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Global Perspectives on Morphological Awareness: A Bibliometric Analysis and Visualization from 1991-2021

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Abstract

Morphological awareness, awareness of the morphological structure of words and ability to manipulate that structure, has received global concern as a research focus in recent years. 691 documents from 1991 to 2021 were selected from the database Scopus and analyzed by CiteSpace 5.8.R3. The results are as follows. 1) The number of publications rose linearly from 1991 to 2021. 2) Reference co-citation analysis reveals that morphological awareness research is centralized and references forming the basis of the field are presented. 3) Keyword co-occurrence analysis and cluster view are combined to figure out the research hotspots. 4) Keyword burst map concludes that clinical studies and adult research are emerging trends in the domain. In general, this paper makes a visual, quantitative and extensive review of the research on MA in the last three decades, and proposes future research directions.

Keywords

Morphological Awareness, CiteSpace, Bibliometric Review

1. Introduction

Morphological awareness (MA) is defined as the ability to reflect upon and manipulate smallest meaningful units in words (Carlisle, 2000). MA is not only a static morpheme knowledge, but also the ability to analyze and predict lexical structure. A great deal of research has focused on uncovering MA predictive of children's reading comprehension. MA can also promote lexical skills, such as word decoding and spelling. MA has become a persistent research hotspot both in the study of first and second language acquisition, which is investigated in linguistics, psychology and so on. It reaches consensus that MA is pivotal to

learning a language and is beneficial to every language learner.

In the past three decades, the number of publications has increased exponentially over time, but the studies focusing on scattered topics lack clear structure. In recent years, bibliometrics has been applied to quantitatively evaluate research trends and scientific knowledge, which is more objective and evidence based. In this review, CiteSpace is employed to specify the general background, research hotspots and research trends of MA research, aiming to provide a clear review for researchers to dig into the field.

2. Literature Review

The contribution of MA to spelling and reading comprehension has been proven in empirical studies. It turned out that dyslexia patients have an extreme lack of MA (Shu et al., 2006; Tong et al., 2011; Vaknin-Nusbaum et al., 2016) and children with better MA tends to perform better in spelling and reading (Yeung et al., 2013; Taha & Saiegh-Haddad, 2016). Morphological instruction provided in language learning can enhance reading development (Zhang, 2016) and have a moderate to high impact on spelling performance (Trussell, 2020). Diachronic research reveals that MA is not only a key factor in literacy skills, but also the most significant predicator of future language acquisition.

With respect to how MA functions, MA makes contribution to reading comprehension directly and indirectly (Kieffer & Lesaux, 2012; Levesque et al., 2017). Levesque et al. (2017) specified two indirect paths between MA and reading comprehension via morphological decoding, then word reading or morphological analysis. First, MA may contribute to reading comprehension via its effects on word reading. Morphemes indicate word structures so as to manifest the word meanings and recognition. Second, MA may enlarge children's vocabulary, in turn enhancing reading comprehension because MA enables children to identify the unfamiliar part in words by decomposing them into smaller parts. However, the evidence to date is far from conclusive. There may exist other mediators and concrete pathways may vary with languages.

3. Methods

3.1. Data Source and Collection

Scopus is chosen as the database of present study. The data for the current study were all collected from the database Scopus. MA research rises in the 1990s. The research early than 1990s is hardly to find. The time span was set from 1991 to 2021. 723 articles were selected based on a topic search of the term "morphological awareness" or "morpheme awareness" in titles, abstracts, or keywords. All the 723 documents were from 51 countries or territories, 160 institutions, and 154 journals. Book chapters, conference papers, editorials, errata, a book and a note were excluded from the analysis. Finally, a total of 691 articles were selected. From Figure 1, we can see the research of the past three decades can be divided into three stages, the preliminary stage (1991-2005), development stage (2006-2016) and exploration stage (2017-2021).
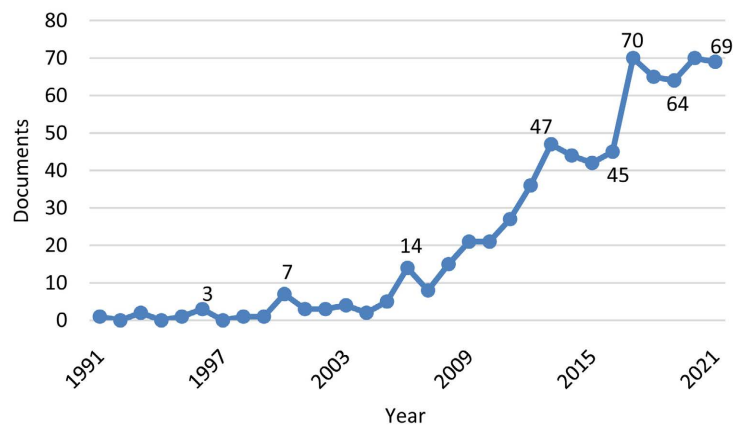
Figure 1. Publications per year of the source paper.

