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Alzheimer's Disease and Language: Development and Prospects

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Abstract

Alzheimer's disease is a degenerative disease of the central nervous system characterized by progressive cognitive impairment and memory impairment. With search keywords set as "Alzheimer's (disease)" and "language" and the publication date set from January 1, 2020 to October 30, 2022, we retrieved 61 pieces of Chinese literature from CNKI and 176 English results from the Web of Science Core Collection. Data were screened manually and processed with CiteSpace 6.1.R3 and biblioshiny. This study tries to map out the developments of research on language related to Alzheimer's disease both in the Chinese science circle and the international academic circle during the recent two decades (2000-2022). Investigations are also conducted to identify possibilities and opportunities for research fronts. Current studies on the association between Alzheimer's disease and language are characterized by task singularity, subject specificality, institution pluralism, and treatment locality. Future studies are suggested to incorporate neuro-scanning technologies to obtain a clearer message of the neural mechanism. Lifelong bilinguals who use language as a profession such as translators and interpreters are also possible subject groups for future investigations to grasp a both general and specific picture of the association between Alzheimer's disease and language.To overcome our limitations, it is crucial to gather more scientific findings using non-destructive and highly sensitive technologies to understand language impairments in Alzheimer's disease more comprehensively.

Keywords: *Alzheimer's Disease, Language, Visualization, CNKI, WOS, Neuro-scanning*

INTRODUCTION

Alzheimer's disease is a combination of memory loss, dementia, and loss of language function caused by the aging of the brain and other bodily functions in old age or premature age. It is primarily associated with the aging process, affecting both the brain and other physical functions, although cases of premature aging can also give rise to the condition. Despite extensive medical research, the origin and pathogenesis of Alzheimer's disease have not yet been identified in medical research, which means that it is difficult to treat Alzheimer's disease. In this study, we try to map out the developments of research on language related to Alzheimer's disease both in the Chinese science circle and the international academic circle during the recent two decades (2000-2022). The purpose of this study is to comprehensively examine the advancements made in language-focused research pertaining to Alzheimer's disease, shedding light on the current state of knowledge within the Chinese scientific community as well as the international academic arena. By delving into the research conducted during this timeframe, we aim to identify trends, patterns, and emerging frontiers in this unique intersection of medicine and linguistics. Investigations are also conducted to identify possibilities and opportunities for research fronts in future studies on this topic with medical and linguistic fields.

It's crucial to understand the impact of Alzheimer's disease on language, as we need language skills in communication, social interaction, and the improvement of overall quality of our lives. Alzheimer's disease is featured by language impairment and has brought significant distressing for them. By examining the literature from the past 20 years, we can gain insights into the progress made in our understanding of language impairment brought with Alzheimer's disease, and relevant challenges. For one hand, understanding the relationship between language and Alzheimer's disease will be of great help when it comes to understanding the underlying neural mechanisms, and developing effective interventions to address language impairments faced by individuals with the disease. For another, the disease's underlying pathophysiology will be investigated, thus providing valuable insights for researchers across the globe.We processed 237 research results, including

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research articles, conference papers, and scholarly publications from both the Chinese and the international academic community. By analyzing the collective findings and trends, we can identify potential research trends and expectations to be further explored in this field.By comprehensively reviewing the developments in language impairment associated with the Alzheimer's disease, we aimed to contribute to grasp a basic knowledge and development of this field, identify research gaps, and indicate future directions. This may lead to improved diagnostic tools, interventions, and support systems for individuals with Alzheimer's disease, enhancing the overall well-being and quality of life.

METHODS

With search keywords set as "Alzheimer's (disease)" and "language" and the publication date set from January 1, 2020 to October 30, 2022, we retrieved 61 pieces of Chinese literature from CNKI and 176 English results from the Web of Science Core Collection. Data were screened manually and processed with CiteSpace 6.1.R3, a Java-based application to visualize research developments with features on clustering of keywords, authors, institutions, and others[1], and biblioshiny, a tool based on an R-package bibliometrix for comprehensive science mapping analysis [2].

By using this methodology, the study aims to provide an overview about language-related research on Alzheimer's disease conducted over the past two decades, encompassing both the Chinese science circle and the international academic community. By analyzing the existing literature, identifying emerging trends, and highlighting potential research directions, this study seeks to contribute to the collective knowledge base and foster advancements in the understanding and management of language impairments associated with Alzheimer's disease.

RESULTS

By dividing the results section into these three subsections, a comprehensive picture of the research landscape in language-related research on Alzheimer's disease is presented. This structured approach aims to helps understand the major research themes, identify influential authors, and recognize the institutional contributions in advancing knowledge and understanding in this field.

THEMES

The themes subsection allows for the identification and categorization of key research themes or topics that emerge from the literature review. It provides an overview of the main areas of focus within the field of language-related research on Alzheimer's disease. By identifying and discussing these themes, we can highlight the breadth and depth of research conducted in this specific area. This subsection helps readers understand the major research areas, trends, and current knowledge gaps.

The study of language function in Alzheimer's disease has an important theoretical and practical value and has a positive impact on neurolinguistic and psycholinguistic research, providing useful references for early detection and language rehabilitation of Alzheimer's disease, and has become a new disciplinary growth point for linguistic research both in China and abroad.

A thematic map of key themes (Figure 1) is drawn based on the data retrieved from CNKI, a Chinese academic database. According to the nodes and connections, cognitive function, language function, discourse analysis, memory, and music therapy are among the major topics in the Chinese academic circle on Alzheimer's disease and language. Cognitive impairment and language dysfunction are closely related to dementia featuring AD.

