Themes and Knowledge Maps for the Study of the Origins of Human Languages

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Abstract: On the basis of viewpoints of bibliometrics and taking the literature of Web of Science core collection as data sources, this study develops a knowledge map on the trend of publication, distribution of disciplines, distribution of journals, research hotspots and fronts of academic research concerning the topic of the origins of human languages. In this way, a panoramic interpretation is performed on this basis. It is revealed that research concerning the origin of human languages has demonstrated an overall upward trend, with a rapid growth since 2012; the topic of the language origins has attracted the attention of authoritative academic positions, with the issue having gained substantial academic support. The research hotspots of language origin are concentrated in molecular biology, neurology and linguistics, while the relevant fields attach importance to the application of specialized theories and techniques to probe the issue of language origin. The follow-up research concerning the language origin can take breakthroughs in various aspects such as disciplinary accumulation, research perspectives, research methods, and research directions, thereby expanding the space for academic development. The exploration of the origin of language has never been an exclusive issue of linguistics or a certain discipline, only through interdisciplinary cooperation can we better solve the problem of the origin of language. Fundamentally, the origin of language is not just a question about language, the study of this issue will help us to better explore human beings themselves.

Keywords: Language Origin, Knowledge Map, CiteSpace, Web of Science

1. Introduction

The issue of the origin of human language has always remained one of the most controversial and intractable issues in the field of linguistics. A number of issues related to the topic of the language origins have also gained some attention.

Prior to the 17th century, it was universally believed that all creatures in the world including human beings were creations of divine power. As a consequence, language was also conferred by God, as recorded in the 11th chapter of Genesis in the *Bible*. During the 18th century, in the wake of the emergence of the Enlightenment, in conjunction with the development of various disciplines, such as zoology, physiology, comparative anthropology, scholars have placed a high degree of emphasis on the issue of the origins of mankind and have revived the discussion of the issue of the language origin again. The previous sages attempted to elucidate that language originates from the self-creation of human beings from two perspectives, namely empiricism and solipsism.

Nevertheless, given the difficulty of verification, most of them remained in the discursive stage. Out of consideration for the absence of substantial research results in the study of the language origin, the discussion of the language origin hit a low point in the 1860s when the Paris Linguistic Society issued a ban on any discussion concerning the origin and evolution of language [1]. Following the vertical development of science and technology, biologists, archaeologists, and psychologists started to engage in the field of language origin in the mid-20th century. In 1972, the first North American Conference on the Origin and Development of Languages was held in Toronto, where various discussions on the origin and evolution of languages revived.

In the exploration of the issue of language origin, from the initial divine authorization of language to various modern hypotheses of language origin to the current contemporary theoretical system derived on the basis of scientific cognition,

it has already spanned several centuries. The language origin has also been transformed from a single philosophical subject of research to a kind of interdisciplinary subject of research. Meanwhile, the knowledge of people about the language origin has turned out to be more systematic, more comprehensive, and more scientific. For this reason, this thesis attempts to conduct an exploration of the academic literature on the origins of human language by adopting the method of bibliometrics, with a view to answering the following research questions:

Research Question 1: What are the number of publications and trends in language origin research, and what are their characteristics?

Research Question 2: How are the main forces of research on the language origin distributed. In other words, what are the disciplines, journals and institutions that have contributed significantly to the study of the language origin?

Research Question 3: What is the core literature on language origins research, who are the representative authors, and what are the primary research directions or research topics addressed?

Research Question 4: What are the characteristics of language origin research as a whole? What are the future development paths?

2. Research Design

2.1. Research Data

This thesis takes the papers in the Web of Science core collection as the source of literature, *language origin*, *the origin of the language* and *human* as the themes of the search, and the relationship between the search fields as *and*. The time limit of the data is from January 1, 2000 to December 31, 2022, the language is limited to English, and the type of document is limited to "thesis", which resulted in a total of 1,459 papers by precise search. The obtained data were imported into CiteSpace software. The time setting is from 2000 to 2022, and the time slice is 2, which denotes a 2-year unit of analysis. Threshold was selected as Top 50, while the

algorithm was selected as Pathfinder to perform optimization on the plots.

2.2. Research Instruments

This thesis employs the CiteSpace 6.1 visual analysis software developed by Chaomei Chen, a professor of computer science and information science in the College of Information Technology and Science at Drexel University [2]. It is a multi-level, time-sharing and dynamic open-source bibliometric software on the basis of Java language, which employs three steps of information extraction, knowledge fusion and knowledge processing to accomplish the visual analysis of knowledge.

