, the objective of the study is to perform a bibliometric analysis on neuromarketing research to get a better understanding on the current actors in the field. We will be able to observe which countries have the highest production of scientific articles, as well as the most popular journals or authors. In addition, we will be able to see production networks and the existence of possible research clusters.

## Methodology

The articles used for the bibliometric analysis were extracted from the Web of Science database, particularly the Web of Science Core Collection on the 17th of December of 2021. We used the keyword "neuromarketing" as the only the search term and found 217 results that met the search criteria. Afterwards, we restricted the search to only scientific articles, which reduced the sample to 184 scientific articles. The metadata of these articles, the full records and references, were exported to be used with the Vosviewer software.

To analyze the interrelationship between the articles, and their metadata, we used Vosviewer, a free software that can be used to create and visualize bibliometric networks (van Eck &

Waltman, 2010). With Vosviewer, the user can create networks composed of items (which represent scientific articles, journals, researchers, research institutions, countries, or keywords) and the links between said items. These items are connected by links that represent degrees of co-authorship, co-occurrence, citation, bibliographic coupling, or co-citation. Vosviewer also allows the user to check other important information that can be extracted from the metadata, such as the number of documents published by each author, journal, or country; in addition to the number of times they have been cited.

The integrated Vosviewer user manual (which can also be found on their website) describes the five possible analyzes that can be carried out with the software. Co-authorship, where the relationship between items depends on the number of co-authored documents. Co-occurrence, where the relationship between the items (only keywords can be used in this type of analysis) depends on the number of documents in which they appear together. Citation, where the relationship between items depends on the number of times they cite each other. Bibliographic coupling, where the relationship between items depends on the number of shared references. And co-citation, where the relationship between items depends on how many times they are cited together.

For this research, the following analysis were carried out: Co-authorship between countries, co-occurrence of author selected keywords, citation of scientific articles and countries, bibliographic coupling of scientific articles and countries, and co-citation of sources (scientific journals) and authors. All analyzes were performed using the predetermined values assigned by Vosviewer. In the case of the analyzes for scientific articles and scientific journals, only the top 40 results are shown in the tables (the bibliographic mapping still considers all items in the sample that have at least one link).

## Results

The results of the analyses are presented in tables and figures 1 to 8. In addition to the type of item used in the analyses (country, keyword, author, journal, or article), the tables also show additional information depending on the items. The countries are accompanied by the number of documents and citations attributed to them and the average number of citations per document. The author defined keywords are accompanied by the number of occurrences of said keywords. Scientific journals, articles and researchers are accompanied by the number of times they are cited. All items are accompanied by the total link strength they have according to the network analysis in Vosviewer. What total link strength represents depends on the type of analysis performed. The figures are the mappings of the bibliometric networks made in Vosviewer. The circles represent the item used for the analysis, the larger the circle, the greater the total link strength. The lines represent the presence of a relationship between the items. The strength of the link is represented by the thickness of the line and the closeness of the items. The color of the items and links indicate the cluster the item belongs to.

### *Co-authorship per country*

This analysis shows the level of joint research for each country. The greater the total link strength, the greater the number of co-authored articles per country. Table 1 shows the levels of co-authorship of the countries found in the sample that authored at least 5 documents (Vosviewer default). Figure 1 shows the graphical representation of table 1.

As can be seen, the United States is the country with the highest number of published articles and citations, while Denmark has the highest citation per document ratio. The United States is also the country with the highest total link strength, which suggests that it has the highest level of collaboration when it comes to joint research with other countries.

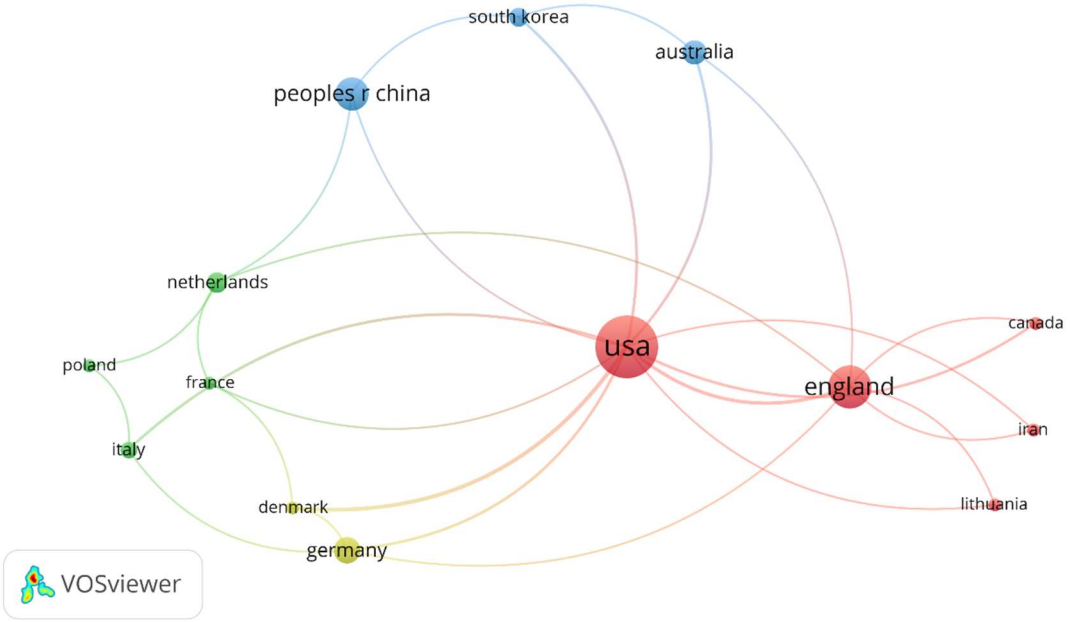
Furthermore, figure 1 shows the United States is the country with the highest number of links (11). The strongest link in the entire map is the one between the United States and Denmark, despite both countries being in separate clusters.