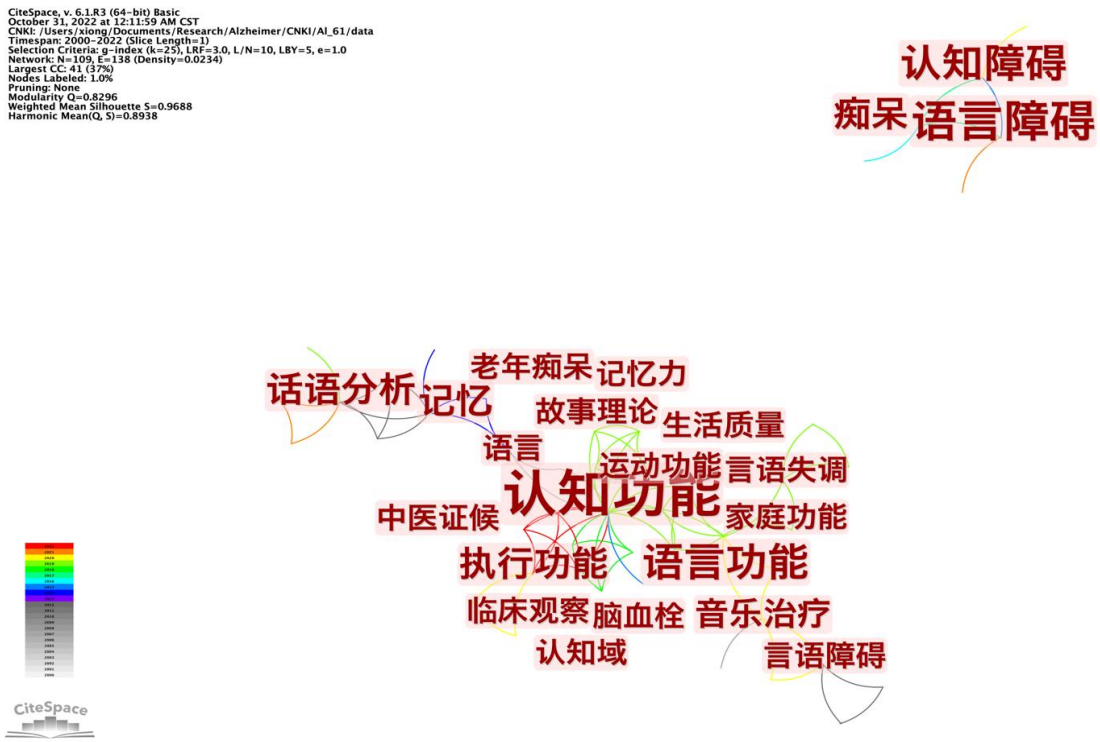

Figure 1. Key themes in the Chinese literature based on the frequency of key words

Zhao & Long [3] conducted a comprehensive review of the types and characteristics of language dysfunctions in patients with Alzheimer's disease. The review shows tremendous potential for studying the receptive language-related functions in AD in terms of receptive and reactive language abilities. From the perspective of pathological linguistics, Liu [4] holds that language impairment in patients with Alzheimer's disease involves linguistics, neuropsychology, and brain cognitive science. Liu reviewed experimental studies on language impairment in individuals with AD from two aspects: 1) experimental studies on phonemic, word finding, syntactic, and discourse level language impairment; 2) experimental studies on cognitive neural mechanisms of language impairment in patients based on eye-movement, EEG and brain imaging techniques. Current experimental studies mainly focus on the lexical, syntactic, and semantic aspects of patients' discourse, yet not enough focus has been made to the complexity of patients' language use. Wang *et al.* [5] reviewed the research progress in pathological changes, clinical manifestations, imaging changes, and biomarkers of these four types of AD language disorders, and discuss the diagnostic and therapeutic research directions of AD.

Concerning the treatment, the effectiveness of music therapy on the language, memory, and mental state of patients with AD is among the major topics. Many experiments have shown that music therapy is effective in Alzheimer's disease. Yu [6] analyzes the syndromes of AD with speech disorders and the possible effects of music therapy on this disease and investigates the effects of both individual therapy and group therapy. Zhou *et al.* [7] argue that music therapy can improve the mental state and language function of individuals with mild to moderate AD. According to Lyu *et al.* [8], music therapy can enhance memory and language function, reduce psychiatric symptoms and caregiver distress in patients with mild AD, and performing songs is more effective than reading the lyrics aloud.

A timeline map (Figure 2) was generated to demonstrate the interest evolution of key topics in the Chinese academic circle. Chinese researchers started to explore the association between Alzheimer's disease and language with a specific focus on cognitive functions in the first five years. A shift to language impairment, rehabilitation, drug therapy, coherence, memory, mental behavior, discourse analysis, and music therapy was realized in the span from 2010 to 2015. Recent trends of research on Alzheimer's disease and language include Chinese medicine symptoms, cognitive domain, clinical observation, quantitative analysis, and linguistics.