3.2. Research Tool

Citespace 5.8.R3 is used as the key analytical tool for the study. Scopus can systematically dig into the interaction of knowledge domain by generating visualization of structural and temporal patterns and scientific trends.

To achieve a systematic and comprehensive review, four main bibliometric methods adopted in the present study are: 1) Co-citation analysis models an intellectual structure; 2) Co-occurrence analysis is applied to count the frequency of co-occurrence in the study and measure the similarity, as a means of ascertaining the degree of interdisciplinarity macroscopically; 3) Cluster analysis refers to the process of grouping the objects into multiple classes composed of similar topics; 4) Burst detection provides insight into the abrupt changes in certain period of time.

4. Results and Discussion

In this section, the knowledge base, research emphasis and research trends of MA research is presented and visualized by CiteSpace. The first subsection outlines the intellectual base by the network of co-cited references. The second subsection illustrates the research major achievements through co-occurrence analysis, and the third subsection further explores emerging trends and research frontier through burst detection of keyword co-occurrence analysis.

4.1. Intellectual Base

Figure 2 shows that major foundation documents tend to be located towards the center of the network because they are often cited together in the same source documents, thereby increasing connectivity and centrality. It can be referred that the documents are similar and interconnected in research themes. The light color of a link indicates the two nodes linked together are not closely connected, which means there exists vulnerability of research that can be strengthened by researchers. The small size of peripheral nodes and clusters shows that research receives little concern with low academic influence.
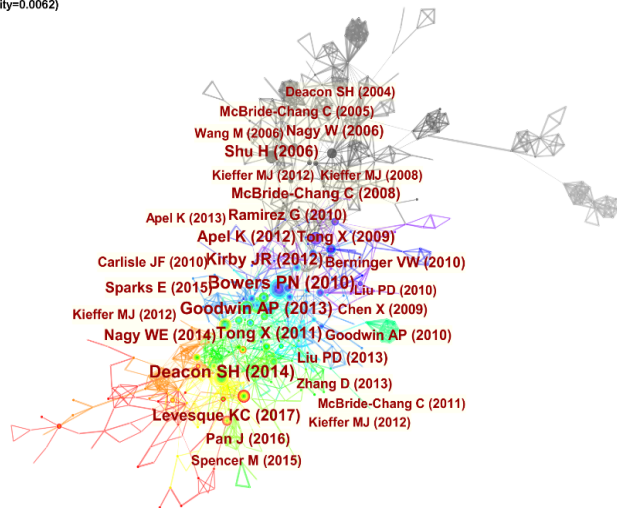
Figure 2. Co-citation network of morphological awareness research.

Table 1 lists top 10 references with highest frequency. Citation frequency refers to the total number of citations of all papers published in the journal since the inception in the statistical year. This is a very objective and practical evaluation index that shows the degree to which the document is used and valued, as well as its role and status in scientific research. The references in **Table 1** present fundamental principles of MA research, which is key to picture a basic outline of the field.