Table 1: Co-authorship per country ordered by number of citations

| Rank | Country | Documents | Citations | Total link strength | C/D |
|---|---|---|---|---|---|
| **1** | Usa | 35 | 1429 | 21 | 40.82857143 |
| **2** | England | 22 | 620 | 9 | 28.18181818 |
| **3** | Denmark | 5 | 417 | 6 | 83.4 |
| **4** | Germany | 12 | 396 | 5 | 33 |
| **5** | Spain | 34 | 284 | 0 | 8.352941176 |
| **6** | Netherlands | 9 | 238 | 4 | 26.44444444 |
| **7** | China | 16 | 223 | 3 | 13.9375 |
| **8** | France | 5 | 204 | 3 | 40.8 |
| **9** | Italy | 7 | 177 | 4 | 25.28571429 |
| **10** | Australia | 11 | 158 | 4 | 14.36363636 |
| **11** | Poland | 5 | 150 | 2 | 30 |
| **12** | Turkey | 6 | 105 | 0 | 17.5 |
| **13** | Canada | 5 | 75 | 3 | 15 |
| **14** | South Korea | 8 | 74 | 4 | 9.25 |
| **15** | Iran | 5 | 31 | 2 | 6.2 |
| **16** | Lithuania | 5 | 16 | 2 | 3.2 |

Minimum number of documents authored by a country: 5
Source: own elaboration

Figure 1: Co-authorship per country network




Source: own elaboration

### *Co-occurrence of author selected keywords*

This analysis shows the level of co-occurrence between keywords, that showed up a minimum of 5 times, selected by the authors of the articles. The highest the total link strength, the higher the number of times the keyword has appeared alongside other keywords found in the sample. Table 2 shows the keywords used in the network and how many times they appear in the documents of the sample. Since the search criteria used for the sample was "neuromarketing", it is not surprising that it is the keyword with the highest number of occurrences and has the highest total link strength by a wide margin. The keyword with the second highest number of occurrences is "consumer neuroscience", which is understandable as "neuromarketing and "consumer neuroscience", despite having some subtle differences, tend to be used interchangeably (Agarwal & Dutta, 2015). For the same reason, it's of no surprise that "neuroscience" is the third highest cited keyword and it's also the keyword with the second highest total link strength. The rest of the table is composed of keywords one would expect to be related to neuromarketing in some way or another, such as "EEG", "Eye Tracking", "Decision-Making", among others.

Table 2 shows the bibliographic mapping of the analysis. As "neuromarketing" is the most popular keyword, it is by far the largest item on the network and has the largest number of links (23). The strongest link in the network is the one between "Neuromarketing" and "Consumer Neuroscience", which can be explained by reason described in the previous paragraph. We should mention, however, that these results might be skewed as there are

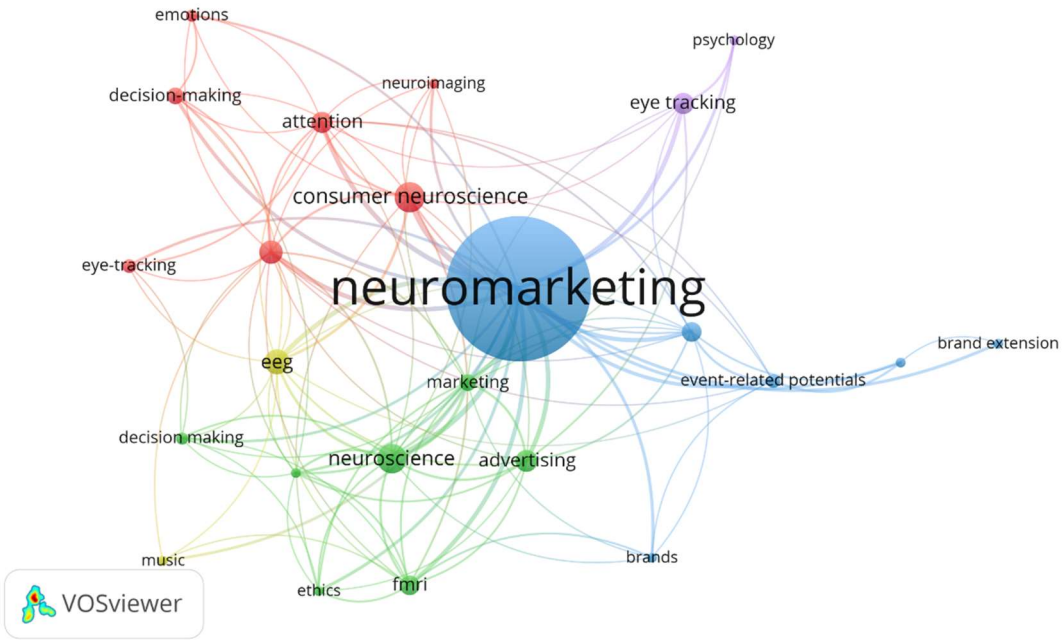
keywords that refer to the same thing yet are considered separate by Vosviewer as they are spelled differently (e.g "Eye-Tracking" and "Eye Tracking").