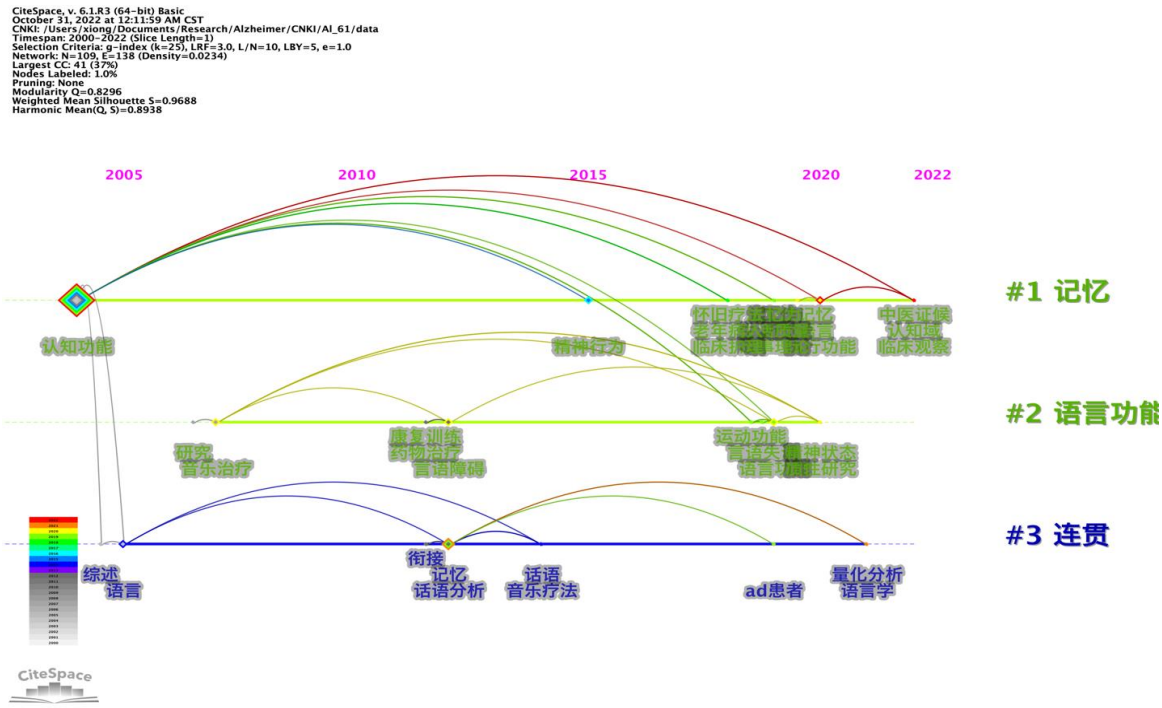

Figure 2. Timeline map

In the international academic circle, dementia (16%), mild cognitive impairment (6%), speech (4%), performance (4%), disease (3%), impairment (3%), and diagnosis (3%) are among the most popular themes to explore the relationship between Alzheimer's disease and language, as indicated in Figure 3, a map of the main topics in the international literature based on the frequency of key words.

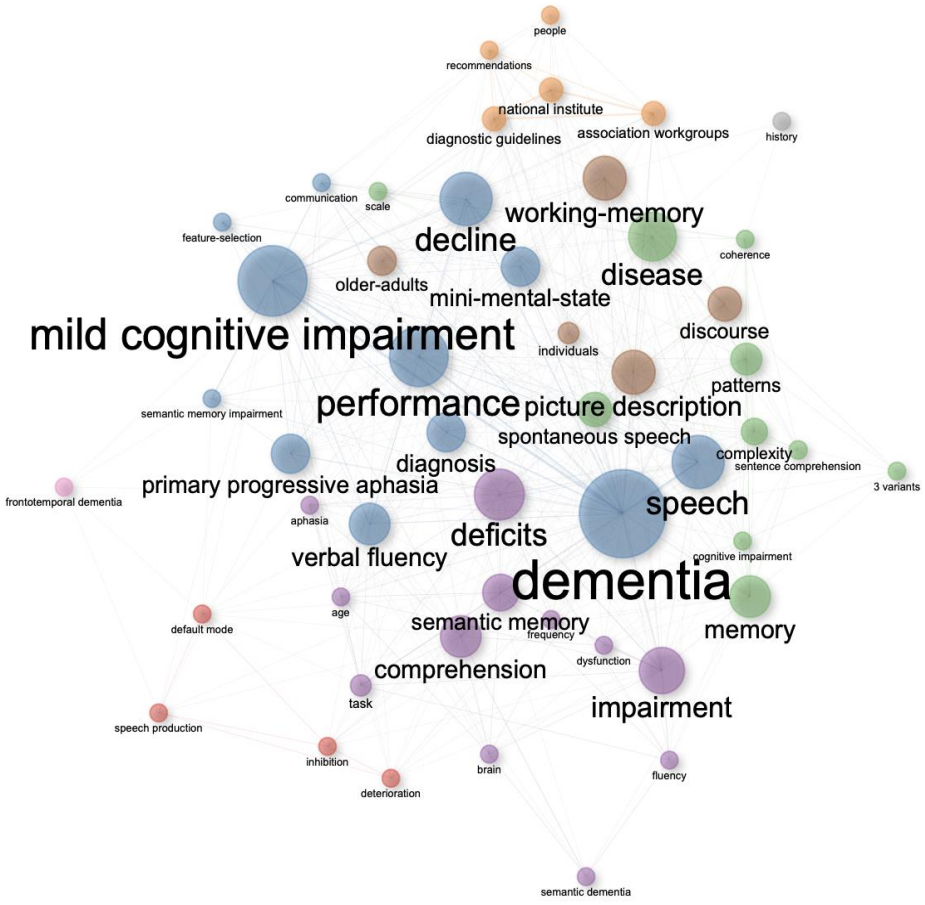

Figure 3. Major themes in the international literature based on the frequency of key words

In a general picture, current studies on AD and language mainly incorporate the investigation into mild cognitive impairment, speech, performance, and working memory, with techniques such as picture description tasks and corpus aided by natural language processing. Research on the translation/interpreting capabilities of individuals with AD has yet to be explored.

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To conclude, the current studies mainly focus on investigating mild cognitive impairment, speech, performance, and working memory. Techniques such as picture naming tasks and natural language processing are typically utilized in these studies. However, there is still a gap in research about the translation and interpreting abilities of individuals with AD.In the international academic community, dementia emerges as the most prominent theme in exploring the correlation between AD and language, followed by mild cognitive impairment, speech, performance, disease, impairment, and diagnosis, as it is shown in Figure 3.

AUTHORS

The authors subsection focuses on the researchers who have contributed to the body of knowledge on language and Alzheimer's disease. By analyzing the authors' contributions, affiliations, and global citations, important insights can be gained. It helps to identify leading researchers or research groups actively engaged in language-related research on Alzheimer's disease. This subsection may also provide information on the diversity of

researchers involved, their expertise, and potential collaborations. Understanding the authorship landscape is valuable for recognizing the key contributors and influencers in the field.

The Chinese authors with the highest number of publications in the field of AD and linguistics, are Zhao Junhai, Huang Lihe, Yang Jingjing, and Pan Yue, as indicated in Figure 4. Among them, Zhao forms a research collaboration cluster with Long, and Huang often co-authors papers with Yang.

