

Bibliometric Review Paper on Palatography

Elmira ESMAEELPOUR¹, Hamideh POSHTVAN², Mandana NOURBAKHSH³

¹Alzahra University, Iran, e.esmaeelpour@gmail.com

²Alzahra University, Iran, hamideh.poshtvan@gmail.com

³Alzahra University, Iran, nourbakhsh@alzahra.ac.ir

ABSTRACT: This study makes an attempt to convey a bibliometric investigation on the public trends in Palatography literature published from 1940 to December 2019. For doing so, in the first part of the paper, using the Scopus database, the keyword “palatography” and “palatograph” were searched in the title of the documents, keywords, and abstracts within all areas of disciplines. In the second part, the search pattern was limited to the domains of “Art and Humanities” and “Social Sciences” including Language and Linguistics from 2010 to 2020. The data was collected from Scopus freely accessed at Alzahra University, and network analysis of research outputs was carried out to analyze the research trends in the Palatography literature. The quantitative analysis of the publications, i.e. publication years, authors, keywords, countries and affiliation, citation per year, subject area, documentation type, were investigated in both parts. Based on the results, Palatography and its applications are fluctuating in recent years. The results show that documents with the focus on Palatography in “Art and Humanities” and “Social Sciences” have deteriorated in citation rate, as the authors were researching in multidisciplinary zones. The top research keywords in all publications investigated in the first part of our study concentrated on “speech”, “palate”, “articulation”, and “tongue”. While, as demonstrated in the second part, the main focus has been on “dental”, “speech”, “palate”, and “phonetics”. The trends of publications on Palatography provide a perspective on the future of research and identifies potential opportunities and challenges.

KEYWORDS: art and humanities, bibliometrics, dental, palate, palatography, social sciences

Introduction

Bibliometrics, by definition, is a statistical, quantitative analysis of publication patterns in a specific field. It informs the readers on the number of papers on a certain subject or domain published in a given period of time; indicates active authors and their affiliation and relations with other authors; demonstrates the leading countries in the given domain; and above all, shows which areas in a certain domain is yet to be explored.

This bibliometric paper is intended to address the studies that have so far concentrated on the speech articulation and difficulties using the clinical method of “palatography” in the domain of phonology and speech therapy. Palatography is a useful means of collecting data concerning the shape of the mouth cavity as well as the contact between the tongue and the roof of this cavity during the production of speech sounds. The palatography involves a number of methods, the early form of which is known as direct palatography. As Ladefoged (1957) describes, in the direct palatography the investigator would spray a black powder on the mouth of the participant and s/he would articulate one word each time. During the utterance whenever the tongue touched the palate, would remove the black powder, enabling the investigator to see via a photograph exactly which areas of the palate contacted the tongue. Another method consisted of an artificial palate made to fit the participant’s mouth and would be covered by a type of marking ink before it was worn by the participant. Once a word was pronounced, the device was removed and the investigator would record the areas where the ink was wiped

away. It would be easy then, to take a photo or draw the false palate. Comparing these two methods, it seems the direct palatography was more preferred since it would enable the researchers to investigate the utterances of many individuals with not much preparations. The second approach the biggest challenge was making the artificial palate. It was a skilled job and the researcher would need a custom-made palate for each participant.

Electropalatography (EPG), first introduced by Grützner in 1879, is an imaging technique that enables phoneticians and speech therapists to observe how and when the tongue touches the hard palate during the articulation. The instrument, palatograph, consists of an artificial palate –specifically designed to fit the speaker’s mouth- with 62 electrodes on one surface that is in contact with the tongue. The instrument is worn by the speaker on the hard palate and while they speak, the points of contact between the tongue and hard palate are recorded by the electrodes. The electrodes (Figure 1) are arranged in an 8*8 grid the first row of which includes 6 electrodes. EPG is especially useful to help patients with articulation disabilities or disorders produce proper speech sounds. Figure 2 illustrates the electrodes and the areas of the hard palate that touch the tongue when articulating /t,s,l/.

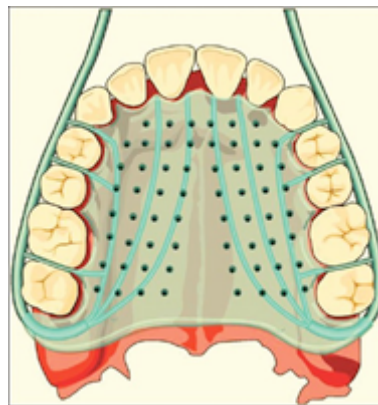


Figure 1. The schema of a palatograph.

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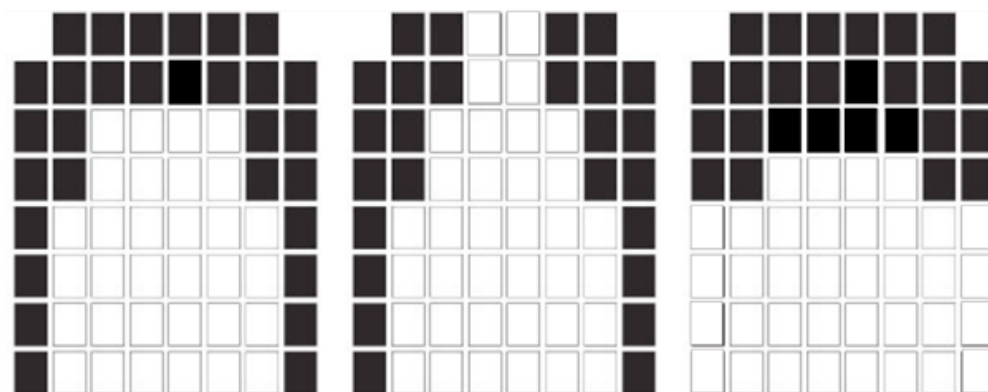


Figure 2. Palatogram of three speech sounds: /t/ in “teen”, /s/ in “seen”, and /l/ in “lean”. The contact between the electrodes and tongue is indicated by black grids (Vernhoeven et al. 2019).