3. Research Results and Analysis

3.1. The Number and Trends of Publications

The changes in the number of publications in the literature is a direct reflection of the progress of the research field. As a consequence, the analysis of the publication trends is one of the most significant metrics to measure the amount of scientific knowledge. This thesis presents a map of the publication trend of research related to the language origin, which not only provides an insight into the current status of publications on the language origin issue in the past two decades, but also serves as a reference for predicting the trend of exploring the related issues in the future. In this thesis, the number of articles published on the Web of Science database concerning the research on the origin of human languages and the cumulative number of articles were firstly collated, with the results presented in Figure 1. After calculation, it was revealed that the average annual publication volume of literature related to the study of the origin of human languages on the Web of Science database was 63 articles over the past two decades. From an overall point of view, the number of literature concerning research on the language origin exhibits a zigzag upward trend, with considerable fluctuations between the years.
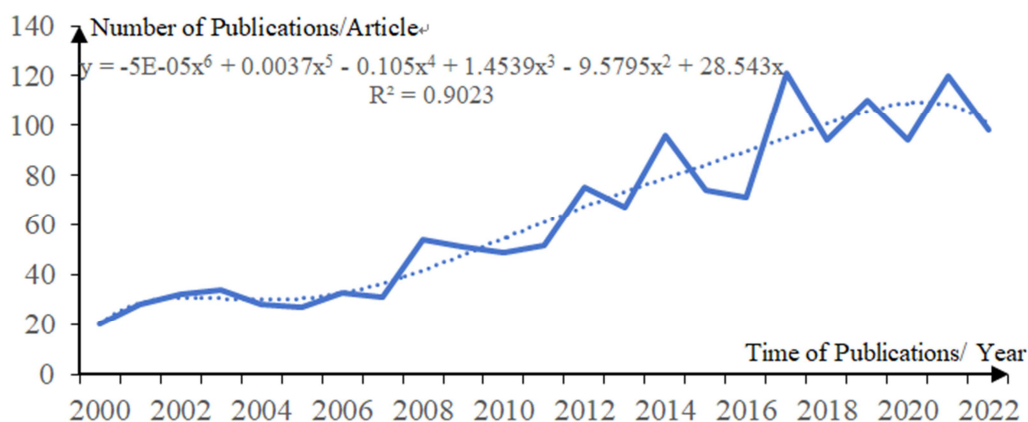

The chart title reads: Number of Publications/Article

$$y = -5E-05x^6 + 0.0037x^5 - 0.105x^4 + 1.4539x^3 - 9.5795x^2 + 28.543x$$
$$R^2 = 0.9023$$

Axis label: Time of Publications/ Year

Figure 1. Publication Trends.

More specifically, the research process regarding the origin of human languages can be categorized into two

phases. The first phase is the slow-growth phase (2000-2011). During this phase, the research regarding the origin of human

languages followed the research of evolutionary linguistics at the end of the last century. By integrating the results of the existing researches and attempting to explore the issue of the language origin by adopting the computational modeling and other emerging means, the number of literature produced each year was comparatively small, with an average of 36 articles per year. The second phase is the rapid growth phase (2012-2022). The number of interdisciplinary researchers concerned with the origin of human languages gradually increased, while the number of annual outputs also expanded, with an average of 93 publications per year, which is two times higher than that of the previous phase. Following the continuous development of cognitive science, as well as the substantial increase of results concerning the origin and evolution of human beings in the fields of heredity, genetics, and archaeology, the exploration of the issue of the origin of human language in the academic world has continuously been deepened and expanded. In accordance with the prediction of the polynomial fit degree R^2 of the cumulative number of publications curve, it is predicted that the cumulative number of publications on the exploration of the origin of human language will amount to about 1,600 articles in 2023.