Table 2 lists top 10 documents published from 1991 to 2021 with citation bursts. Citation burst is an indicator of a most active area of research, which provides evidence that a particular publication is associated with a surge of citations (Chen et al., 2014). In other words, the publication evidently has attracted an extraordinary degree of attention from its scientific community. The first three articles that were detected are Shu et al. (2006), Nagy et al. (2006) and McBride-Chang et al. (2005) from 2008, which indicates that MA started to receive much attention and cause heated discussion. Three articles confirmed great significance of MA empirically in various levels of reading ability, various grades and various languages respectively. It is MA that can distinguish dyslexic readers from age-matched normal readers and MA was the strongest consistent predictor of a variety of literacy-related skills across both groups (Shu et al., 2006); MA made a significant unique contribution to reading comprehension, reading vocabulary, and spelling for all 3 groups of different grades (Nagy et al., 2006); MA may be more important for reading in Chinese and Korean than for reading in English (McBride et al., 2005).

From 2010 to 2018, one document registered sharp increases every year. Mcbride-Chang et al. (2008) further studied the compound awareness of Cantonese, Mandarin and Korean speakers, which was characterized by multilingualism. Tong et al. (2009) and Tong et al. (2011) respectively demonstrated that

Table 1. The top 10 frequency of cited documents.

Documents	Frequency
Bowers et al. (2010)	33
Deacon et al. (2014)	30
Goodwin et al. (2013)	29
Shu et al. (2006)	23
Levesque et al. (2017)	22
Tong et al. (2011)	21
Kirby et al. (2012)	20
Tong et al. (2009)	19
Apel et al. (2012)	19
Nagy et al. (2006)	17

Table 2. The top 10 references with citation burst.

Documents	Strength	Begin	End
Shu et al. (2006)	13.17	2008	2011
Nagy et al. (2006)	9.69	2008	2011
McBride-Chang et al. (2005)	8.67	2008	2010
McBride-Chang et al. (2008)	9	2010	2013
Tong et al. (2009)	8.84	2011	2014
Bowers et al. (2010)	14.46	2012	2015
Tong et al. (2011)	11.02	2013	2016
Kirby et al. (2012)	8.53	2014	2017
Deacon et al. (2014)	10.97	2016	2019
Levesque et al. (2017)	8.72	2018	2021

poor MA may lead to Chinese spelling errors and poor reading comprehension, which described the significance of MA from the reverse side. Kirby et al. (2012) proposed that MA was a significant predictor of word reading accuracy and speed, pseudoword reading accuracy, text reading speed and reading comprehension. Based on the research of Kirby et al. (2012), Deacon et al. (2014) found that MA is both a meditator and a predicator of reading comprehension. Levesque et al. (2017) further revealed two indirect relations and one direct relation between MA and reading comprehension. Berninger et al. (2010) has the strongest citation burst in the entire data set (strength = 14.46). The crucial innovation lied in the adoption of growth curve in biology to quantify the specific age of the development of metalinguistic awareness. Also, it discussed MA from two perspectives, a part of metalinguistics awareness and a combination of derivational

awareness, inflectional awareness and compound awareness. Research found that three kinds of MA show greatest growth in the first three or four grades but derivational awareness continues to show substantial growth after fourth grade. The research results are key to provide useful instruction for language learners and instructors.

From the above data, it can be concluded that MA research is relatively concentrated and highly relevant. It takes about two or three years for work to be cited and the duration of bursts lasts around three years. However, Levesque et al. (2017) have a quick uptake with citations bursting only one year after publication. The documents with strongest citation bursts all analyzed MA from a different perspective or solve a further problem based on the previous research.

4.2. Research Emphasis and Hotspots

Several keywords imply certain correlation, and this correlation can be expressed by the frequency of co-occurrence (Chen et al., 2014). Co-occurrence analysis is used to determine the relationship between the topics in the discipline by counting the frequency of the keywords of a group of documents. As the search terms for data collection are "morphological awareness" or "morpheme awareness", the two terms are combined in the visualization along with "morphological awareness" in order to minimize the effect of search term and the knowledge map.

The keywords in the dataset are further arranged according to the frequency and centrality and listed the top 10 of both cases in Table 3. Centrality is a measurement of the influence of a node in a network where keywords and themes that have high betweenness centrality value indicate the greater influence in the development of MA research field and the importance of such keywords in connecting several other research topics. Table 3 shows significant difference in raking based on frequency and centrality, where the keyword "morphological

Table 3. Top 10 keyword according to frequency and centrality.