Zhao mainly focuses on the types and characteristics of language dysfunction in AD [9], analysis of articulation and coherence in the discourse of Alzheimer's patients [10], the association between discourse and memory in patients with AD [11], and advances and trends in language research in dementia brought by this disease[12], and deep formality of discourse of Alzheimer's patients based on corpus mining [13]. Zhao believes that the application of artificial intelligence for language assistance in Alzheimer's-type dementia is promising, despite the fact that related research is just beginning.

Huang & Yang [14] used Coh-Metrix, a computerized automatic text analysis tool, to analyze a corpus of 60 Chinese-speaking patient groups with AD and healthy control groups on picture description tasks to examine the discourse dysfluency of this group of patients. The patients were found to score significantly lower than the healthy control group on the picture description task and showed impairment in both information and language fluency. They considered that impaired language function is a typical manifestation in elderly adults with Alzheimer's disease, and relevant features are highly exogenous and sensitive, which are useful for cognitive evaluation and clinical diagnosis. Huang & Yang [15] explored the phenomenon of non-fluency and mental processing of the spoken output of the picture description task between patients with AD (or Dementia of the Alzheimer type, abbreviated by DAT) and healthy controls based on the speech output model. They observed that the differences in oral fluency in DAT patients compared to healthy controls were mainly in three indicators: speech rate, articulation speed, and the average length of silent pauses. The study concluded that there are two behavioral purposes of "temporal buffering" and "discourse modification" in the non-fluency phenomenon, which are reflected in the external speech performance of silent pauses, filling pauses, repetition and modification, mainly occurring in the conceptual synthesis stage, form preparation stage and self-monitoring stage, and self-monitoring stages. Semantic memory impairment and reduced visual perceptual ability are among the main causes of non-fluency in DAT patients. Drawing from a discourse-pragmatic impairment, Huang & Yang [16] extracted indicators from 53 studies of discourse-pragmatic impairment in DAT patients using a meta-analytic approach, and grouped and reorganized them according to the definitions of the indicators. They found that differences in indicators, subjects and language tasks were the three main influencing factors and proposed that in the face of severe population aging, China should strengthen the study of language aging in healthy and elderly people with AD with Chinese as native language, and build a constant model of language ability at the level of the chapter discourse to provide a reference standard for the diagnosis of neurodegenerative diseases. Huang *et al.* [17] also believe that Coh-Metrix and LIWC are clinically important for the early detection and assessment of dementia in the elderly.

Pan [18] explored the modal meaning potential and construction of meaning in the discourse of individuals with moderate to mild AD from a systemic functional linguistic perspective, investigated the metaphorical thinking ability of individuals with cryptogenic AD [19], and conducted a Python-based natural language processing study on the discourse of mild AD patients [20].

Overall, the contributions of these Chinese authors provide valuable insights into various aspects of language dysfunction in AD, including discourse analysis, language fluency, non-fluency phenomena, and metaphorical thinking. Their research sheds light on the understanding, diagnosis, and assessment of AD and emphasizes the potential of computational tools in clinical applications.

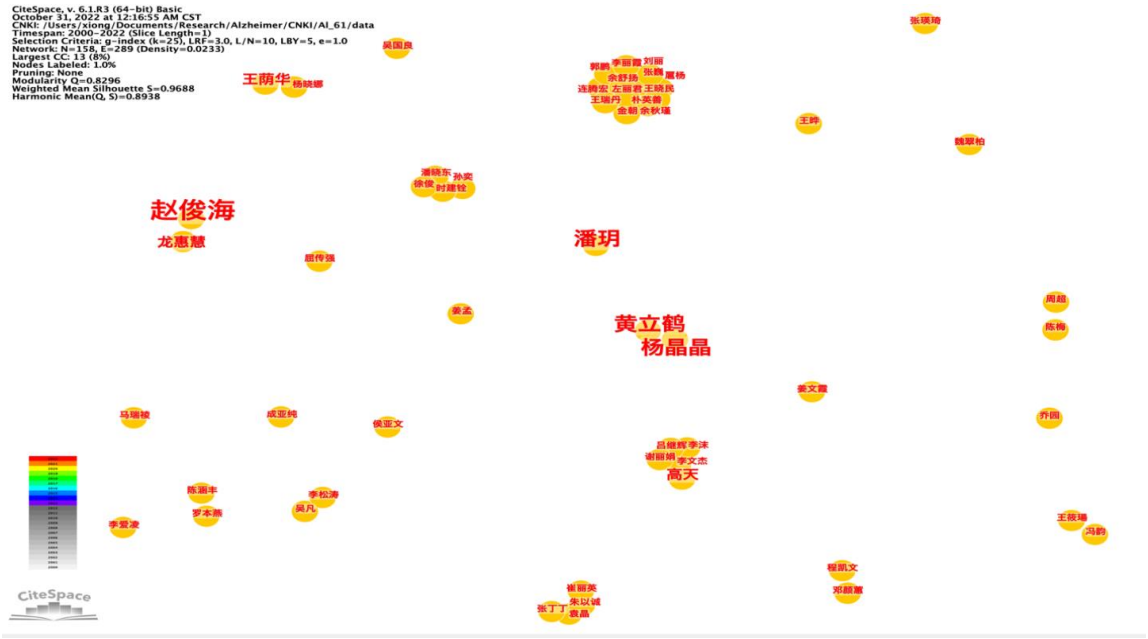

Figure 4. Author collaboration clusters

Figure 5 displays the Most Relevant Authors, ranked by the number of documents. Tocco, Graham, and Saxton [21], [22], [23], [24], [25], [26] focus on the memantine treatment's effectiveness on language and communication in individuals with moderate to severe AD. Ferris & Farlow [27] explored language impairment brought by AD and the effects and advantages of acetylcholinesterase inhibitors, and this paper won 73 global citations. Mueller [28] conducted a study on connected speech and language in individuals with mild cognitive impairment and Alzheimer's disease, paying particular attention on picture description tasks.