3.2. Analysis of the Distribution of Disciplines

A map of discipline co-occurrence can be utilized to gain a macroscopic understanding of the related disciplines in a research field and the relationship between the related disciplines. In this thesis, the Category was selected as the analyzing node through CiteSpace software to draw the map of discipline co-occurrence, which obtained a total of 93 nodes, 125 connecting lines, and a density of 0.0292, as illustrated in Figure 2. As can be recognized from Figure 2, the nodes and fonts of Psychology, Neurosciences & Neurology, Science & Technology, Neurosciences, Multidisciplinary Sciences, Biology, Genetics & Heredity, Linguistics are relatively large. This indicates that in the study of the origin of human language, the literature is comparatively extensive in the disciplines of psychology, neurology, biology, genetics and linguistics, which is inextricably linked to the nature of the issue of language origin itself. Moreover, there are multiple connecting lines exist among various disciplines, which indicates that the existing research is not a longitudinal study of a single discipline, but rather a comprehensive study of multidisciplinary intersection and integration. Disciplines ranked with a frequency of 100 and above are psychology (182 times), neuroscience and neurology (117 times), science and technology (106 times), and multidisciplinary science (100 times). This reveals that research concerning the language origin is primarily centered in the fields of neurology and psychology. Furthermore, as indicated by the centrality index, most of the literature on language origin involves content related to the disciplines of psychology (0.91), neurology (0.88), and evolutionary biology (0.99). In addition, this is also a direct indication that the research on the issue of language origin is principally grounded in neurology, psychology and evolutionary biology.
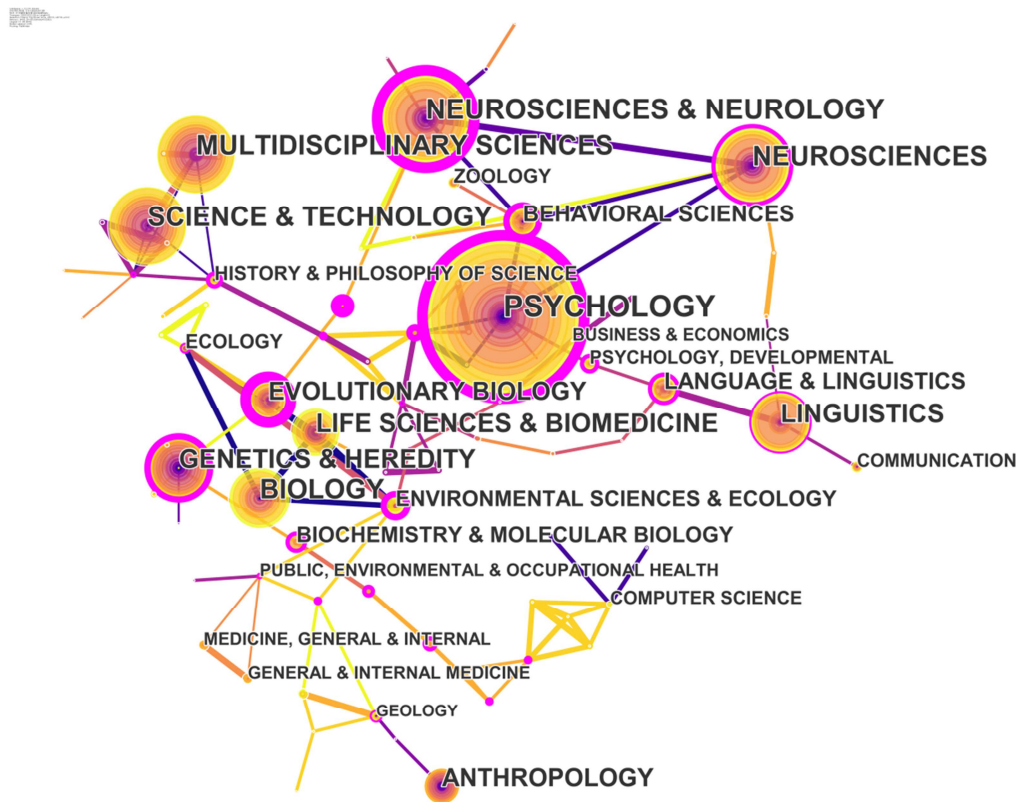

Figure 2. Discipline Co-occurrence.

3.3. Analysis of Journal Distribution

In this thesis, the distribution of the top 10 journals within the field of research on the language origin was tallied, as illustrated in Figure 3. Within the scope of research on the language origin, journals with more than 20 articles include *Philosophical Transactions of The Royal Society B-Biological Sciences* with 41, *Plos One* with 38, *Frontiers in Psychology* with 37, *Proceedings of The National Academy of Sciences of The United States of America* with 35, *Scientific Reports* with 23, and *Proceedings of the Royal Society B-Biological Sciences* with 20. As can be judged from the percentage of publications, the overall percentage of publications in the top 10 journals is 17.5%, which does not exceed 50%. This