Section 1. General search pattern. Methodology

We collected the data from Scopus on December 21st, 2019 where it was openly accessible. The main keyword “palatograph” OR “palatography” (TITLE-ABS KEY

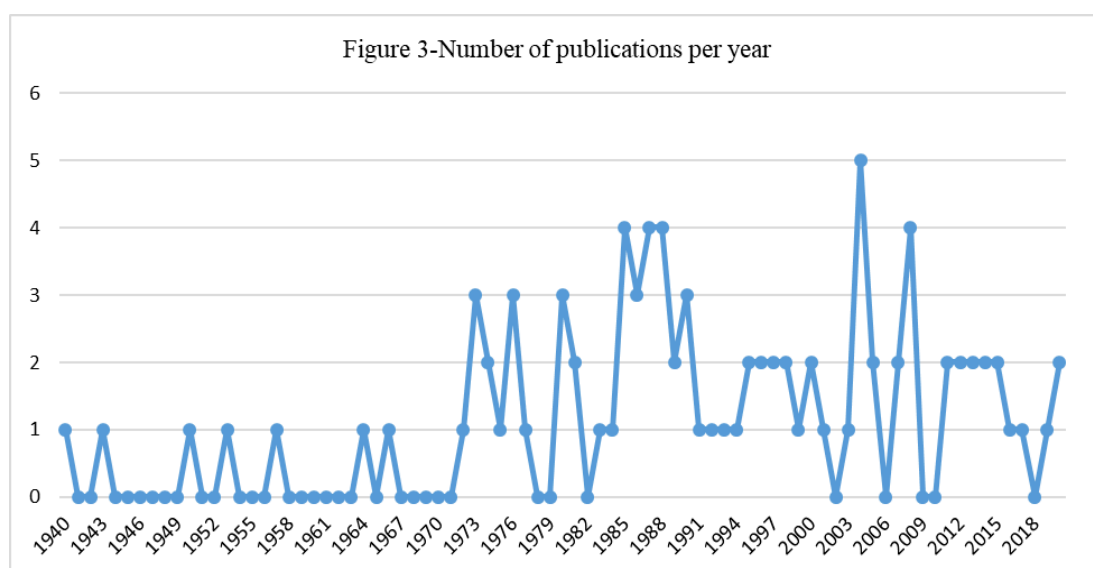
(palatograph) OR TITLE-ABS-KEY (palatography)) was searched in the article title, abstract, and keywords of the publications during the years 1940 to 2020. The result included 90 documents. The quantitative patterns of the publications, i.e. publication years, authors, keywords, countries and affiliation, citation per year, subject area, documentation type, are studied. Then, the search pattern is limited to categories of “arts and humanities” and “social sciences” between 2011 and 2020 (TITLE-ABS-KEY (palatograph) OR TITLE-ABS-KEY (palatography)) AND (LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011)) AND (LIMIT-TO (SUBJAREA , "ARTS") OR LIMIT-TO (SUBJAREA , "SOCI")). In order to analyze the data quantitatively, Excel 2016 is used to visualize the statistical results based on Scopus analysis.

The resulting documents were further visualized by VOS Viewer (<http://www.vosviewer.com/>) on the basis of the keywords, the origin of the authors, and their affiliations. Figure 4 illustrates the number of publications per year, from 1940 to 2020. VOS Viewer enables us to restrict the keywords to the most frequent ones used by the authors or indexed in Scopus and to analyze how closely those keywords are related to each other.

As mentioned earlier, the Scopus database search rendered 90 academic papers where the keywords “palatograph” or “palatography” appeared either in their keywords, title, or abstract. Only 7 papers out of 90 were related to the methodology of palatography limited to categories of “arts and humanities” and “social sciences” between 2011 and 2020. In this paper, we focus on the qualitative analysis of all papers regardless of their annual citation rate and afterward as well. We investigate the methodological implications through the analysis of the seven papers that have addressed palatography method in particular. In the following sections, first, the title of the papers are analyzed and then, the research methods are surveyed.

Result and discussion

Publications per year analysis

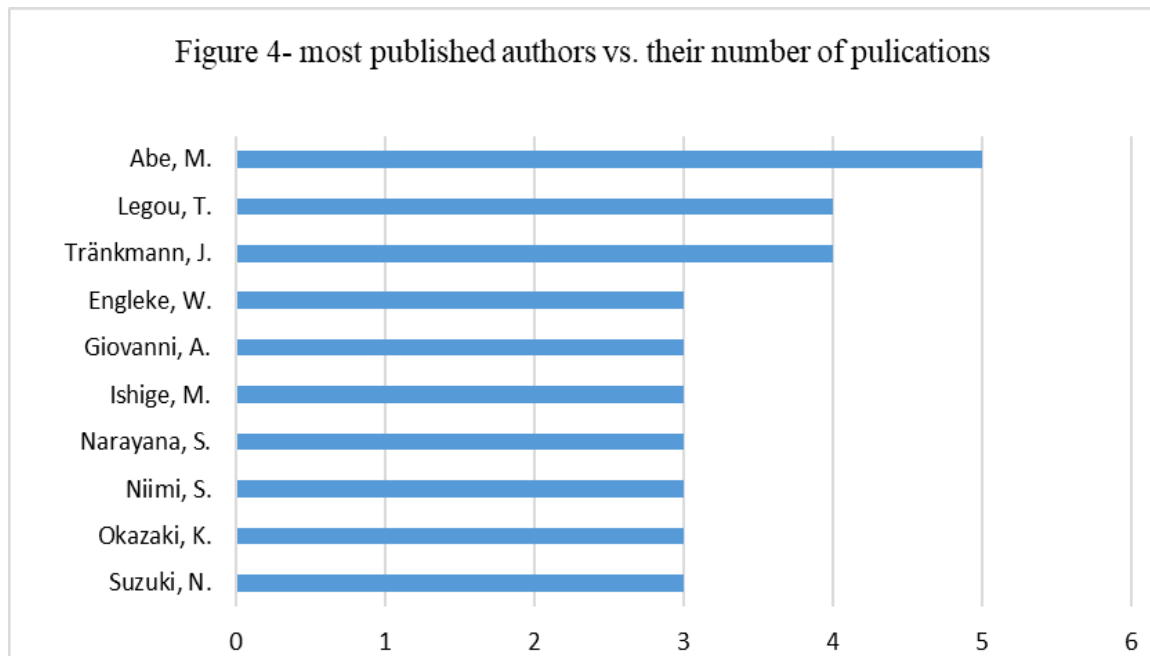


Analysis of publication years

Our investigation covers a period of 80 years starting from 1940. Although palatography and electropalatography as its sub-set were introduced in 1879, the approach did not come into attention for a century; only one paper at times was dedicated to the subject. The year 1972 was apparently a turning point (Figure 3), where the number of scholarly papers increased to 3 per year and from then on, more than one and up to five papers (the year 2014) were published each year.