Table 2: Co-occurrence of author selected keywords ordered by number of occurrences

| Rank | Keyword | Occurrences | Total Link Strength |
|---|---|---|---|
| **1** | Neuromarketing | 129 | 178 |
| **2** | Consumer Neuroscience | 19 | 38 |
| **3** | Neuroscience | 18 | 43 |
| **4** | EEG | 15 | 32 |
| **5** | Neuroeconomics | 14 | 33 |
| **6** | Advertising | 13 | 30 |
| **7** | Attention | 12 | 28 |
| **8** | Eye Tracking | 12 | 20 |
| **9** | Emotion | 11 | 27 |
| **10** | Fmri | 11 | 29 |
| **11** | Decision-Making | 9 | 15 |
| **12** | Marketing | 9 | 30 |
| **13** | Event-Related Potentials | 7 | 18 |
| **14** | Eye-Tracking | 7 | 9 |
| **15** | Decision Making | 6 | 13 |
| **16** | Emotions | 6 | 8 |
| **17** | Brand Extension | 5 | 6 |
| **18** | Brands | 5 | 11 |
| **19** | Consumer Behavior | 5 | 19 |
| **20** | Ethics | 5 | 15 |
| **21** | Music | 5 | 7 |
| **22** | Neuroimaging | 5 | 9 |
| **23** | Neuromanagement | 5 | 11 |
| **24** | Psychology | 5 | 9 |

Minimum number of occurrences of a keyword: 5
Source: own elaboration

Figure 2: Co-occurrence of author selected keywords network




Source: own elaboration

### *Citations per scientific article*

This analysis shows the degree in which articles cite each other. Unlike the other analysis, there is no total link strength for the items. The information table 3 shows for each article is the number of times they have been cited and the number of articles of the sample they cite and have been cited by.

The most cited article by far is "Lee (2007)", which refers to the article "What is 'neuromarketing'? A discussion and agenda for future research" by Lee, N.; Broderick, A; and Chamberlain, L. Given that said article was published in February 2007 (the 4th oldest paper in the sample), its high number of citations, and its content; it's very likely that all links associated to this article are from being cited by other papers in the sample, which highlights its relevance to the subject of neuromarketing. Figure 3 shows the bibliographic mapping of the analysis.

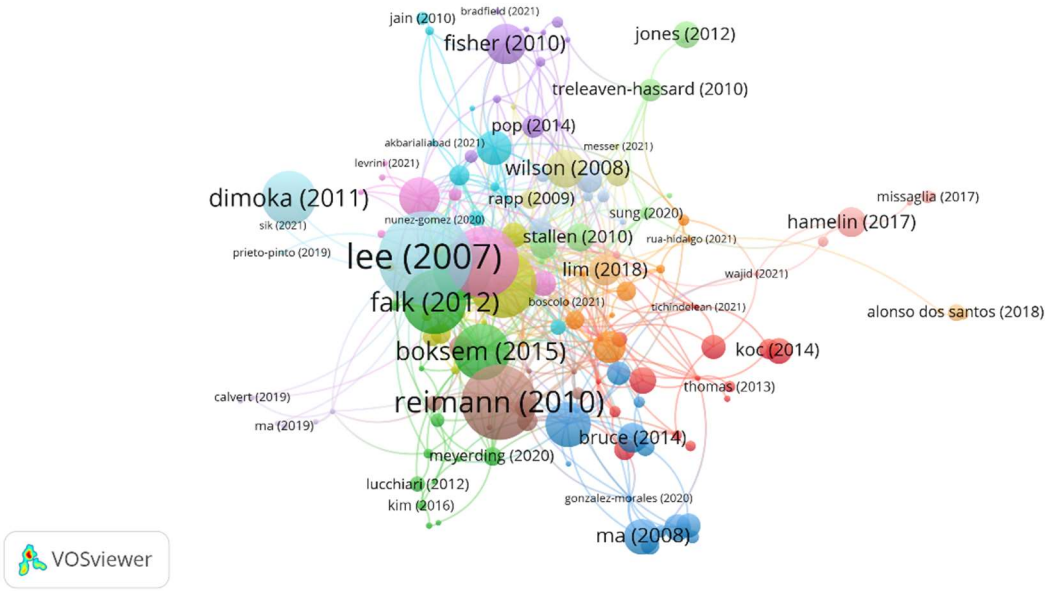
Table 3: Citations per scientific article (top 40 articles with the most links)

