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Bibliometric and Visualization Analysis of Language Ability Research on Deaf and Hard-of-Hearing Individuals

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Abstract

This study conducts a comprehensive bibliometric and visualization analysis of research on deaf and hard-of-hearing (DHH) language ability published between 2006 and 2025, using CiteSpace and Microsoft Excel. Based on 1250 SSCI-indexed publications from the Web of Science database, the study explores publication trends, core contributors, and evolutionary hotspots. The results show that: (1) The number of publications exhibits a stage-specific trend---slow fluctuating growth (2006-2011), rapid expansion (2012-2020, peaking at 104 articles in 2020), and stable high-level output (2021-2025). (2) Core contributors are dominated by the U.S. (599 publications), with prolific authors including Marschark, M. and Easterbrooks, S. R., and high-impact journals such as Journal of Deaf Studies and Deaf Education. The top-cited references focus on cochlear implant (CI) outcomes and language predictors. (3) Research hotspots have evolved from foundational assistive technology and phonological awareness (2006-2011) to cognitive mechanisms and comparative studies (2012-2020), with recent trends emphasizing personalized intervention (e.g., "predictors") and cognitive development. This study systematically maps the intellectual structure and evolutionary paths of DHH language ability research, providing a reference for future interdisciplinary exploration and practical intervention.

Keywords

Bibliometric analysis, Deaf and hard-of-hearing (DHH), Language ability, CiteSpace.

1. Introduction

The widespread adoption of assistive listening technologies (e.g., cochlear implants [CIs], hearing aids [HAs]) and advancements in speech-language pathology have revolutionized language intervention for deaf and hard-of-hearing (DHH) individuals [1]. Language ability, defined as the competence to understand and express meaning through spoken, signed, or written modalities [2], is a core component of communicative competence that directly impacts DHH individuals' academic achievement, social integration, and quality of life [3]. For DHH populations, language development often faces unique challenges---such as delayed phonological awareness [4, 5]---making it a longstanding focus of interdisciplinary research spanning audiology, linguistics, education, and cognitive science.

Over the past two decades, research on DHH language ability has evolved from foundational studies on disability-related deficits to nuanced explorations of modifiable factors (e.g., age at implantation, family language input, educational placement) and their interactions [6]. Early research primarily emphasized the efficacy of single interventions (e.g., CI surgery) [7], while contemporary studies increasingly adopt a holistic perspective, integrating cognitive mechanisms (e.g., working memory)[8], bilingual communication (e.g., English and the home language) [9], and contextual influences (e.g., parental education level) [10]. According to the World Health Organization (WHO) (2021), over 5% of the global population lives with disabling

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hearing loss, and timely language support can mitigate long-term developmental gaps, underscoring the practical significance of advancing this field.

Despite the growing body of literature, existing research is fragmented across disciplines and regions, with limited systematic syntheses of its intellectual structure, evolutionary paths, and emerging frontiers [11]. Bibliometric analysis, a rigorous method for mapping scientific knowledge through quantitative examination of publication trends, author collaborations, and keyword dynamics [12], offers a solution to integrate these dispersed findings. This approach has been successfully applied to decode thematic patterns in related fields (e.g., blended learning, special education) [13], but its application to DHH language ability research remains underutilized.

To address this gap, the present study conducts a comprehensive bibliometric and visualization analysis of DHH language ability research published between 2006 and 2025. Using CiteSpace and Microsoft Excel, we systematically examine publication output, core contributors (authors, countries/regions, journals), and keyword evolution. The specific research questions guiding this study are as follows:

1. What is the overall publication trend in DHH language ability research from 2006 to 2025?
2. Which authors, countries/regions, journals, and articles have made the most significant contributions to this field?
3. What are the research hotspots in different periods, and what emerging trends can be identified?

2. Materials and Methods

2.1. Data collection.

In this study, data analysis was performed on Social Sciences Citation Index (SSCI) journals collected from the Web of Science (WOS) database, a well-known multidisciplinary database platform. The topics of “language ability OR communicative competence OR phonology OR phonological ability OR vocabulary OR lexical ability OR syntax OR grammar OR grammatical ability OR discourse OR discourse competence OR pragmatics OR pragmatic ability OR language comprehension OR language production OR communication” and “deaf OR hearing impaired OR hearing disability OR hearing impairment OR hearing loss” were searched simultaneously, spanning from 2006 to November 21, 2025. An initial topic search resulted in 4518 records published between 2006 and 2025. After filtering out fewer representative records, such as book reviews, proceedings papers, and notes, the dataset was reduced to 1250 records with complete bibliometric information available.