Analysis of authors

Figure 4 illustrates the ten top authors with more than three publications on the theme “palatography”. As it is shown, Abe, M. tops the list with five papers. The next two high standing authors, Legou, T. and Tränkmann, J., have participated in four publications. These three writers together have produced about 14.5 percent of the total papers on the subject under question within the 80-year period.



Keywords analysis

Keywords are useful means for researchers who may wish to replicate specific surveys in order to examine the efficiency and the application of the previous methods in diverse settings and conditions. The quantitative analysis of keywords will help future researchers to scrutinize their research topic within the hottest domains. As far as “palatography” is concerned, the most frequent keyword in our corpus was “speech”, while the less frequent one among the top 5 keywords was “articulation”. The usage frequency of each keyword is depicted in Table 1.

Table 1. The top five keywords by their frequency of appearance

Keyword	speech	palate	human	tongue	articulation
Frequency	128	88	87	79	40

The density of the most frequent keywords within our corpus was visualized by voyant tools, an application that is freely accessible online at www.voyant-tools.org. As it is obvious (Figure 5), the more a keyword appears in the corpus, the thicker and bigger it is visualized by voyant tools.



Figure 5. The density of keywords related to “palatography” research (voyant-tools.org)

Moreover, VOS Viewer is used to visualizing the interactions between the authors and indexed keywords based on the specific time periods. Those keywords with dark colors represent the keywords (e.g. speech disorder and diagnosis) that the scholars were interested in nearly 35 years ago. This can confirm the fact that most of the subject areas are related to Medical and Health issues shown in Figure 6. Keywords in blue (e.g. articulation and palate) are associated with the years 1990 and 1995. We can consider the years 1995 to 2000 a turning point, given the fact that authors used the most frequent keywords the most interactions with other ones. In this regard, human and tongue appeared in this period of time and studies based on Normal humans began in 1995, as well. Furthermore, the size of the keywords depends on the frequency of their appearance in the literature. Therefore, human, palate, tongue, and speech are the most frequent keywords and the rest with smaller sizes represent the less frequent ones in our corpus. The brighter colors represent the most state-of-the-art keywords being considered in the literature of the domain under study since 2000. These keywords include electropalatography and dynamic palatography, leading to the fact that those techniques were applied in studies right after their advent.

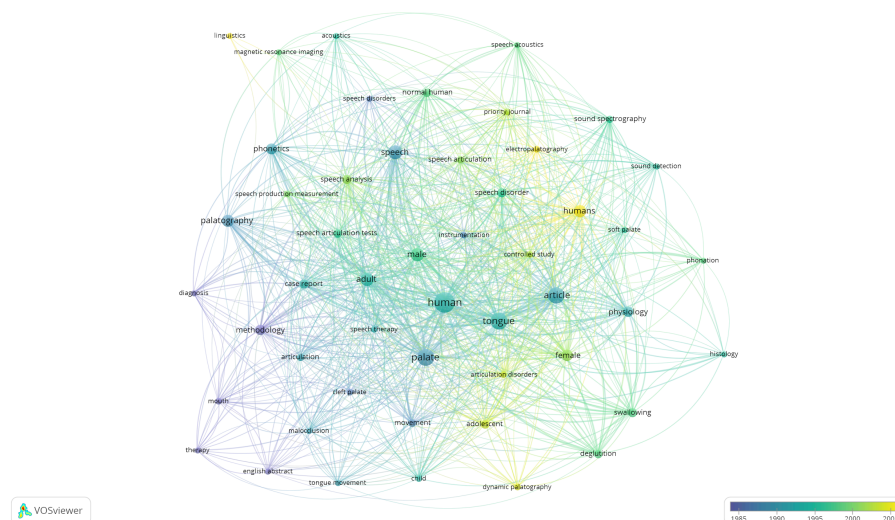


Figure 6. The diversity of keywords and their interactions with other keywords

Analysis of countries and affiliations

It is important for researchers to know which countries are the most active in conducting research programs on specific topics because it helps them find appropriate research partners and co-authors. For the same reason, being informed of the affiliation of the most published authors are important as well. Figure 7 below demonstrates the top ten countries that have been pioneers in the domain of palatography along with the number of their publications during the period under our investigation. As it is shown, Japan with 17, Germany and the United States with 14 publications each are the leading countries. These three countries have produced 50 percent of the total academic output worldwide.