| Rank | Document | Citations | Links |
|---|---|---|---|
| **1** | Lee (2007) | 299 | 55 |
| **2** | Plassmann (2012) | 189 | 36 |
| **3** | Lim (2018) | 50 | 29 |
| **4** | Lee (2018) | 29 | 26 |
| **5** | Morin (2011) | 175 | 21 |
| **6** | Boksem (2015) | 129 | 18 |
| **7** | Javor (2013) | 58 | 16 |
| **8** | Berns (2012) | 135 | 15 |
| **9** | Venkatraman (2012) | 75 | 15 |
| **10** | Constantinescu (2019) | 4 | 15 |
| **11** | Ohme (2010) | 88 | 14 |
| **12** | Wilson (2008) | 66 | 14 |
| **13** | Varan (2015) | 34 | 14 |
| **14** | Spence (2019) | 24 | 14 |
| **15** | Nilashi (2020) | 2 | 13 |
| **16** | Stanton (2017) | 38 | 12 |
| **17** | Levallois (2021) | 3 | 12 |
| **18** | Shahriari (2020) | 3 | 12 |
| **19** | Reimann (2010) | 207 | 11 |
| **20** | Fisher (2010) | 73 | 11 |
| **21** | Schneider (2012) | 35 | 10 |
| **22** | Pop (2014) | 28 | 10 |
| **23** | Meyerding (2020) | 20 | 10 |
| **24** | Mileti (2016) | 17 | 10 |
| **25** | Sung (2020) | 11 | 10 |
| **26** | Gonzalez-morales (2020) | 1 | 10 |
| **27** | Falk (2012) | 156 | 9 |
| **28** | Hubert (2010) | 34 | 9 |

| | | | |
|---|---|---|---|
| **29** | Guixeres (2017) | 31 | 9 |
| **30** | Lee (2014) | 23 | 9 |
| **31** | Nemorin (2017) | 6 | 9 |
| **32** | Ramsoy (2019) | 5 | 9 |
| **33** | Banos-gonzalez (2020) | 1 | 9 |
| **34** | Li (2022) | 0 | 9 |
| **35** | Ulman (2015) | 30 | 8 |
| **36** | Schneider (2015) | 10 | 8 |
| **37** | Tichindelean (2021) | 0 | 8 |
| **38** | Alvino (2021) | 0 | 8 |
| **39** | Vecchiato (2014) | 51 | 7 |
| **40** | Cuesta-cambra (2017) | 24 | 7 |

Source: own elaboration

Figure 3 Citations per scientific article




Source: own elaboration

### *Citations per country*

Table 4 shows the degree in which articles cite each other. Similar to table 1, this table shows each country, their number of published scientific articles, the number of times they have been cited, their total link strength and the ratio of citations per document. As the countries in table 4 are the same as those in table 1, all results are identical save for total link strength. Once again USA is the country with the highest total link strength, meaning it is the most cited, and is the one that either cites or is cited by other papers in the sample the most. This result can be explained by the high number of published documents and citations the United States has.

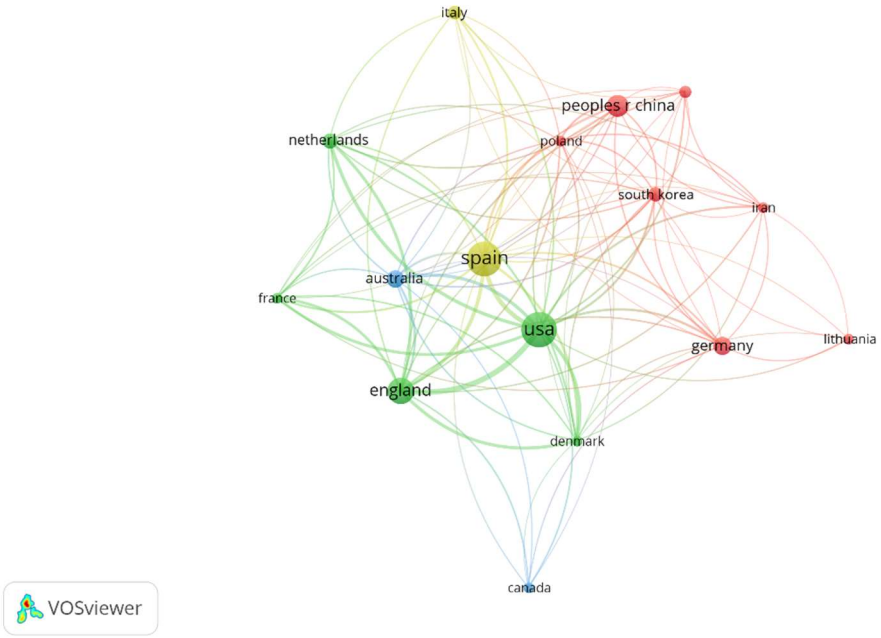
Figure 4 shows a graphical representation of table 4. Both the United States and Spain (the country with the third highest link strength) are the items with the highest number of links, both at fifteen. The strongest link in the network is the one between USA and England, highlighting the strong scientific relationship between the two.

Table 4: Citations per country

| Rank | Country | Documents | Citations | Total Link Strength | C/D |
|---|---|---|---|---|---|
| **1** | Usa | 35 | 1429 | 192 | 40.8285714 |
| **2** | England | 22 | 620 | 145 | 28.1818182 |
| **3** | Denmark | 5 | 417 | 70 | 83.4 |
| **4** | Germany | 12 | 396 | 37 | 33 |
| **5** | Spain | 34 | 284 | 111 | 8.35294118 |
| **6** | Netherlands | 9 | 238 | 66 | 26.4444444 |
| **7** | China | 16 | 223 | 33 | 13.9375 |
| **8** | France | 5 | 204 | 54 | 40.8 |
| **9** | Italy | 7 | 177 | 23 | 25.2857143 |
| **10** | Australia | 11 | 158 | 61 | 14.3636364 |
| **11** | Poland | 5 | 150 | 40 | 30 |
| **12** | Turkey | 6 | 105 | 20 | 17.5 |
| **13** | Canada | 5 | 75 | 16 | 15 |
| **14** | South Korea | 8 | 74 | 39 | 9.25 |
| **15** | Iran | 5 | 31 | 27 | 6.2 |
| **16** | Lithuania | 5 | 16 | 8 | 3.2 |

Minimum number of documents authored by a country: 5
Source: own elaboration

Figure 4: Citations per country




Source: own elaboration

### *Bibliographic coupling per document*

This analysis shows the degree in which articles share references. Table 5 shows the top 40 articles with the highest link strength of the sample. "Lee (2018)" is the article with the highest link strength, meaning it is the paper that shares the most references with other scientific articles.