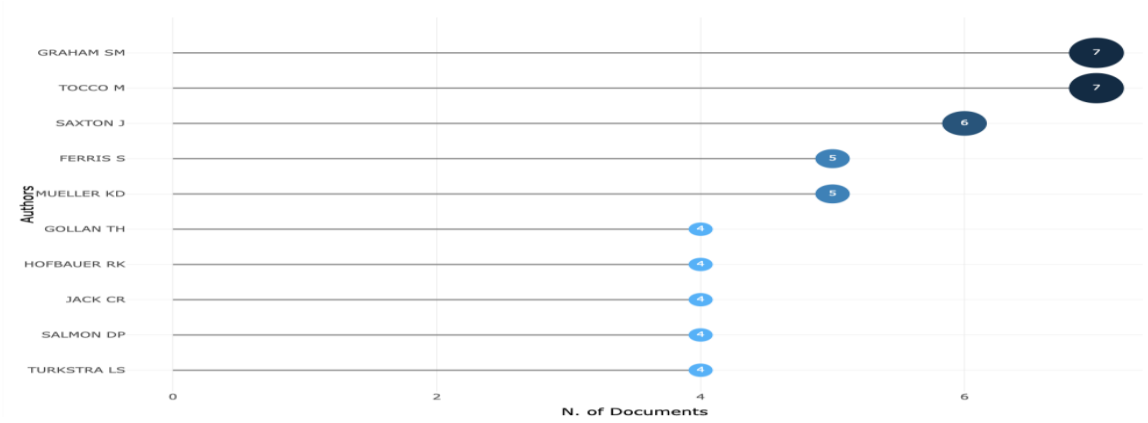

Figure 5. Most relevant authors

Figure 6 lists documents with the most global citations. Taler & Phillips [29] conducted a comparative review on language performance in Alzheimer's disease and mild cognitive impairment. They reviewed language performance in Mild Cognitive Impairment, or MCI, compared these findings with those seen in AD, and identified the main issues in understanding language performance in MCI and selecting tasks with diagnostic and prognostic value.

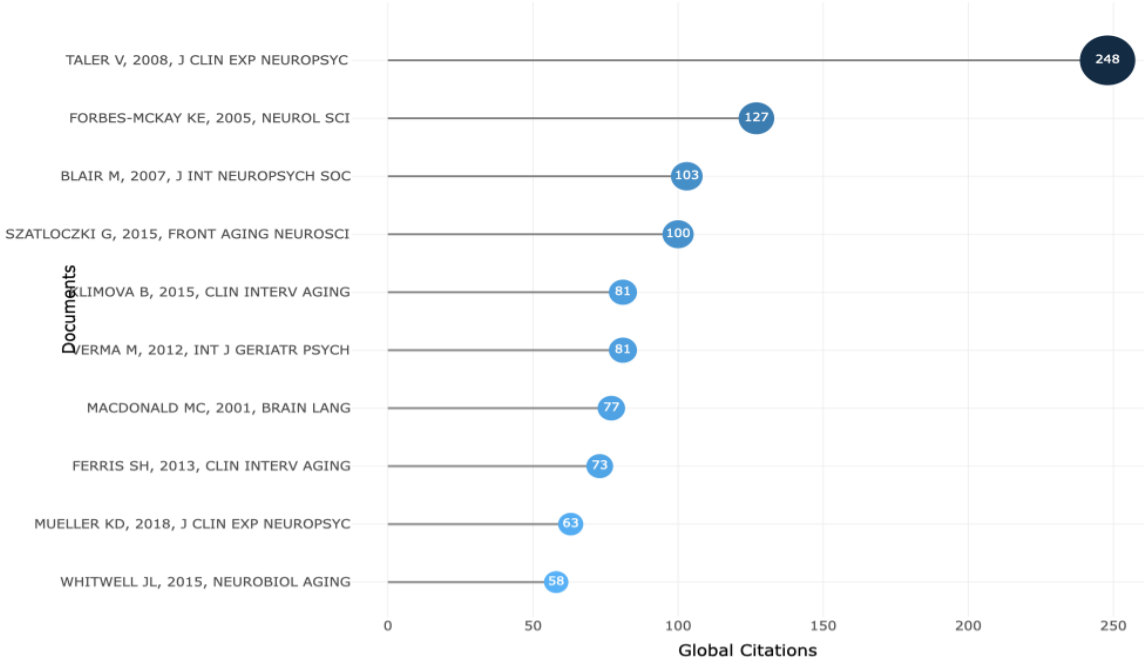

Figure 6. Documents ranked by global citations

An increasing number of evidence suggests that mitochondrial function suffers significant impairement during the development of AD. In light of it, recent therapeutic approaches have focused on targeting specific pathways implicated in the pathophysiology of AD. While in researches investigating the relationship between language impairment and the AD, researchers from linguistic community offer different approaches to address language impairment associated with this disease.

Using an image description task, Forbes-McKay [30] found that even in people with very early-stage Alzheimer's disease, deficiencies may be seen when the sophisticated form of the task was utilized. The task was used to identify subtle declines in spontaneous language ability in early AD. They suggested that an image description task can be used to measure spontaneous language abilities prospectively in order to identify modest impairments in language that are nduced by AD at an early stage. A longitudinal research of language degradation in AD and frontotemporal dementia was conducted by Blair et al. [31]. The authors made the case that this type of study gives us a unique insight of how language deterioration develops over time in different dementias. Szatloczki [32] researched the significance of language ability alterations in Alzheimer's disease and looked into whether speaking is an early indicator of the condition. To demonstrate the effects of informal caregivers and appropriate medications in the improvement of these language disorders, Klimova [33] studied the social intervention and medical therapy of AD and its related language impairments. Language and semantic memory loss during the initial phrases of AD were evaluated by Verma & Howard [34]. MacDonald [35] assessed working memory and language comprehension in Alzheimer's disease. Whitwell [36] used a task-free fMRI comparison to examine dysfunctions in working memory and language network in patiencts with logopenic aphasia and AD.