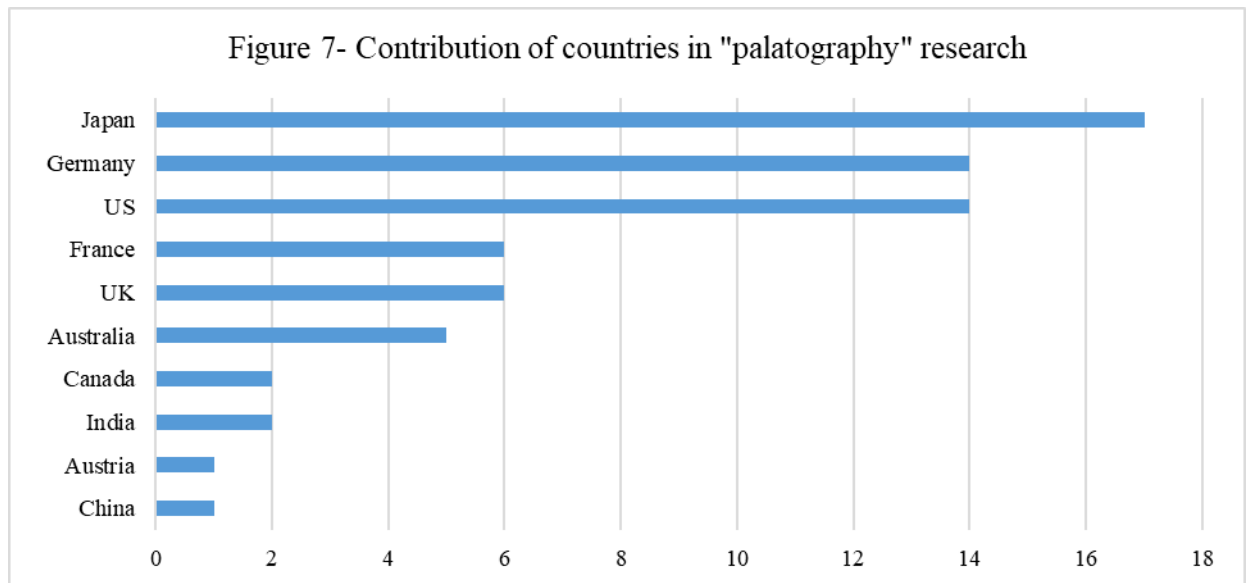
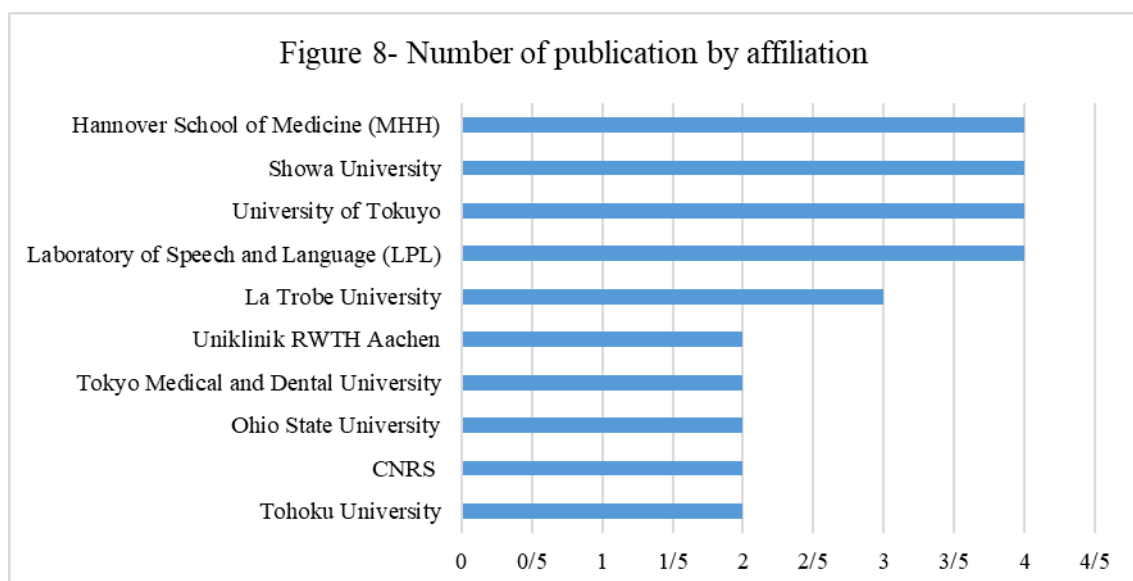
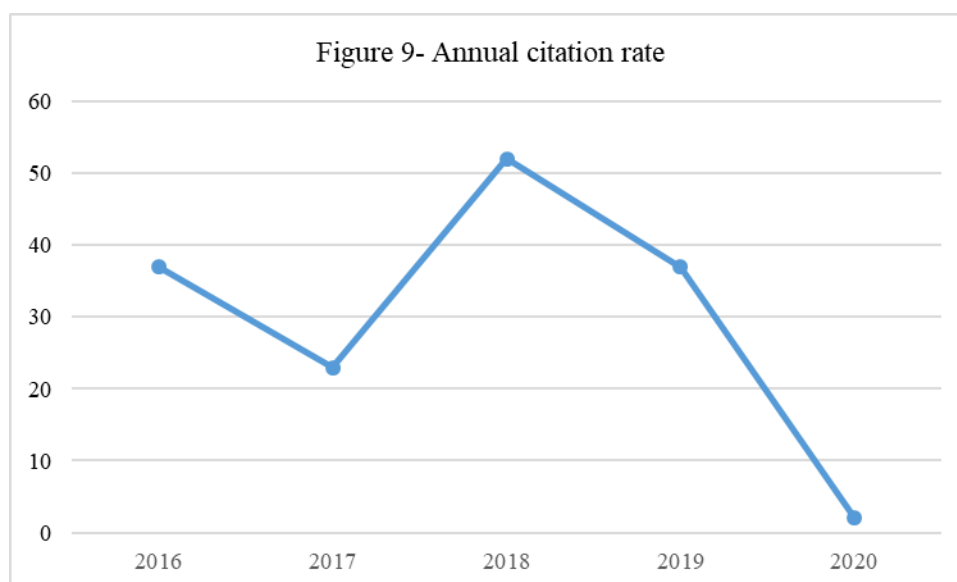


Figure 8 below presents the publication rate of the top ten universities and research institutes around the world. Hannover Medical School (MHH) in Germany, Showa University and the University of Tokyo in Japan, and Laboratory of Speech and Language (LPL) in France, with 4 papers each, are the top four institutes that have had the most contribution in the publication of palatography research worldwide. These four institutes have produced about 18 percent of the total scholarly work on palatography.



Citation per year

As mentioned earlier, our database consisted of 90 documents in total and Figure 9 below demonstrates the rate of annual citation to the whole database since 2016. As can be seen, the year 2018 with the total citation of 52 was the most cited year and the current year with 2 is the least cited year. This shows that the attraction of this field has a downward trend up to 2020.