Given that the analysis shows shared references between articles, it was expected that most of the articles in the list are from the last 5 years. By comparison, most of the articles in table 3 (citation analysis) are older than that. Figure 5 shows the bibliographic mapping of the analysis.

Table 5: Bibliographic coupling per document (top 40 articles with the greatest link strength)

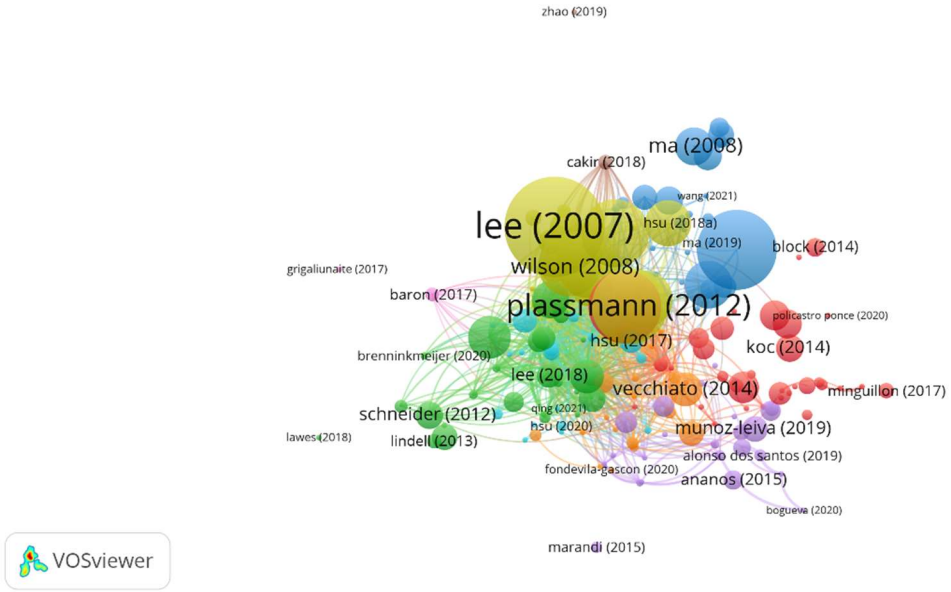
| Rank | Document | Citations | Total Link Strength |
|---|---|---|---|
| **1** | Lee (2018) | 29 | 816 |
| **2** | Lim (2018) | 50 | 769 |
| **3** | Spence (2019) | 24 | 603 |
| **4** | Nilashi (2020) | 2 | 585 |

| | | | |
|---|---|---|---|
| **5** | Plassmann (2012) | 189 | 539 |
| **6** | Levallois (2021) | 3 | 521 |
| **7** | Javor (2013) | 58 | 518 |
| **8** | Sung (2020) | 11 | 508 |
| **9** | Ramsoy (2017) | 8 | 433 |
| **10** | Ramsoy (2019) | 5 | 377 |
| **11** | Hubert (2010) | 34 | 367 |
| **12** | Stanton (2017) | 38 | 360 |
| **13** | Li (2022) | 0 | 349 |
| **14** | Schukat (2021) | 0 | 348 |
| **15** | Nemorin (2017) | 6 | 344 |
| **16** | Gonzalez-morales (2020) | 1 | 338 |
| **17** | Touchette (2017) | 15 | 331 |
| **18** | Lee (2017) | 15 | 329 |
| **19** | Venkatraman (2012) | 75 | 325 |
| **20** | Mileti (2016) | 17 | 317 |
| **21** | Wilson (2008) | 66 | 313 |
| **22** | Sanchez-nunez (2021) | 2 | 310 |
| **23** | Garczarek-bak (2021) | 1 | 309 |
| **24** | Al-kwifi (2016) | 12 | 306 |
| **25** | Andreu-sanchez (2014) | 5 | 299 |
| **26** | Cakir (2018) | 13 | 292 |
| **27** | Bakardjieva (2017) | 12 | 287 |
| **28** | Fisher (2010) | 73 | 278 |
| **29** | Berns (2012) | 135 | 276 |
| **30** | Boksem (2015) | 129 | 276 |
| **31** | Pop (2014) | 28 | 274 |
| **32** | Dimoka (2011) | 120 | 269 |
| **33** | Meyerding (2020) | 20 | 262 |
| **34** | Varan (2015) | 34 | 250 |
| **35** | Hakim (2021) | 0 | 247 |

| | | | |
|---|---|---|---|
| **36** | Schwarzkopf (2015) | 8 | 246 |
| **37** | Nunez-gomez (2020) | 0 | 244 |
| **38** | Asuncion hernandez-fernandez (2019) | 6 | 244 |
| **39** | Alvino (2021) | 0 | 244 |
| **40** | Tichindelean (2021) | 0 | 243 |

Source: Own elaboration

Figure 5: Co-authorship per country network




Source: own elaboration

### *Bibliographic Coupling per country*

Similar to the previous analysis, this one shows the degree of shared references between countries. Table 6 shows the same information about countries as table 1 and 4 save for the total link strength which, in this analysis, represents how much a shared references a country has. Once again, the United States is the country with the highest link strength of the sample, followed by England. As the United States and England are the countries with the highest number of published articles, it is not surprising they have the most shared references of the group.