demonstrates that the distribution of research on the origin of human languages is comparatively decentralized, with the results not concentrated in a small number of journals. With regard to the impact factors, the average impact factor of the top 10 journals in terms of the number of publications reaches 7.795, and the impact factors of some individual journals, such as *Proceedings of The National Academy of Sciences of The United States of America*, reaches 13.451, and *Trends in Cognitive Sciences* reaches 25.441. This suggests that authoritative journals also attach great importance to the study of the origin of human language. From this perspective, the study of language origin enjoys a promising research prospect.
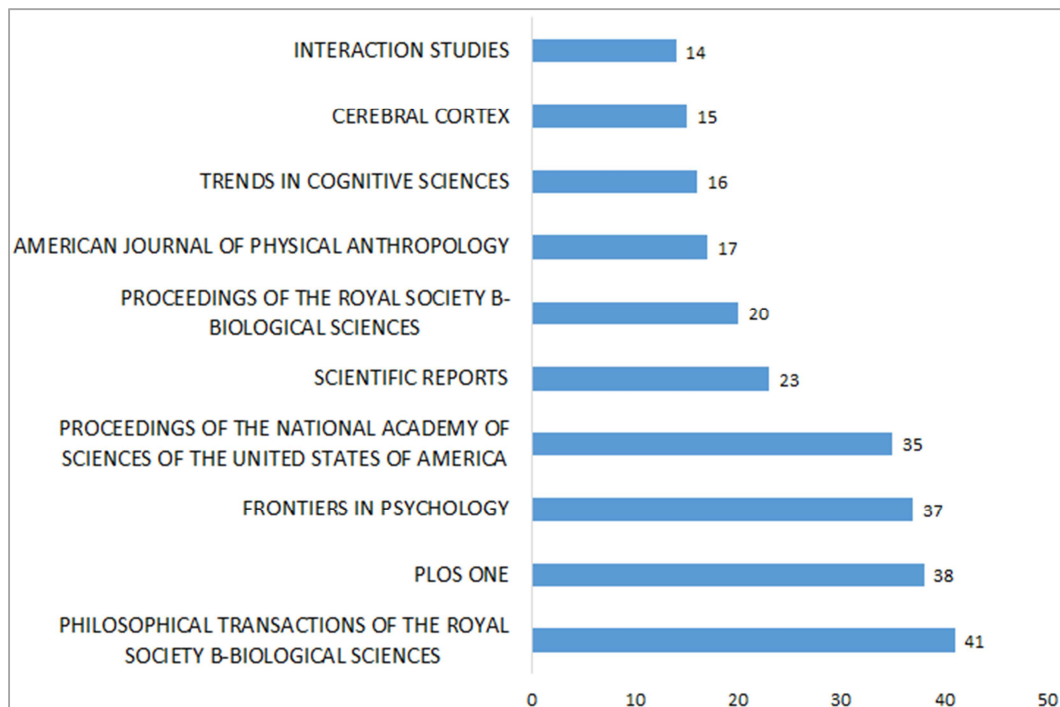

Figure 3. Journal Distribution.

3.4. Analysis of the Cited Document

The statistics of the Co-citation frequency of the research document can uncover the knowledge base constructs of the research area. In this thesis, Reference was selected as the analyzing node to map the document co-citation, which yielded a total of 337 nodes, 606 connecting lines, and a density of 0.0107. As illustrated in Figure 4, Tomasello M (2008), Fitch WT (2010), and Hauser MD (2002) have comparatively large nodes and fonts, which are highly cited literature on the issue of the origin of human language. *A Focus on Infrastructure*, published in 2008, is the most cited paper in the field of the origins of human language with a citation frequency of 34, which is derived from the *Conference on the Origins of Human Communication*. Another work with the same 34 citations is entitled *The Evolution of Language*. This work contends that the

understanding of advances in language evolution necessitates a highly interdisciplinary integration of extensive amounts of data stemming from linguistics, anthropology, genetics, neuroscience, and evolutionary biology. It suggests that scientific research should acknowledge that prior studies have overlooked the neural and genetic basis of language in the human brain. Meanwhile, and proposes that language evolution should be probed with respect to mechanisms, individual occurrence, phylogeny, and function. The paper with a citation frequency of 30 is entitled *The faculty of language: what is it, who has it, and how did it evolve?*. This study contends that the study of language origin entails the exploration of human linguistic abilities. In the same vein, it indicates that the understanding of linguistic abilities involves a great deal of interdisciplinary collaboration. On the basis of the distinction between Faculty of Language in Broad Sense (FLB) and Faculty of Language in Narrow

Sense (FLN), it is tentatively hypothesized through experimentation that FLN is exclusive to human beings. As can be recognized from the information of highly cited literature, the highly cited literature basically originates from authoritative journals or top conferences. For instance, *The faculty of language: what is it, who has it, and how did it evolve?* was published from the journal *Science*, while *A*