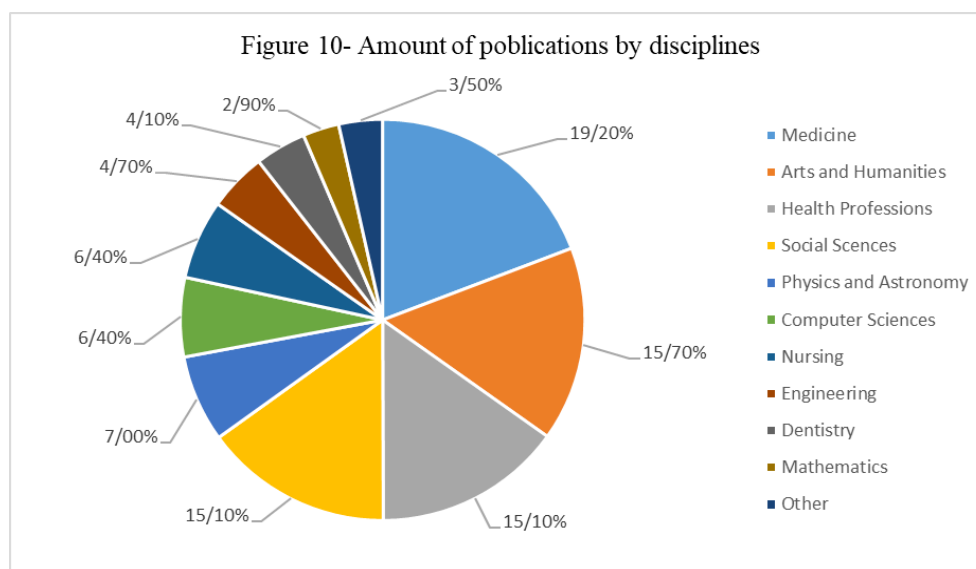
Interestingly, the most cited paper on palatography was published in a medical journal in 2003 and to date, it has received 205 citations. The two other top-cited papers with 51 and 49 citations were published in linguistics-related journals. Table 2 presents more detailed information in this regard.

Table 2. Top-cited papers related to palatography in all domains

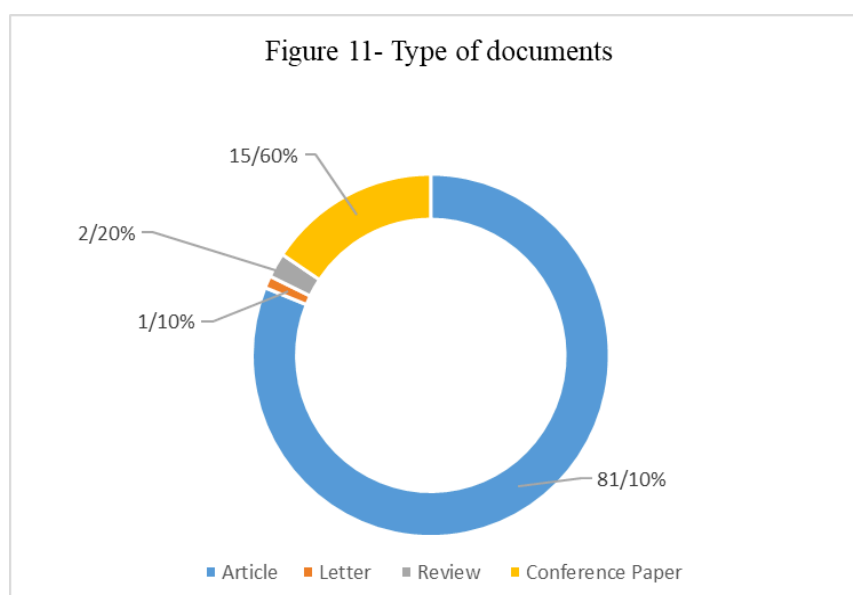
Title	Authors	Year	Journal	Citation rate
Tongue movement in feeding and speech	Hiiemae, K. M., Palmer, J. B.	2003	Critical review in oral biology and medicine	205
Articulatory and voicing characteristics of adult dysarthric and verbal dyspraxic speakers: An instrumental study	Hardcastle, W. J., Barry, R. A. M., Clark, C. J.	1985	International journal of language and communication disorders	51
Compensating for a bite block in /s/ and /t/ production: Palatographic, acoustic, and perceptual data	Flege, J.E., Fletcher, S.G., Homiedan, A.	1988	Journal of acoustical society of America	49

Analysis by subject area

Figure 10 presents the share of different disciplines in the whole research papers published during the 80 years starting in 1940. It seems that research domains related to “platography” and “platograph” include a variety of disciplines and interdisciplinary studies. The most dominant domain is related to Medicine with 19 percent. It shows that “platography” and “platograph” are studied to find remedies for medical issues. Besides, health professions enjoy 15 percent of the total. Moreover, 31 percent of the total subject areas is associated with Art and Humanities together with Social Sciences as interdisciplinary areas, covering language and linguistics research themes. This can show the importance of these areas in paving the way for the other areas by providing the infrastructures. Other areas are mostly related to Computer and Pure Sciences, such as Physics and Astronomy (7 percent), Computer Sciences (6.4 percent), Mathematics (2.9 percent). Interestingly, 4 percent of the whole subject areas pertains to Dentistry, having seemingly more interests regarding “platography” and “platograph”.



Analysis of documentation type



As it is demonstrated in Figure 11, five types of documents have so far been published based on the keyword of our focus -i.e. “palatography” and “palatograph”- in the present investigation. The majority of documents are articles making up 81 percent of the total literature in our corpus. One interpretation for scholars interested in this domain may be that this is a mature area to undertake further studies. While 15.6 percent of the total are conference papers presented in the conferences related to the issue, only 2.2 percent of the whole documents are review papers and the rest (1.1 percent) are letters.

Section 2. Limited search pattern

In order to concentrate on the studies related to Social Sciences and Art and Humanities, including Language and linguistics, the second part of this study investigates those papers resulted from the search pattern limited to these two categories during the years 2011 to 2020. The 10-year period is on the focus of our paper to be able to thoroughly investigate the related literature. The search pattern for this section was: (TITLE-ABS-KEY(palatograph) OR TITLE-ABS-KEY (palatography)) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011)) AND (LIMIT-TO (SUBJAREA, "ARTS") OR LIMIT-TO (SUBJAREA, "SOCI")). In order to analyze the data quantitatively, Excel 2016 was used to visualize the statistical results of the Scopus analyses. The analyses include Publication years, Authors, Keywords, Countries and Affiliations, Subject Areas, Documentation Type, and Citation per year. Afterward, the most cited papers in this part will be compared to the most cited paper presented in the first section of this paper.