Keywords	Frequency	Keywords	Centrality
morphological awareness	299	comprehension	0.13
reading	190	adult	0.13
child	149	clinical article	0.12
vocabulary	109	Chinese	0.11
reading comprehension	96	dyslexia	0.10
phonological awareness	83	adolescent	0.08
spelling	79	child language	0.07
dyslexia	67	controlled study	0.06
language development	59	child development	0.06
Levesque et al. (2017)	8.72	2018	2021

awareness" and "reading" show highest frequency among all others at 299 and 190 respectively. This is then followed by keywords "child" (149), "vocabulary" (109), "reading comprehension" (96) and "phonological awareness" (83). On the other hand, the keyword "comprehension" shows highest centrality value at 0.13. Other keywords such as "adult", "clinical article", "Chinese", "dyslexia" and "adolescent" at betweenness centrality scores range from 0.13 to 0.06. These results represent the widely discussed terms and their active role in the linkage to distinct aspects and concepts in the research field.
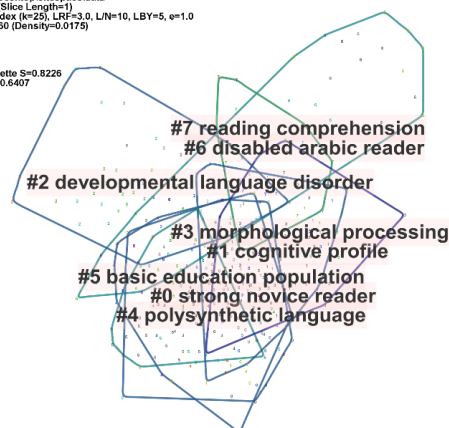
Based on Figure 3 and co-occurrence of keywords analyzed, CiteSpace enabled further interpretation of the information into clusters by using Log-likelihood ratio (LLR) clustering algorithm. A high-frequency keyword clustering map of the biggest eight clusters is vividly depicted in Figure 4. The modularity = 0.5246 > 0.3, and the mean silhouette = 0.8226 > 0.5, indicating good clustering and clear outline.
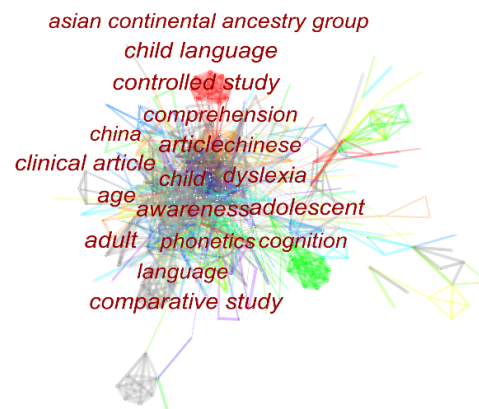
Figure 3. Co-citation network of keyword network.

Figure 4. Clustering map of keywords.

Cluster #0 strong novice reader and Cluster #5 basic education population focus on the ages of most participants because MA comes into effect in early literacy. The exact age when MA comes into effect is in primary school, which has been examined in many studies. For example, Grade 1 French children had MA before specific instruction (Wolter et al., 2009); Grade 4 - 9 English students all showed MA in reading comprehension (Nagy et al., 2006) and so on.

Cluster #1 cognitive profile mainly investigates the basic features of MA. Firstly, MA grow with age (Mahony et al., 2000; Singson et al., 2000). Secondly, the roles of three kinds of MA are played to varying degrees in literacy development (Grigorakis & Manolitsis, 2021). Thirdly, the significance of each awareness depends on different languages. Chinese is characterized by more compound morphemes and fewer derivational morphemes, while Indo European languages are abundant in derivational morphemes. Derivational awareness accounted for more variance in vocabulary and reading comprehension than did compound awareness and inflectional awareness in English (Kieffer & Lesaux, 2012; Diamanti et al., 2018). Chinese students' acquisition of derivational morphology seems to lag behind that of compounding rules, reflecting the nature of Chinese word formation in that there are far fewer derivatives than compounds in Chinese (Zhang & Koda, 2013).

Cluster #2 developmental disorder is related to the disability in literacy development. It turns out that people with dyslexia are extremely lack in MA, so they have difficulty in reading (Abu-Rabia et al., 2003; Shu et al., 2006; Goodwin & Ahn, 2010). For people with dyslexia, morphological instruction is meaningful to develop their MA (Arnbak & Elbro, 2000).