Figure 6 shows the bibliographic mapping of table 6. Unlike all other figures presented in this paper, every single item on this map has the same number of links, fifteen, which means

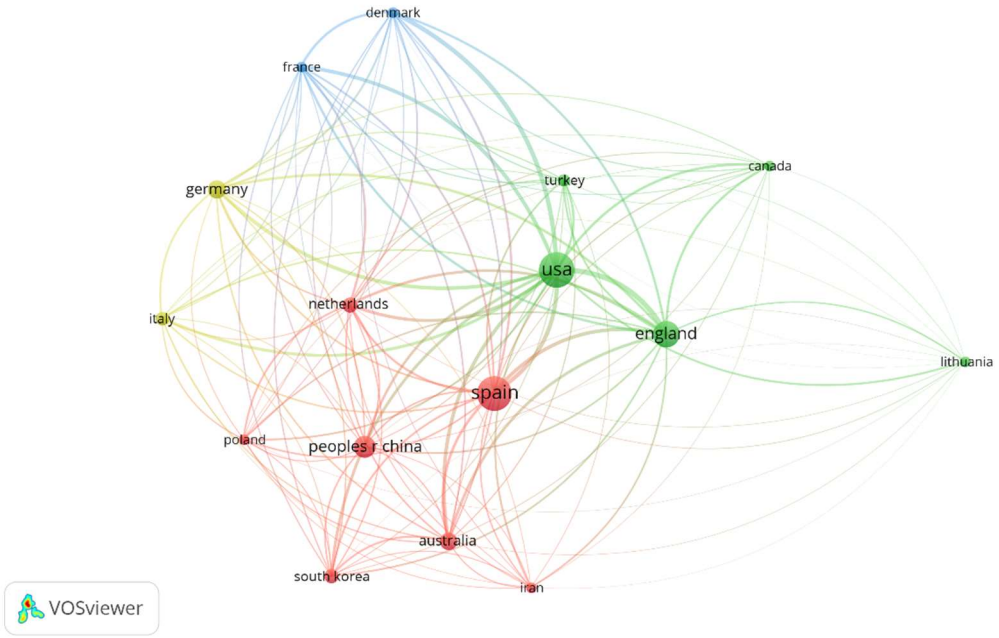
every single country in the sample has at least one shared reference with every other country in the sample. Just like in figure 4, USA and England belong to the same cluster and have the strongest link of the group.

Table 6: Bibliographic Coupling per country

| Rank | Country | Documents | Citations | Total link strength | C/D |
|---|---|---|---|---|---|
| **1** | Usa | 35 | 1429 | 6970 | 40.82857143 |
| **2** | England | 22 | 620 | 4287 | 28.18181818 |
| **3** | Denmark | 5 | 417 | 2332 | 83.4 |
| **4** | Germany | 12 | 396 | 2028 | 33 |
| **5** | Spain | 34 | 284 | 3216 | 8.352941176 |
| **6** | Netherlands | 9 | 238 | 2106 | 26.44444444 |
| **7** | China | 16 | 223 | 1259 | 13.9375 |
| **8** | France | 5 | 204 | 2093 | 40.8 |
| **9** | Italy | 7 | 177 | 1204 | 25.28571429 |
| **10** | Australia | 11 | 158 | 2241 | 14.36363636 |
| **11** | Poland | 5 | 150 | 961 | 30 |
| **12** | Turkey | 6 | 105 | 1010 | 17.5 |
| **13** | Canada | 5 | 75 | 862 | 15 |
| **14** | South Korea | 8 | 74 | 1439 | 9.25 |
| **15** | Iran | 5 | 31 | 725 | 6.2 |
| **16** | Lithuania | 5 | 16 | 363 | 3.2 |

Minimum number of documents authored by a country: 5
Source: own elaboration

Figure 6: Network of Bibliographic Coupling per country




Source: own elaboration

### *Co-citation per source*

This analysis shows the frequency in which scientific journals are cited together. Table 7 shows the top 40 scientific articles with the strongest total link strength and the number of times they have been cited. The higher the total links strength, the higher the number of times they have been cited alongside another scientific journal of the sample. The two most cited articles are "j marketing res" (which also has the highest total link strength) and "j consum res", which refer to "Journal of Marketing Research" and "Journal of Consumer Research" respectively. Both of these are high impact American journals in the Business and Science Field. As neuromarketing is a known topic of research in both the fields of consumer decision and marketing, this result was expected. As the table shows, many of the journals present also belong to fields such as neuroscience, business, psychology, advertising, among others.

Figure 7 shows the co-citation map of scientific journals. Many of the journals in the map share the highest number of links, 75, indicating a high degree of co-citation among journals. The map consists of three clusters. The first cluster (colored red and on the right) is composed mainly by journals of marketing, advertising, and consumer behavior. The second (colored green and on the top left) is formed mainly by journals of psychology. And the third cluster (colored blue and on the bottom left) is mostly formed by neuroscience journals.