Analysis of publication years

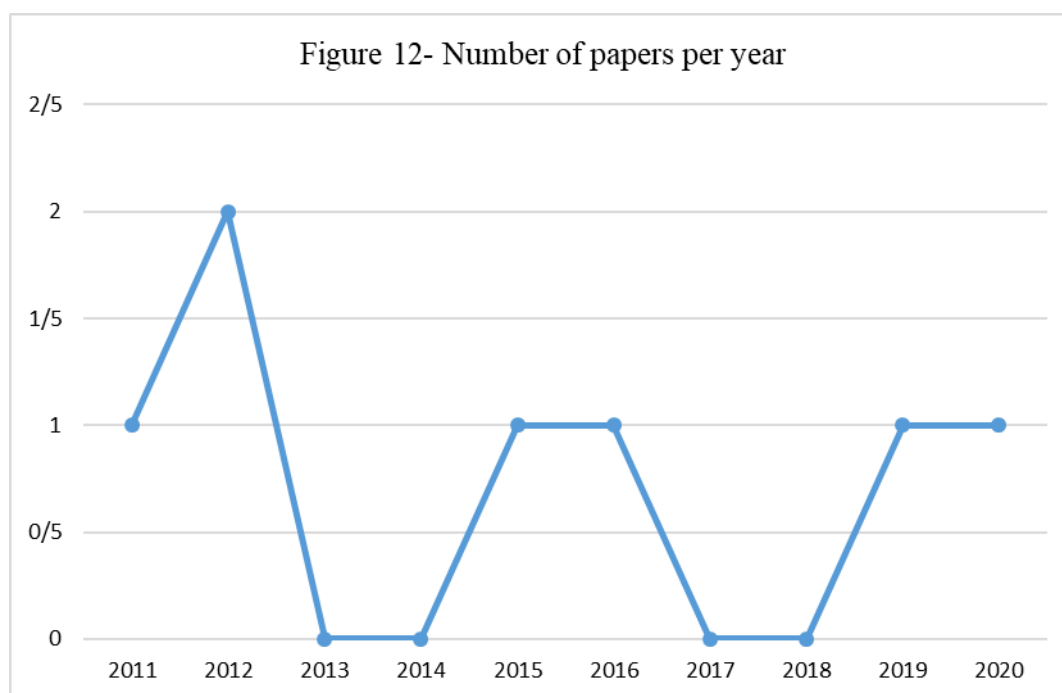


Figure 12 illustrates the dispensation of published articles limited to Art and Humanities and Social Sciences from the year 2011 to the first half of 2020. As can be seen, the year 2012 ranks the highest in terms of the number of publications. No publication was reported for the years 2014 to 2014 and 2017 to 2018. The rest of the years in the interval under our investigation had only one publication. Furthermore, the first half of 2020 has so far recorded one publication and we can expect an increase for the rest of the year. This result for the limited search pattern is very similar to the trend illustrated in Figure 1.

Analysis of documentation type

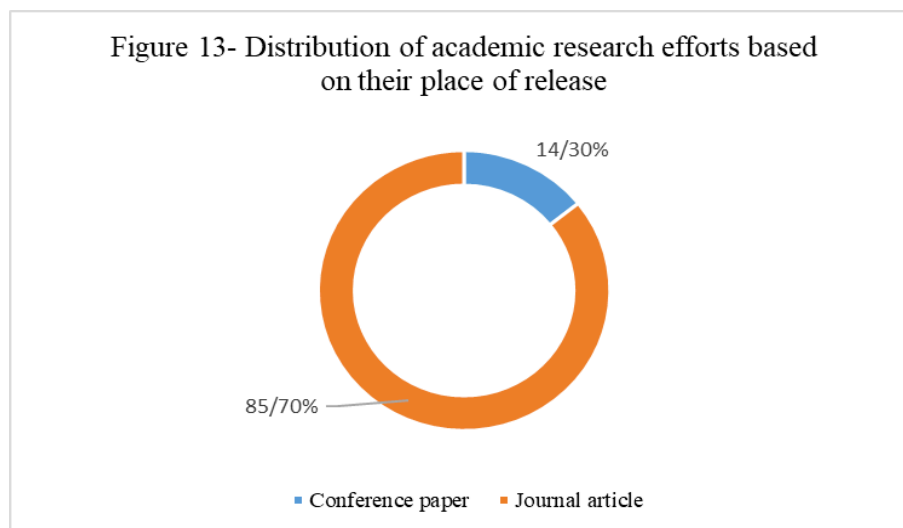


Figure 13 presents the diversity of the publication types. The issue under study has apparently been published either in journals (X percent) or conferences (Y percent). The trend is similar to the publications of the first section, where 85.7 percent of documents were journal papers and 14.3 percent were conference presentations.

Documentation by countries and affiliation

As can be seen in Figure 14, the brighter the color, the more active the country is in producing research output. As a result, in this domain with respect to Art and Humanities and Social Sciences, Australia, the brightest, is the most active country since 2010. New Zealand and Taiwan are the other two active countries in this field, yet less active than Australia.

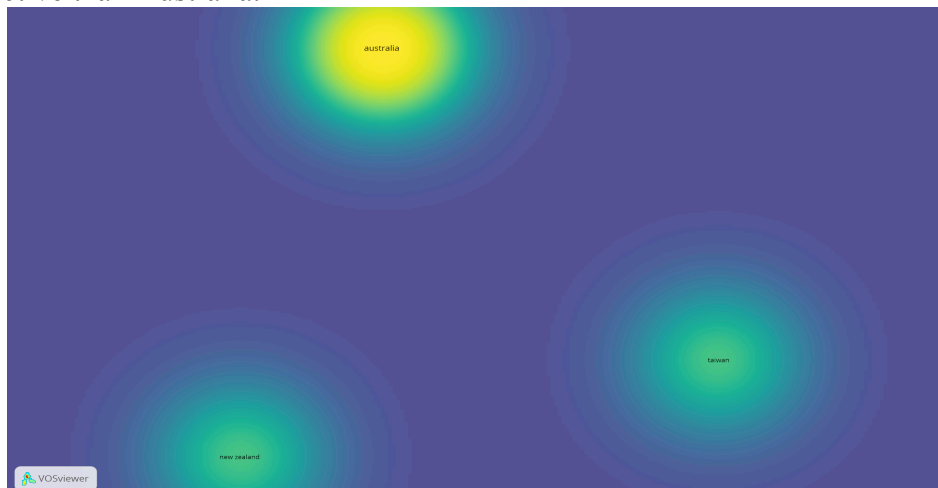


Figure 14. The most active countries in the domain Art, Humanities and Social Sciences

As far as the affiliation of authors is concerned, Australian universities are still the most active ones. La Trobe and Western Sydney University are the most active institutes with two and one publications respectively. The other institutes and universities illustrated in Figure 15 published one document in this domain.