Focus on Infrastructure was published from the conference *Origins of Human Communication*. Furthermore, the average number of co-authors of highly cited literature is 2.3, which illustrates that the vast majority of highly cited literature is the result of collective wisdom. Moreover, this also reveals that future research on language origins still necessitates multidisciplinary collaborations.
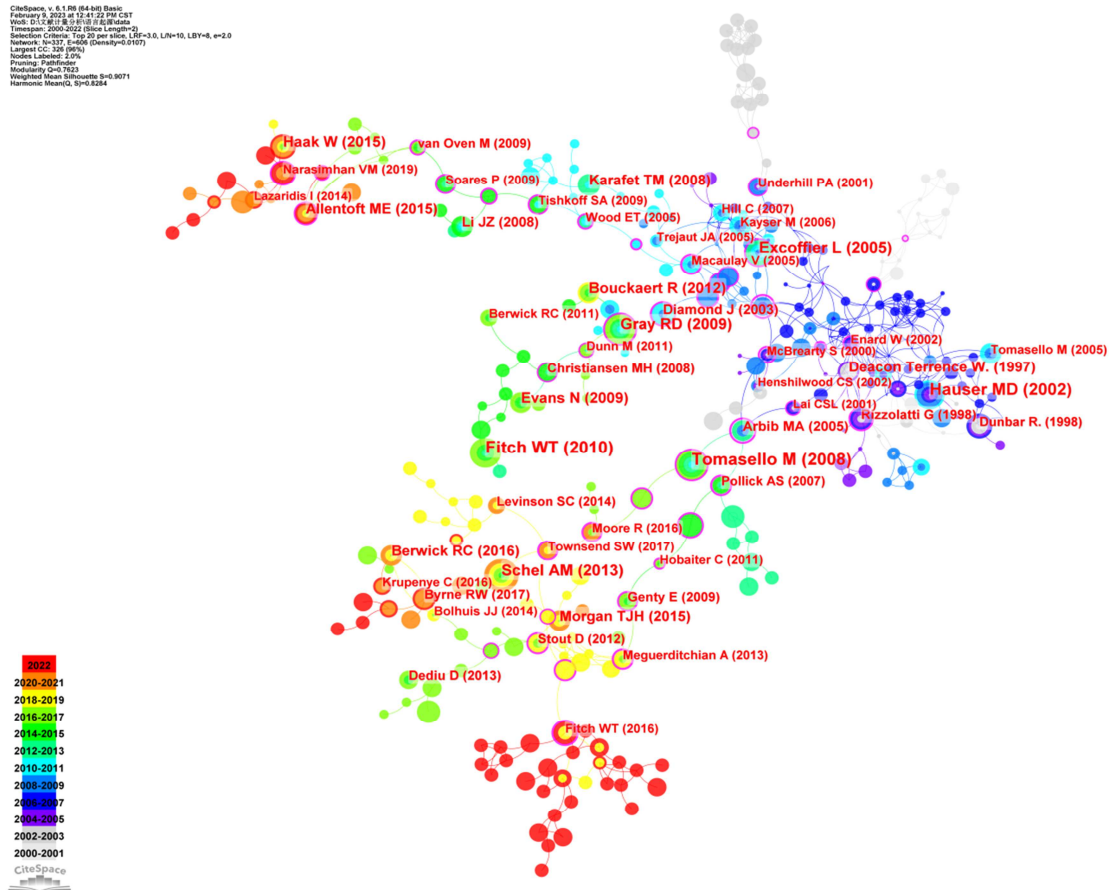

Figure 4. *Document Co-citation.*

Table 1. *Information on the Cited Document.*

No.	Citation Frequency	Centrality	Year	Information on the Cited Document
1	34	0.34	2008	Tomasello M, 2008, JEAN NICOD LECT, V0, P1
2	34	0.01	2010	Fitch WT, 2010, EVOLUTION OF LANGUAGE, V0, P137
3	30	0.05	2002	Hauser MD, 2002, SCIENCE, V298, P1569, DOI 10.1126/science.298.5598.1569
4	26	0.09	2013	Schel AM, 2013, PLOS ONE, V8, P0, DOI 10.1371/journal.pone.0076674
5	25	0.22	2005	Excoffier L, 2005, EVOL BIOINFORM, V1, P47, DOI 10.1177/117693430500100003
6	24	0.22	2009	Gray RD, 2009, SCIENCE, V323, P479, DOI 10.1126/science.1166858
7	22	0.01	2015	Haak W, 2015, NATURE, V522, P207, DOI 10.1038/nature14317
8	22	0.08	2009	Evans N, 2009, BEHAV BRAIN SCI, V32, P429, DOI 10.1017/S0140525X0999094X
9	21	0.01	2012	Bouckaert R, 2012, SCIENCE, V337, P957, DOI 10.1126/science.1219669
10	20	0.18	2015	Allentoft ME, 2015, NATURE, V522, P167, DOI 10.1038/nature14507

3.5. Research Hotspots

CiteSpace can generate cluster identifiers by automatically extracting keywords or noun phrases from the cited literature, which can be utilized to study the focus of the clusters, with each cluster being recognized as a comparatively well-connected and independent research area [3]. In this

thesis, the keywords were clustered and analyzed by CiteSpace, as illustrated in Figure 5. A total of 10 clusters were obtained. In particular, Modularity (Q-value) is 0.7623, while Silhouette (S-value) is 0.9071. In general, Q-value > 0.3 implies that the clustering structure is significant, while S-value > 0.5 implies that the clustering is reasonable. The data in this thesis fulfills the criteria of the study. As a consequence, the clustering results are of reference value for

subsequent analyses.