Cluster #3 morphological processing has received particular empirical attention in spelling and reading research in a variety of languages (Deacon & Kirby, 2004; Liu, 2013), mainly conducted in adults with typical reading skills or, in some cases, in dyslexic adults, adolescents, and partly children. Morphological processing is related to the mechanism of human brain in Psychology.

Cluster #4 polysynthetic language deals with Dene Suliné (Chipewyan), an indigenous and highly endangered language spoken in Northwestern Canada (Rice et al., 2002).

Cluster #6 disabled Arabic reader is the participant of Saiegh-Haddad & Taha (2017), which found that while phonological awareness emerged as the strongest predictor of reading, MA was also found to predict unique variance in reading, and even more so in spelling, beyond phonological awareness and cognitive skills.

Cluster #7 reading comprehension has been investigated from school years to adulthood. The mechanism of the influence of MA on reading comprehension Singson et al. (2000) proposed the contribution of MA to accurate word reading, which lays the foundation for successful reading comprehension. Empirical studies support this view (Carlisle, 2000), but the majority suggest that word reading partially accounts for the relationship between MA and reading comprehension. Direct effects are still found between reading comprehension and MA

(Deacon et al., 2014). Building on this, Levesque et al. (2017) showed that MA predicts the decoding of morphologically complex words, which in turn predicts reading comprehension via general word reading. Importantly, MA contributed unique variance to reading comprehension beyond its indirect influence via word reading.
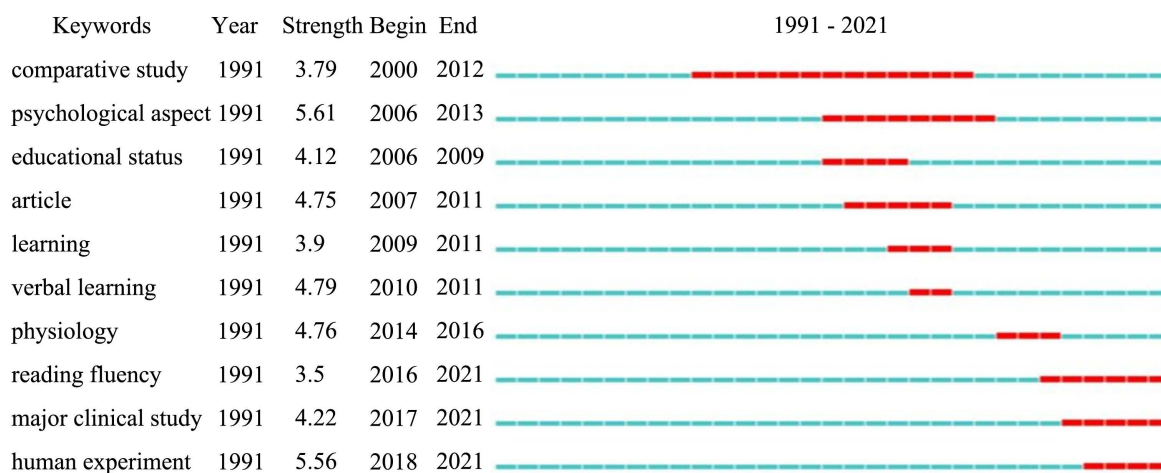
4.3. Research Frontier

The research frontier can be regarded as a scientific problem or topic discussed by a group of literature based on burst terms in a certain period of time. CiteSpace can give the literature of these emergent words on the basis of identifying them, which provides an important analysis tool to explore the research frontier accurately and quickly.

In Figure 5, keywords are sorted by the beginning year of burst, of which duration of bursts lasts till 2021 are reading fluency, major clinical study and human experiment, indicating the frontier of the field. Human experiment ranks first in strength, followed by major clinical study, then reading fluency. However, reading fluency lasts for the longest time of five years. Major clinical study and human experiment reveal a tendency of MA research combined with psychology and physiology.