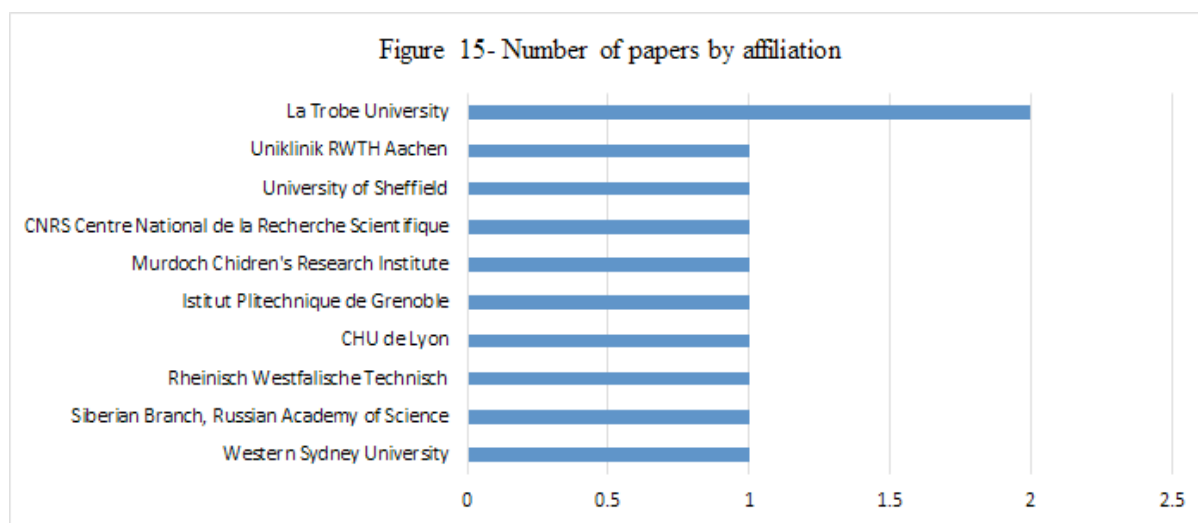


Figure 15. The number of publications by the affiliation of the authors

Analysis of authors

As can be observed in Figure 16, the most active author is Tabian, M. who has taken part in two articles out of the overall number of 7 in the field of “palatograph” and “palatography” restricted to the domains of Art and Humanities and Social Sciences. The other nine authors have participated in only one publication.

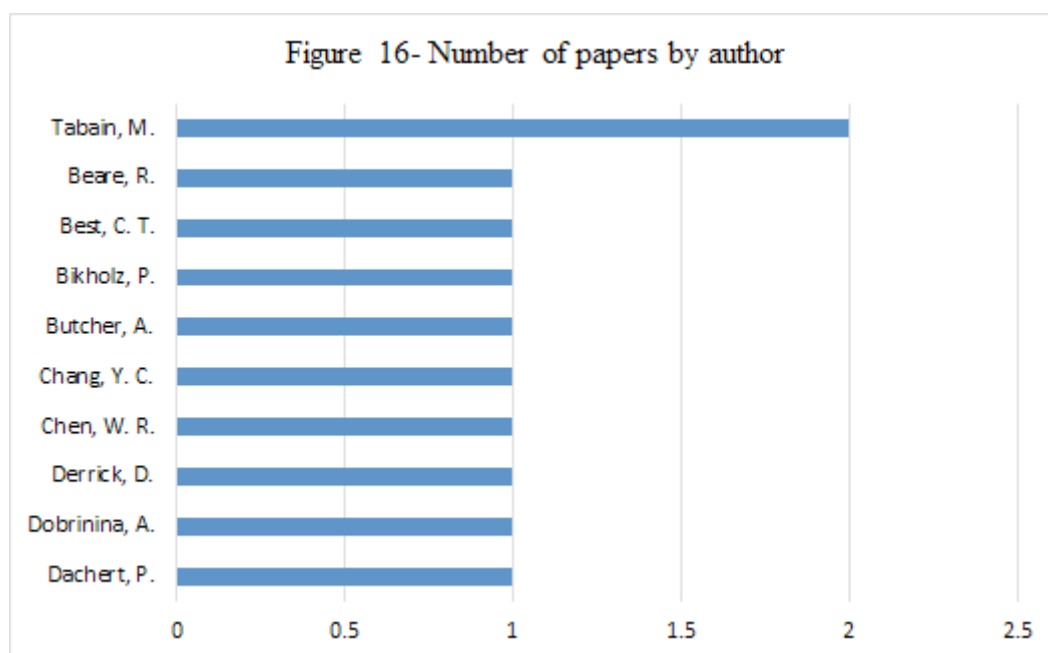


Figure 16. The share of the top ten authors in publications

Keywords Analysis

Keywords found in part 2 overlap to some extent with those of the first section (namely, speech and palate). As far as “palatography” is concerned, the most frequent keyword in our corpus, extracted freely by the accessible online tool at www.voyant-tools.org, was “speech” exactly the same as part one, while the less frequent one among the top 5 keywords was “palate” and “computer”. The average number of words per sentence is 215 in our corpus. Interestingly, “dental” has a pretty high frequency in comparison with the results in part one, revealing the fact that dental studies enjoy more attention in the domains of Art and Humanities and Social Sciences. The usage frequency of each keyword is depicted in Table 2.

Table 2. The top five keywords by their frequency of appearance

Keyword	speech	palate	dental	phonetics	computer
Frequency	10	5	7	6	5

Figure 17 below visualizes the keywords based on their frequency. Apparently, the focus of the studies in these two domains is on men and adults as the participants. Studies on dental issues are still more than those on the palate. The keyword “australian” shows the concentration of the research on the languages in Australia.