In the meantime, this study counted the information of 10 clusters, as illustrated in Table 2. The 11 research themes generated are, #0 y chromosome; #1 mitochondrial dna; #2 asymmetry; #3 cultural evolution; 4 brocas area; #5 hemispheric specialization; #6 music; #7 hemispheric specialisation; #8 monte carlo simulations; and #9 pretend. Accordingly, it can be concluded that the core areas of research on the language origin involve: molecular biology (#0&#1), neurology (#4&#5&#7&#8&#9), and linguistics (#3), with the following major findings.

Table 2. *Cluster Information.*

| No.	Number of Nodes	Homogeneity	Average Year	Keyword Content
0	23	0.919	2003	y chromosome (15.11, 0.001); africa (10.84, 0.001); geography (6.45, 0.05); caucasus (6.45, 0.05); y-chromosome (6.29, 0.05)
1	18	0.777	2007	mitochondrial dna (15.85, 1.0E-4); ancient dna (10.67, 0.005); archaeology (9.34, 0.005); mtdna (9.32, 0.005); language evolution (8.21, 0.005)
2	18	0.933	2004	asymmetry (7.43, 0.01); handedness (6.49, 0.05); functional variability (6.39, 0.05); genetic variation (6.39, 0.05); anatomical variability (6.39, 0.05)
3	16	0.885	2006	cultural evolution (22.03, 1.0E-4); origin of language (8.3, 0.005); cooperation (7.64, 0.01); rhythm entrainment (7.64, 0.01); animal culture (7.64, 0.01)
4	16	0.971	2009	brocas area (8.4, 0.005); tool use (8.37, 0.005); mitochondrial dna (4.98, 0.05); laryngeal cortex (4.19, 0.05); cultural diversity (4.19, 0.05)
5	14	0.963	2007	hemispheric specialization (15.63, 1.0E-4); nonhuman primates (6.55, 0.05); semantics (5.77, 0.05); gestural communication (5.77, 0.05); theory of mind (5.34, 0.05)
6	12	0.938	2002	music (7.96, 0.005); mitochondrial dna (7.13, 0.01); human language (7.07, 0.01); sex differences (7.07, 0.01); emotions (7.07, 0.01)
7	12	0.94	2007	hemispheric specialisation (8.32, 0.005); communicative gestures (7.2, 0.01); functional transcranial doppler ultrasonography (ftcd) (6.85, 0.01); parallel processing hypothesis (6.85, 0.01); landmark task (6.85, 0.01)
8	12	0.841	2002	monte carlo simulations (7.71, 0.01); speech perception (7.71, 0.01); phonological tendencies (7.71, 0.01); speech production (7.71, 0.01); mon-khmer (7.71, 0.01)
9	12	0.923	2003	pretend (5.23, 0.05); neural modeling (5.23, 0.05); spoken language (5.23, 0.05); coping (5.23, 0.05); speech synthesis (5.23, 0.05)
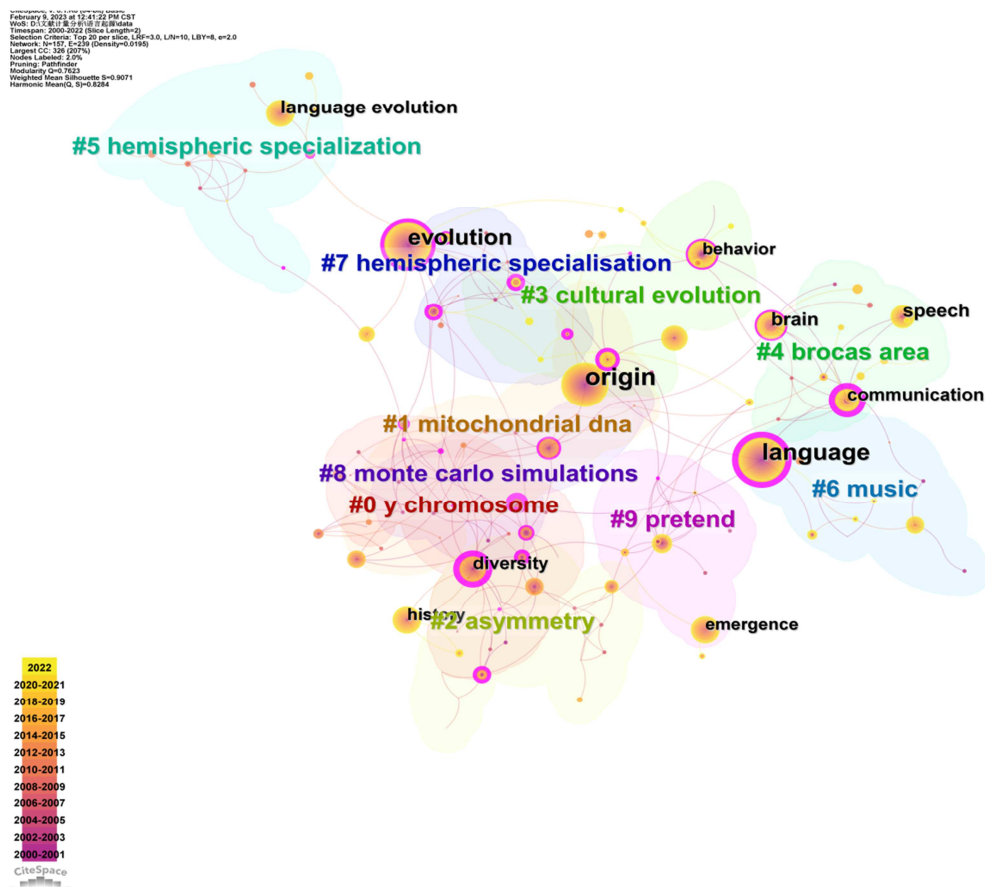
Figure 5. *Cluster Analysis.*