Reading fluency refers to the ability to read connected text quickly and accurately. Poor readers or dyslexic children may adopt different reading strategies, which may result in slow reading speed. Reading fluency can be considered as a "proxy" for high-level reading competencies (Nunes et al., 2012). Previous studies suggest that MA has a facilitating and predicting role in reading fluency (Pan et al., 2016; Zhao et al., 2020). Reading fluency was also considered to be the mediator of MA and reading comprehension (Kieffer et al., 2013). The interrelationship between MA and reading fluency is complex and still needs further exploration.

Top 10 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	1991 - 2021
comparative study	1991	3.79	2000	2012	
psychological aspect	1991	5.61	2006	2013	
educational status	1991	4.12	2006	2009	
article	1991	4.75	2007	2011	
learning	1991	3.9	2009	2011	
verbal learning	1991	4.79	2010	2011	
physiology	1991	4.76	2014	2016	
reading fluency	1991	3.5	2016	2021	
major clinical study	1991	4.22	2017	2021	
human experiment	1991	5.56	2018	2021	

Figure 5. The Top 10 keywords with the strongest citation bursts.

Major clinical study used to focus on dyslexia readers and research have found that dyslexia is attributed to lack of MA. Recently, focus has been shifted to people with listening deficiency. Similar to dyslexia, people with hearing loss MA to some degree. It has not been proven that MA is a critical factor influencing the performance. The research about people with speaking and writing difficulties has not yet well developed.

Human experiment on MA has been made on a growing number of adults. Research on adults, far less than that on children, is about adults with dyslexia (Leikin & Hagit, 2006; Coleman et al., 2009) and adult basic education students (Tighe & Schatschneider, 2015), suggesting the need for morphological interventions for adult learners.

5. Conclusion and Future Research

The study demonstrates that a new methodology can be utilized to better understand a research field. In this paper, we have drawn on bibliometric data relating to 691 journal articles listed in the database Scopus in the past three decades. The co-occurrence analysis, cluster analysis and co-citation analysis are adopted to figure out the intellectual base, research hotspots and research frontier of MA research.

The intellectual base of MA research is presented by reference co-citation analysis, providing a map of key references in the field. The nodes on the co-citation map cluster together, showing that the research on MA is interconnected and concentrated. The references are studied from two perspectives: citation frequency and citation burst, which not only reveals the most cited works, but also those that receive extremely much attention within a short period. It is likely that the frequently cited works will continue to be well cited in the future because these works provide insights into the basic and well-recognized viewpoints. Documents with high citation burst all explored MA from a brand-new and different perspective and answered the questions proposed in the previous studies.

Keyword co-occurrence analysis enables us to explore the research hotspots of MA. Though keywords with high frequency differ from those with high centrality, these keywords are mainly about research participants, several aspects of the influence of MA and research method. Keyword clusters map further specifies detailed information. The eight clusters are highly concerned issues which are also the hotspots that most researchers in the MA domain focus on, especially in recent years.

The burst map of keywords shows the research frontier. The Top 10 keywords with the strongest citation bursts of which duration of bursts lasts till 2021 are reading fluency, major clinical study and human experiment.

Researchers should pay more attention to interdisciplinary field and combine the research methods of psychology and linguistics. At the same time, researchers ought to dig out the reasons of language difficulty and try to propose the so-

lutions, which requires researchers to make experiments rather than making theoretical hypothesis.

Besides these findings, the evolution trend is classified into three distinctive stages: preliminary stage (1991-2005) when no significant study was found; development stage (2006-2016) when it shows the initial debating of the influence of MA; exploration stage (2017-2021) suggests the more detailed investigation into MA.

The current study also has some limitations. First of all, there are several typical limitations related to bibliometric analysis. The analyzed data in this study was downloaded from Scopus; therefore, data from other databases or collected at different times may have different results and conclusions. Besides that, we used theme (covering titles, abstracts and keywords) as search range, those only searched in article titles or keywords that may lead to other findings. These limitations can be addressed in future research by extending the coverage of databases and types of documents and using similar terms.

To conclude, CiteSpace enables researchers to grasp the points by maps directly. The results of this study demonstrate the intellectual base, research hotspots and development trends of MA and enable researchers to quickly understand the key information in the field, to grasp research directions and to improve research efficiency.

Acknowledgements

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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