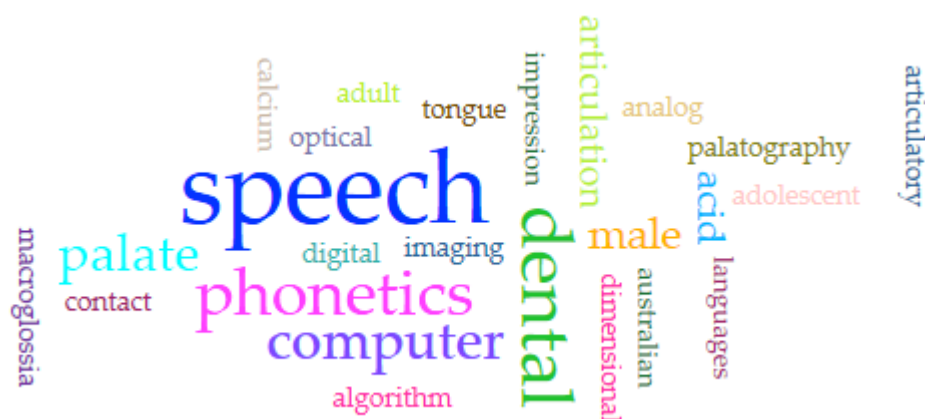


Figure 17. the density and variety of keywords in the domains restricted to Arts and Humanities and Social Sciences

Citation per year

As mentioned earlier, our database consisted of 7 documents in total and Figure 18 below shows the rate of annual citation in the whole database since 2016. As can be seen, the year 2016 stands significantly higher compared to the other years in terms of the number of citations -5 citations during the whole year. The trend follows a sudden fall in 2017 with 1 citation. But there is an upward trend in 2018 reaching two citations and since then, there is a decrease from one in 2019 to zero in the present year.

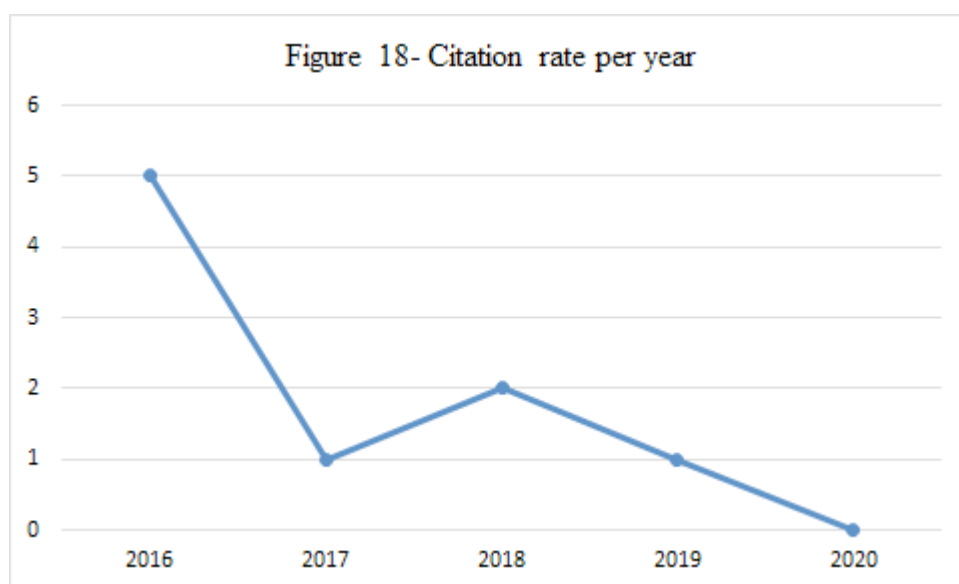


Figure 18. Citation rate per year in the domains restricted to Arts and Humanities and Social Sciences

A comparison between the three most cited papers of section 1 and section 2

In order to compare the top-cited papers in all domains (yielded by our keyword search of “palatography” and “palatograph”) with those of our search limited to domains Arts and Humanities and Social Sciences between 2010 and 2020, we present here Table 3 with detailed information of those publications. In the first part of the table, as it is clearly indicated, the highest-cited paper (205) belongs to the domain of Medicine and Medical Sciences and the other two with lower citations belong to Linguistics-related domains. However, the second part of Table 3 shows that still the top-cited paper (the second in the list with 14 cites) is indirectly related to Arts and Humanities in general and Linguistics in particular. The author of this paper, Tabain, M., is the most cited author in the domains limited to Arts and Humanities and Social Sciences, while he is the 18th in the list of top authors in the first section of our survey.

Table 3. Top-cited papers related to palatography in all domains vs. the restricted two domains

Top-cited papers in all domains					
o	Title	Authors	Year	Journal	Citation rate
	Tongue movement in feeding and speech	Hiiemae, K. M., Palmer, J. B.	2003	Critical review in oral biology and medicine	205
	Articulatory and voicing characteristics of adult dysarthric and verbal dyspraxic	Hardcastle, W. J., Barry, R. A. M., Clark, C. J.	1985	International journal of language and communication disorders	51

	speakers: An instrumental study				
	Compensating for a bite block in /s/ and /t/ production: Palatographic, acoustic, and perceptual data	Flege, J.E., Fletcher, S.G., Homiedan, A.	1988	Journal of acoustical society of America	49
	Top cited paper in the restricted domains				
	Title	Authors	Year	Journal	Citation rate
8	An EPG study of palatal consonants in two Australian languages	Tabain, M., Fletcher, J.	2011	Language and speech	12

Conclusion

In this survey, we attempted to have a quantitative analytical view toward the publications that have focused on “palatography” as a clinical means of investigating the articulation of specific speech sounds as well as speech disorders for 80 years. The bibliometric study on this subject matter will help researchers target appropriate areas and avoid replications. Our investigation comprises of two parts; in the first part, we used “palatography” and “palatograph” as our main keywords to search all documents in the Scopus database. This search yielded 90 documents that included a variety of document types, such as journal papers and conference presentations. The quantitative analysis of the publications, i.e. publication years, authors, keywords, countries and affiliation, citation per year, subject area, documentation type, were investigated. In the second part of the survey, we restricted the same keywords to two domains of Arts and Humanities and Social Sciences from 2010 to 2020. This time our search rendered only 7 papers of both journal articles and conference presentation types. Additionally, the quantitative analyses were done, as well.

Generally speaking, palatography is a very useful means for linguists and phonologists who wish to closely examine the interaction of tongue-palate in the articulation of speech sounds and its differences across languages and language families. It will help scientists to delve into the differences in the human articulatory system. It is also a valuable method for speech therapists to identify the exact problem of their patients with regard to speech production.

Based on our analyses and findings, since the advent of palatography has yet to gain attention, especially in the realm of Linguistics and Phonology. The number of academic investigations in domains other than Arts and Humanities and Social Sciences is lower than what one would expect. This might be interpreted as the absence of willingness of therapists and scientists to share their clinical findings and experiments with their peers.

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