3.5.1. Molecular Biology

Molecular biology primarily probes the language origin through genomic data from modern and ancient populations [4, 5]. In 2001, by examining families and individuals with language disorders, researchers identified mutations in the FOXP2 gene that are strongly associated with the development of language ability. The defects in the FOXP2 gene can exert an influence on the development of language-related regions of the brain, thereby affecting facial mobility, as well as expressive and cognitive abilities in language [6]. From this point on, the FOXP2 gene has emerged as a key candidate gene for language evolution, while becoming a major focus of research in the last two decades. Following advances in whole-genome sequencing technology and extraction methods, and through studies of sequenced DNA from extinct archaic humans in 2007, Krause et al. further exhibited that amino acid substitutions in the coding sequence of the FOXP2 protein were actually found in our shared ancestor with Neanderthals. As a consequence, it is unlikely that these changes could have appeared as recently as 200,000 years ago. This study has validated the fact that the FOXP2 gene has not been under intense selection during the evolution of modern humans. Nevertheless, the study by Atkinson et al. further identified that the expression of the FOXP2 gene is remarkably low in human brain tissue. Consequently, it may have exerted a special role throughout history, which reconfirms that FOXP2 is truly of evolutionary significance for the development of language. Meanwhile, the FOXP2 gene may have served to regulate the expression of key phonological genes [7]. Building on this foundation, scholars have embarked on a search for more candidate genes for language evolution [8]. For instance, Fisher and his team identified additional genes that may be correlated with speech and language disorders by the use of a variety of novel screening methods, which uncovered a number of genes, including CHD3, SETD1A, and WDR5. Nevertheless, this is merely a further development of the genetic theory of language evolution. More importantly, it is essential to ascertain whether or not they have been subject to selection during the course of evolution. As Enard indicated, this is much more challenging to determine. The biggest concern lies in the fact that there is not a well suited modeling system or assay to test these genes. In this light, the study of language origin from a genomic standpoint is subject to further development [9].