In conclusion, the research conducted by various authors provides significant contributions to our understanding towards language impairments in AD. Overall, these studies collectively expand our understanding of the correlation between AD and language impairments, offering insights into potential therapeutic interventions, diagnostic tools, and the progression of language deterioration over time.

INSTITUTIONS

The institutions subsection provides information about the affiliations and institutions where the research is conducted. It helps to identify the research organizations, universities, hospitals, or research centers that have

been actively involved in AD research focusing on language-related aspects. This subsection can shed light on institutional strengths, collaborations, and the geographical distribution of research efforts. It also helps establish the institutional context within which the research has been conducted, which can be valuable for future collaborations and resource allocation.

Based on the number of publications in Chinese and international journals, Figure 7 is mapped out for the research institution clusters on this topic and Figure 8 is generated for articles published in international journals. Major research institutions include universities, medical schools, and hospitals (either affiliated or independent).

It is noticeable that Tongji University, Yunnan Minzu University, Zhenjiang College, The Hong Kong Polytechnic University, Nanjing Drum Tower Hospital, the Affiliated Hospital of Nanjing University Medical School, and Peking University First Hospital are the research institutions most interested in the investigation of the association between Alzheimer's disease and language. On the international academic stage, the University of Wisconsin is the research institution with the most publications (N=22) in this field, followed by Columbia University (N=10), Mayo Clinic (N=10), University of Toronto (N=10), Vrije Universiteit Amsterdam (N=8), University of California San Diego (N=7), Indiana University School of Medicine (N=6), Korea University (N=5), University of California Los Angeles (N=5), and University of Hull (N=5).

In conclusion, the investigation of the relationship between Alzheimer's disease and language has gathered wide interest from a wide range of research institutions in both the Chinese and international academic circles.

The diverse range of research institutions involved demonstrates the interdisciplinary nature of this field of study, as universities, medical schools, and hospitals all have made necessary contributions, paving the way for future breakthroughs in diagnosis, treatment, and care for individuals affected by Alzheimer's disease. Moreover, it is encouraging to see both Chinese and international institutions involved in this research area, indicating a global commitment to tackling the challenges and threats posed by Alzheimer's disease.