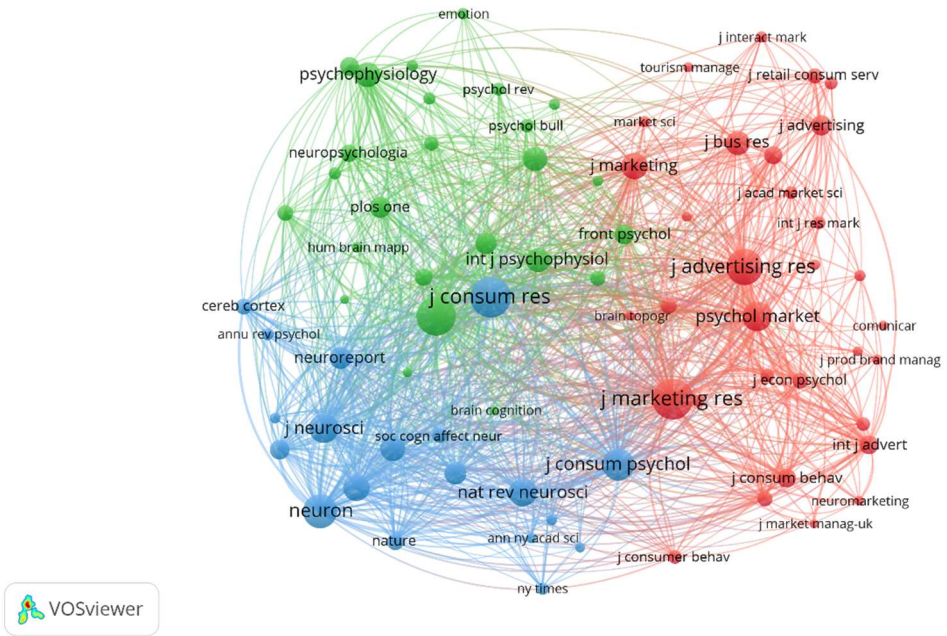
Table 7: Co-citation per scientific journal (top 40 articles with the greatest link strength)

| Rank | source | citations | total link strength |
|---|---|---|---|
| **1** | j marketing res | 238 | 9703 |
| **2** | j consum res | 238 | 9452 |
| **3** | neuroimage | 227 | 8776 |
| **4** | neuron | 179 | 7616 |
| **5** | j neurosci | 141 | 6593 |
| **6** | j consum psychol | 155 | 6571 |
| **7** | j advertising res | 195 | 5922 |
| **8** | psychol market | 138 | 5848 |
| **9** | nat rev neurosci | 127 | 5149 |
| **10** | science | 115 | 5062 |
| **11** | p natl acad sci usa | 108 | 4643 |
| **12** | trends cogn sci | 87 | 3979 |
| **13** | j marketing | 117 | 3920 |
| **14** | neuroreport | 84 | 3718 |
| **15** | nat neurosci | 73 | 3469 |
| **16** | int j advert | 69 | 3463 |
| **17** | psychophysiology | 106 | 3153 |
| **18** | int j psychophysiol | 100 | 3116 |
| **19** | j pers soc psychol | 103 | 3115 |
| **20** | j consum behav | 69 | 3053 |
| **21** | j bus res | 103 | 2971 |
| **22** | front hum neurosci | 82 | 2740 |
| **23** | plos one | 79 | 2725 |
| **24** | psychol sci | 60 | 2600 |
| **25** | nature | 56 | 2452 |
| **26** | cereb cortex | 50 | 2346 |
| **27** | market lett | 46 | 2277 |
| **28** | eur j marketing | 63 | 2239 |

| | | | |
|---|---|---|---|
| **29** | j econ psychol | 51 | 2161 |
| **30** | j advertising | 77 | 2152 |
| **31** | biol psychol | 68 | 2126 |
| **32** | front psychol | 73 | 2067 |
| **33** | neuropsychologia | 59 | 2037 |
| **34** | soc cogn affect neur | 44 | 2003 |
| **35** | adv consum res | 39 | 1937 |
| **36** | j cognitive neurosci | 52 | 1922 |
| **37** | j neurosci psychol e | 52 | 1895 |
| **38** | front neurosci-switz | 43 | 1511 |
| **39** | j consumer behav | 39 | 1483 |
| **40** | j consum mark | 40 | 1471 |

Minimum number citation per source: 20
Source: own elaboration

Figure 7: network Co-citation sources




Source: own elaboration

### *Co-citation per author*

Just like the source co-citation analysis, this one shows how often researchers are cited together. Table 7 shows the authors who had at least 20 citations to their name, the number of times they have been cited and their total link strength, which represents how often they are cited alongside another author in the sample. The author with both the highest number of citations and highest total link strength is "plassmann, h". Since they are the most cited author of the sample, it is understandable that they are also the author who has been cited the most alongside other authors of the group.

Figure 8 shows the bibliographic network of table 8. Despite being not having one of the highest number of citations or co-citations, "reimann, m" is the author with the highest number of links with 30. The strongest link in the network is the one between "plassmann, h" and "lee, n", the two most cited, and co-cited, authors.