3.5.2. Neurology

In the 1970s, it was universally recognized in the academic community that language functions are processed asymmetrically in the human brain, with the left hemisphere being dominant. In particular, the region of planum temporale (PT) was identified as one of the functional centers of the language network, since it partially overlaps with Wernicke's area and encompasses the auditory correlate cortex. Studies have demonstrated that the planum temporale in the left hemisphere is of special significance in a variety of auditory and language-related processes. Following the advent of magnetic resonance imaging (MRI) in the 1990s, by comparing the structural differences between the structures of human language-related brain regions and their anatomical counterparts in human relatives, such as rhesus monkeys and chimpanzees through brain imaging methods, such as the classical language area, the volume of the Broca's area, the depth of the sulcus of the transversal temporal gyrus, and the symmetry of volumes of the left and right hemispheres, researchers have investigated the origin of language functions [10]. In accordance with the research findings, brain lateralization in language regions is not the origin of human language, with East African baboons and chimpanzees also exhibiting significant asymmetries. This indicates that asymmetries in brain morphological structures alone are inadequate for illuminating the functionality of the human brain, especially the specificity and evolutionary origin of language [11]. In 2008, James Rilling, a researcher at the Yerkes National Primate Research Center at Emory University in the United States, identified a dorsal arcuate bundle of nerve fiber tracts in the brain by means of diffusion tensor imaging (DTI). It is rarely present in the brains of rhesus monkeys, which is also comparatively small in the brain of chimpanzees, whereas it is remarkably large in the brain of human beings. Thereafter, almost all comparative neuroscientists have concerned about the importance of this arcuate bundle for the study of the origin of human language. Nevertheless, given the difficulty of determining the homology of functional brain regions among various species as a means of performing cross-species evolutionary studies of brain structure and function, this research suffered from a lack of reliable technical means and fell into a low ebb for a short period of time [12]. In 2021, Luqi Cheng and other scholars recommended the adoption of studying the evolutionary patterns of various species by means of drawing cross-species brain network group maps, so as to produce subregion-scale brain connectivity maps of the subparietal lobules of humans, chimpanzees, and rhesus monkeys. It was revealed that the asymmetry of brain anatomical connectivity patterns exhibited a gradient-like evolutionary pattern among the three primate species. In other words, there is no asymmetry of brain connectivity in rhesus monkeys that are more distantly related to humans. Nevertheless, asymmetry in brain connectivity began to appear in chimpanzees, which are more closely related to humans, with this asymmetry being more extensively demonstrated in the human brain. This finding substantiates the asymmetry between primate brain structures and their anatomical connectivity patterns, which is the biological basis for driving the evolution of language as well as the capability of sophisticated tool use [13]. Nevertheless, the question of whether it is associated with the evolutionary origin of human language functions remains to be answered by further dissecting the evolutionary relationship of brain structure and function among various species [14].

3.5.3. Linguistics

In 2011, Atkinson of the University of Auckland in New Zealand published an article on the language origin in the journal *Science*. By selecting phonemic diversity as a clue, and on the basis of the hypothesis of the serial founder effect, he integrated the main quantifiable factors affecting phonemic diversity into a statistical model, and examined them at the level of independent and interrelated language families, language branches and individual languages [15]. Eventually, it was concluded that human language had its origins in Africa. In 2011, a special issue of the Journal of the Linguistic Typology Society devoted a focused discussion to this article. In 2012, a number of review articles were published in the form of special issues of the journal *Science*, which stirred up a great deal of discussion. Can the founder effect and the population bottleneck effect in biology be trivially applied to the field of linguistics? Is the choice of phonemes as the main subject of study scientifically sound? Is there a correlation between the number of phonemes and the size of the population and the distance to Africa? Is it possible to reconstruct primitive phonemic conditions and population sizes with extant data? A number of debates have demonstrated that the research of Atkinson is problematic. Nevertheless, his research perspective is innovative, with biological theories and methods employed to study the language origin, as well as an attempt to identify linguistically quantifiable factors that can be applied to data modeling and testing. This interdisciplinary perspective and research methodology is of significant revelation to the study of language origin [16].

4. Conclusion

The language origin is an archaic and new question. In this thesis, the literature related to the study of the origin of human languages in the Web of Science database from 2000 to 2022 was statistically analyzed with CiteSpace 6.1 visual analysis software. Judging from the publication trends, the number of research papers related to the origin of human language presents an overall growth trend, which has entered a fast-growing phase since 2012. Regarding the distribution of disciplines, the literature is comparatively abundant in the disciplines of neurology, biology, genetics, and linguistics, with existing researches featuring comprehensive studies on the intersection and integration of multiple disciplines. From the viewpoint of journal distribution and cited document, despite the dispersed distribution of research on the origin of human language, the impact factor scores are high, with the research on the origin of human language receiving extensive attention from the academic community. From the point of view of research hotspots, the core areas of research on the origin of human language concentrate on molecular biology, neurology and linguistics, while the origin of human language requires further research on the basis of existing studies.

In conclusion, there is an arduous task and the road is long to explore the origin of human language. The current research results regarding the origin of human language are generally presented in molecular biology, neurology,

archaeology, and other aspects. In this regard, linguists are encouraged to break away from the barriers of their disciplines, to absorb the nutrients from outside the field, to learn new research methods and means, as well as to accept new theoretical concepts. In the wake of the continuous development of cognitive science, interdisciplinary cooperation will remain the development trend of research on language origin in future studies. The issue of language origin will also inevitably be explained scientifically with the joint efforts of experts and scholars from various fields. Furthermore, by exploring this issue, we are likely to obtain more mysteries about human beings.

Acknowledgments

Conflicts of Interest

The author declare no conflicts of interest.

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