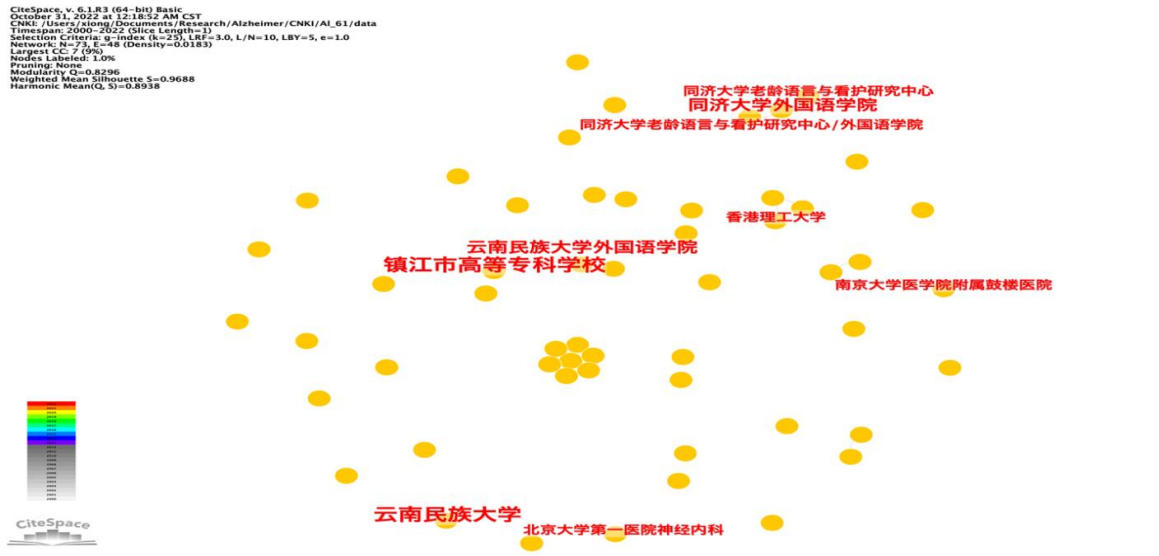

Figure 7. Research institution clusters in China

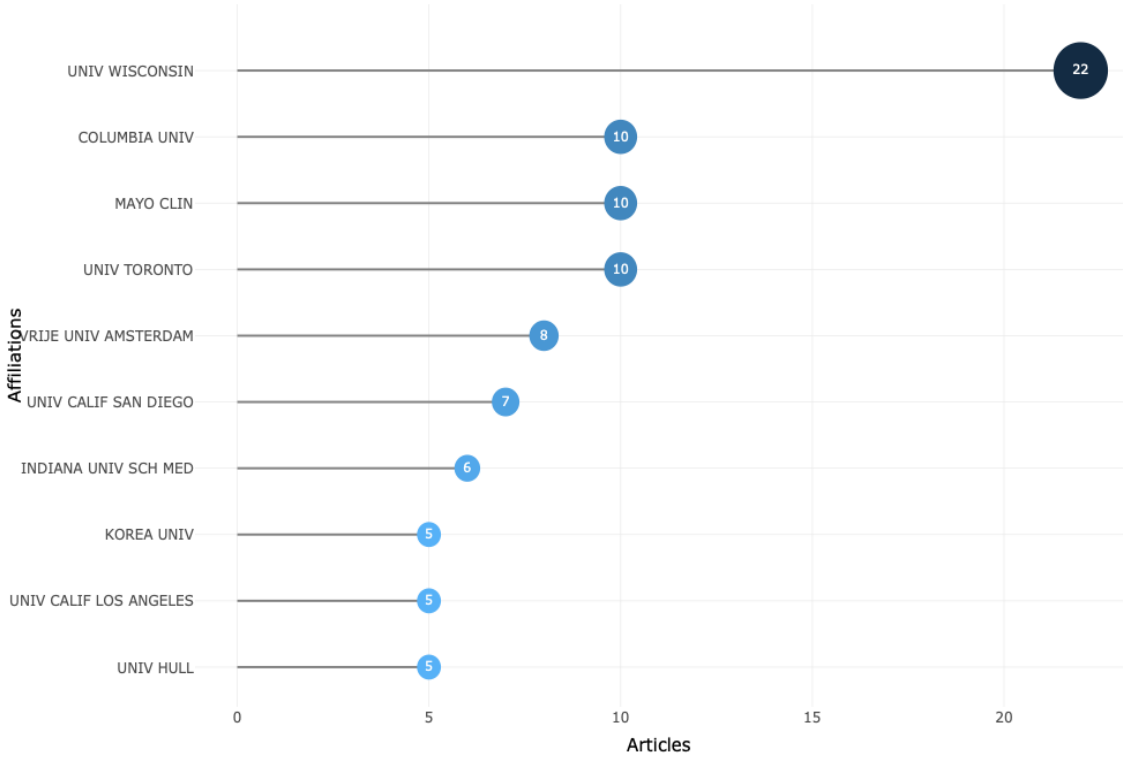

Figure 8. Most relevant affiliations in the international research circle

PROSPECTS

With relevance degree (centrality) as the horizontal axis and development degree (density) as the longitudinal axis, a two-dimensional thematic map (Figure 9) is drawn for co-word analysis to display classified themes, namely basic themes, motor themes, niche themes, and emerging or declining themes.

Regarding the intuitive thematic plot with annotations on bubbles in different sizes and colors placed in four quadrants, we obtained a clear message of the most/least trendy topics with the most/least heated discussions in the international academic circle.

Basic themes in the lower-right quadrant include semantic dementia and frontotemporal lobar degeneration; people and nursing-home residents; as well as 3 variants pathology. Niche themes or highly specialized themes in the upper-left quadrant include basal ganglia, perception, and word; default mode, positron-emission-tomography, and state; as well as extrapyramidal signs and predictors. Motor themes in the upper-right quadrant are dementia, mild cognitive impairment, and speech; deterioration, speech production, and dysfunction; as well as scale, communication, and memantine. Emerging or declining/disappearing themes in the lower-left quadrant are the declarative/procedural model and lifelong bilingualism; frontotemporal dementia and features; diagnostic criteria; and risk.

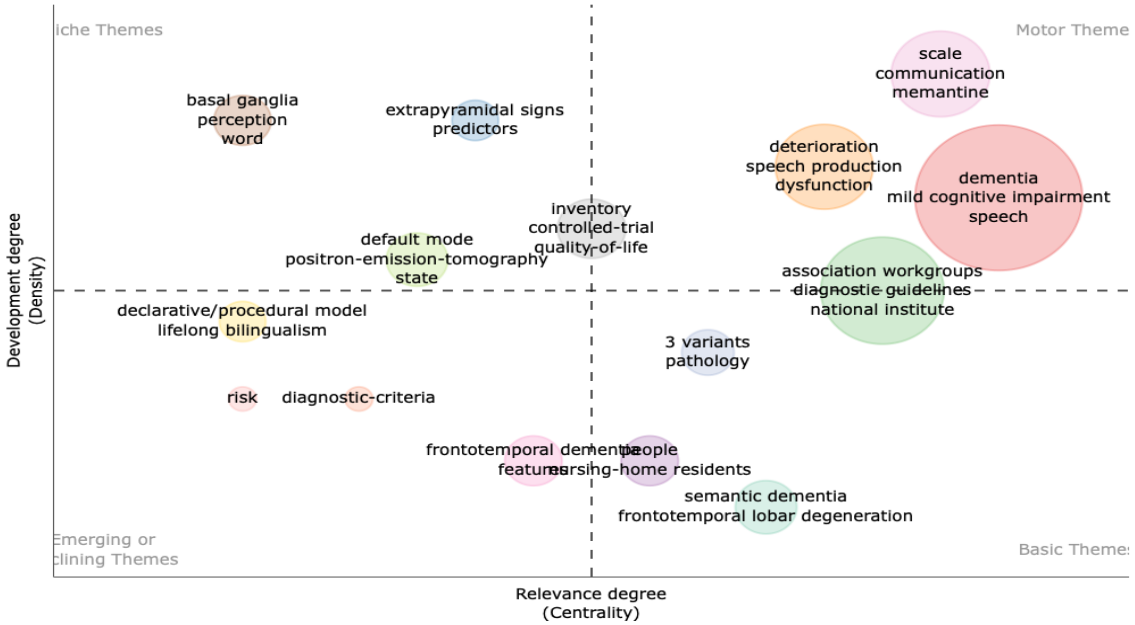

Figure 9. Thematic map for co-word analysis

In Chinese academic circle, researches on AD and related memory decline and the loss of language skills are well studied. Taking cognitive impairment and speech dysfunction into consideration, Sun Guojing [37] selected corpus examples analysis of the clinical application of the intelligent speech companion system for patients with cognitive impairment in order to explore the characteristics of the pragmatic loss in patients with Alzheimer'S Disease. Then, her research attempted to give targeted suggestions to patients with AD. For semantic impairment, Fang [38] called for a more sensitive semantic memory tests rather than the normally used tests like picture naming and verbal fluency tasks, and for considering the influence what the linguistic and cultural background could bring to patients with AD. According to Huang *et al.* [17], future research should focus on the feasibility of automated transcription and cut scores, using such tools for long-term follow-up studies of dementia patients to improve the accuracy of disease course judgments, and further evaluating whether such methods can be used clinically to detect the process of cognitive level changes in older adults. In future studies, the incorporation of advanced neuro-scanning technologies holds great potential for obtaining a clearer understanding of the neural mechanisms underlying the association between Alzheimer's disease and language. Techniques such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and magnetoencephalography (MEG) can provide valuable insights into the brain regions, networks, and functional connectivity involved in language processing and how they are affected in individuals with Alzheimer's disease. By combining these neuroimaging techniques with linguistic analyses, researchers can explore the intricate interplay between language impairments and neural changes, shedding light on the underlying pathophysiology.It is necessary for China to accelerate the construction of a discourse corpus for the elderly, and also carry out the development of automatic text analysis tools for the Chinese language.