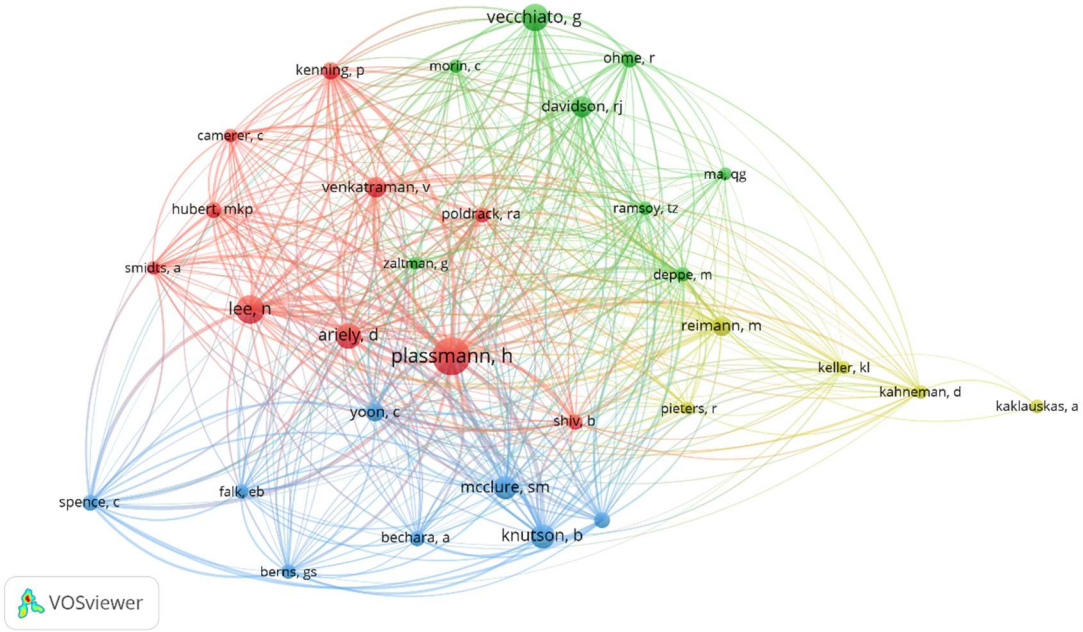
Table 8: Co-citation per author

| Id | Author | Citations | Total Link Strength |
|---|---|---|---|
| **1** | Plassmann, H | 119 | 1537 |
| **2** | Lee, N | 76 | 872 |
| **3** | Vecchiato, G | 68 | 494 |
| **4** | Ariely, D | 63 | 592 |
| **5** | Knutson, B | 56 | 662 |
| **6** | Mcclure, Sm | 53 | 532 |
| **7** | Davidson, Rj | 44 | 412 |
| **8** | Venkatraman, V | 42 | 520 |
| **9** | Reimann, M | 39 | 512 |
| **10** | Yoon, C | 36 | 531 |
| **11** | Kenning, P | 34 | 512 |
| **12** | Ohme, R | 30 | 328 |
| **13** | Hubert, Mkp | 29 | 349 |
| **14** | Spence, C | 29 | 475 |
| **15** | Schaefer, M | 28 | 405 |
| **16** | Bechara, A | 26 | 272 |
| **17** | Poldrack, Ra | 26 | 350 |
| **18** | Shiv, B | 26 | 363 |

| | | | |
|---|---|---|---|
| **19** | Berns, Gs | 25 | 318 |
| **20** | Deppe, M | 25 | 403 |
| **21** | Falk, Eb | 24 | 258 |
| **22** | Camerer, C | 23 | 309 |
| **23** | Morin, C | 23 | 237 |
| **24** | Ramsoy, Tz | 23 | 307 |
| **25** | Kahneman, D | 22 | 208 |
| **26** | Kaklauskas, A | 22 | 17 |
| **27** | Smidts, A | 22 | 314 |
| **28** | Pieters, R | 21 | 169 |
| **29** | Keller, Kl | 20 | 151 |
| **30** | Ma, Qg | 20 | 103 |
| **31** | Zaltman, G | 20 | 244 |

Minimum number of citations per author: 20
Source: own elaboration

Figure 8: Co-citation per author network




Source: own elaboration

## Conclusions

Bibliometric analysis helps us visualize the current state of neuromarketing research found in the Web of Science database. We extracted the metadata from 184 articles from the Web of Science Core Collection to use with Vosviewer software. Our results show that the United States is at the forefront of the field. In addition to being the country with the most citations and published documents, it is also the country with the highest number of co-authored documents, has the most shared references in its articles, and is the country most involved in the citation process. Also, the two most cited journals of the sample are from the United States.

After the United States, the European countries, particularly England, showed the highest number of citations, published documents, co-authored documents and shared references. In addition, the 2 most cited authors, are from European institutions. Our results also show that England and the United States have a strong research relationship when it comes to neuromarketing research, showing one of the strongest relationships in all analyses that involved both countries.

The most popular keywords in scientific articles about neuromarketing tend to be either those pertaining to research fields such as neuroscience, neuroeconomics, decision making, and advertising; or pertaining to methodology such as EEG or eye-tracking. Regarding scientific articles, "What is 'neuromarketing'? A discussion and agenda for future research" by Lee, N; Broderick, A; and Chamberlain, L. (2007) is the most cited article about neuromarketing in WOS.

The most cited journals when it comes to neuromarketing research are "Journal of Marketing Research" and "Journal of Consumer Research". In addition, most of the scientific journals found in the sample were about subjects related to neuromarketing such as neuroscience, psychology, marketing among others. The most cited author is Plassmann, H. followed by Lee, N.

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