In terms of the relationship between Alzheimer's disease and language, many scientific researches were conducted internationally as well [39], [40], [41], [42]. For example, the aim of Fraser [40] was to demonstrate the state-of-the-art accuracy of automatic recognition of Alzheimer's disease from short narrative samples elicited by picture description tasks and to reveal salient linguistic factors associated with statistical factor analysis. This research was about the speech production and AD's diagnostic criteria, belonging to the upper-right and lower-left quadrants of Figure 9, respectively and showing both future trend and the trendiest topic of researches related to the Alzheimer's disease. To identify novel genetic variants associated with language performance, Deters [41] performed a genome-wide association study (GWAS) using a composite measure of language performance from the Alzheimer's Disease Neuroimaging Initiative (ADNI; n=1560), occupying the basic research field of the language and communication of people with Alzheimer's disease in the lower-right

quadrant of the figure. Moreover, a search was performed by Morello *et al.*, in 2017 [46] on SciELO, LILACS, PubMed, and PsychINFO databases using such keywords as Alzheimer's disease, language, communication, cognition, cognitive intervention, rehabilitation, and therapy and their corresponding Portuguese and Spanish terms, finding hat studies concerning Alzheimer's Disease were performed on a relatively small scale, and that two intervention techniques, namely lexical-semantic approaches and interventions associated with different cognitive skills were probably effective. HashemiKamangar [42] hypothesized that the concept of resilience in scale-free semantic networks can truly simulate and predict semantic language deficits in Alzheimer's disease. Other influential work includes Kertesz et. al., 1986 [43], Bayles et. al., 1993 [44], Price et. al., 1993 [45].

Zhao and Long [3] believe that there is still room for the study of the lexical category effect, the manifestation and essence of grammatical impairment, and the nature of discourse coherence impairment in output language functions. According to Liu [4], a multimodal corpus-based systematic investigation of patients' natural speech is urgently required from a communicative pragmatic standpoint. The neural mechanisms underlying the relationship between communication and cognition in patients with Alzheimer's disease are anticipated to be further investigated by specialists and academics in cognitive science, speech therapy, and related fields in order to discover effective rehabilitation treatments for patients with language disorders. In the international academic community, Morello [46] recommend higher levels of evidence in the investigation of interventions focused on language and communication skills. Moreover, HashemiKamangar [42] suggest increasing the diversity of words in the lexicon for people with Alzheimer's disease, and increasing the flexibility of their semantic network through decomposition. In addition, expanding the size of semantic networks for Alzheimer patients could make them more resilient.

Additionally, for lifelong bilinguals, especially those who use language as a profession such as translators and interpreters, investigations on these people can provide a unique perspective on the relationship between Alzheimer's disease and language. Lifelong bilingualism has been shown to have cognitive and neural benefits effects, which may delay the onset of Alzheimer's disease and reduce its severity. By studying proficient bilinguals, researchers can examine the effects of bilingualism on language-related cognitive decline in the context of Alzheimer's disease. This could involve assessing differences of bilingual and monolingual patience with Alzheimer's disease regarding to language performance, neural activation patterns, and cognitive reserve. Such investigations may, in turn, contribute to a deeper and more comprehensive understanding of the role of language proficiency or experience and cognitive reserve in mitigating the impact of Alzheimer's disease on language function.

Furthermore, the effects of interventions or training programs on patients with Alzheimer's disease, such as speech and language therapy, cognitive language stimulation activities, or programs designed specifically targeted at individual's linguistic abilities, should be paid extra attention. By systematically evaluating the effects of these interventions, researchers can develop targeted strategies to support and enhance language function in individuals who are affected by this disease in their daily routines.

In summary, future studies in the field of Alzheimer's disease and language should consider incorporating neuroimaging techniques to unravel the neural mechanisms, investigate the role of lifelong bilingualism and language experience, and explore the efficacy of language-related interventions. By delving deeper into these areas, researchers can gain a more comprehensive understanding of the complex relationship between Alzheimer's disease and language and contribute to the development of innovative approaches for diagnosis, treatment, and support for individuals with Alzheimer's disease.

As for our limitation, more scientific findings using non-destructive and highly sensitive technologies considering language impairments brought by the Alzheimer's disease should be concluded as well. For example, the Nuclear Magnetic Resonance (or NMR) spectroscopy technique has made valuable contributions to Alzheimer's disease research, particularly in the study of biomarkers, protein interactions, and metabolic alterations associated with the disease. It aids in biomarker discovery, understanding protein misfolding, characterizing amyloid aggregates, exploring metabolic alterations, and supporting drug discovery efforts, offering valuable tools and techniques to advance our understanding of Alzheimer's disease pathogenesis and develop potential diagnostic and therapeutic strategies.

CONCLUSION

Alzheimer's disease is a degenerative disease of the central nervous system characterized by progressive cognitive impairment and memory impairment. Current studies on the association between Alzheimer's disease and language are characterized by task singularity, subject specificality, institution pluralism, and treatment locality. Future studies are suggested to incorporate neuro-scanning technologies to obtain a clearer message of the neural mechanism. Lifelong bilinguals who use language as a profession such as translators and interpreters are also possible subject groups for future investigations to grasp a both general and specific picture of the association between Alzheimer's disease and language.

CONSENT FOR PUBLICATION

- Not applicable

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CONFLICT OF INTEREST

- The authors declare no conflict of interest, financial or otherwise.

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- Declared none

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