2.2. Research tools.

CiteSpace 6.3 R1 was used as the main tool for bibliometric analysis, which quantitatively evaluates and interprets scholarly literature [14, 15]. CiteSpace is widely applied for mapping co-citation and keyword networks, helping to identify research trends and frontiers.

In this study, CiteSpace was used to analyze keyword co-occurrence, clustering, and co-authorship networks, supplemented with bibliometric indicators such as highly cited references, prolific authors, and high-frequency keywords. This enabled a systematic examination of research trends, core contributors, collaboration patterns, and emerging hotspots in the field. And Microsoft Excel was used for organizing data and creating diagrams.

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3. Results

3.1. Publication output.

As illustrated in Table 1, out of the 1250 publications, there were 174 journals, 2723 authors, 2500 institutions, and 296 countries or regions that contributed to the studies of language ability research on deaf and hard-of-hearing individuals from 2006 to 2025.

The number of articles published from 2006 to 2011 was remained low (23-44articles/year), mainly focusing on the assistive technologies and foundational language development. But in the year 2012, there was a significant increase in publications, marking a turning point. The doubling of publications in 2012 may be driven by policy expansions in newborn hearing screening and key technological advancements in assistive devices. By 2012, universal newborn hearing screening (UNHS) had become mandatory in most developed countries. Centers for Diseases Control and Prevention (2012) showed that the U.S. had expanded UNHS coverage to >98% of newborns. Cochlear Americas announced the Cochlear Baha BIA400 Implant [16], and launched the Aqua+®1 accessories in 2012 [17], expanding device accessibility for DHH individuals.

The number from 2013 to 2020 shows an overall upward trend, and reached the peak with a count of 104 in 2020. Publications in this period included CI-related studies [18], literacy interventions [19], and orthography reading research [20]. It may be driven by the policy and cognitive mechanism research maturing. In 2019, some global events, such as the "Cross-border Innovation Hearing Technology Summit" in China, highlighted DHH literacy needs. And by 2019, studies on working memory [21], metacognitive awareness [22] and bimodal communication [23] had accumulated sufficient data, leading to a wave of syntheses and empirical papers---evident in the keyword burst "cognitive development" (Fig. 5) emerging around 2020.

The number of papers published in 2021 to 2025 declined compared to the second peak in 2020, but remained stable (56-80 annually).

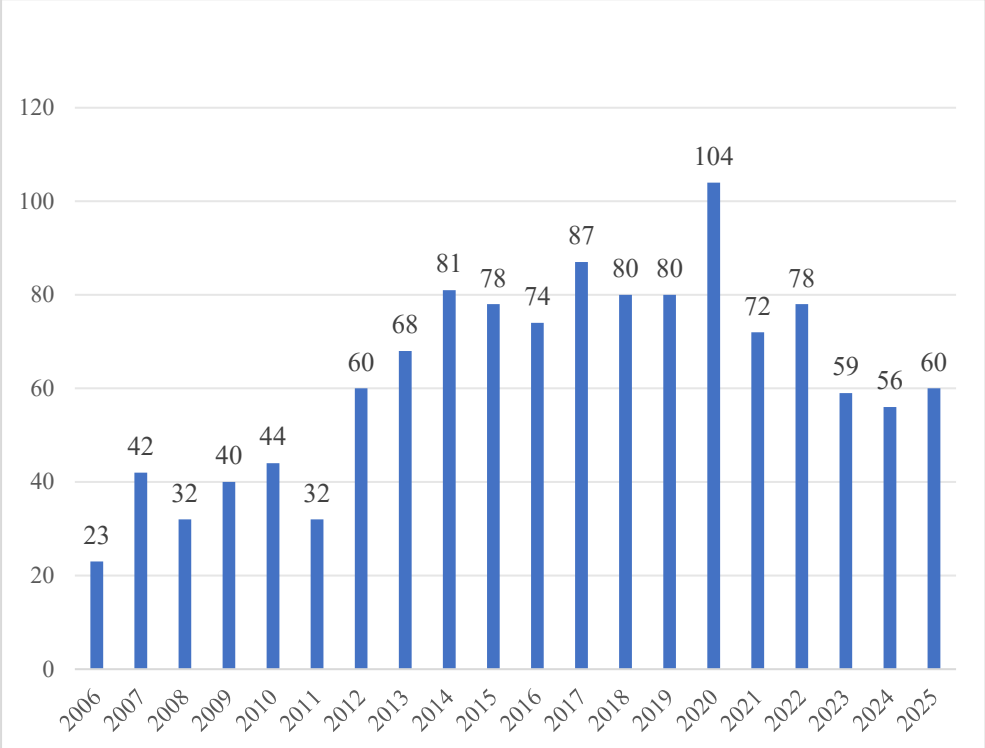

Figure 1. Distribution of publications by years (2006-2025)

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Table 1. Bibliographic statistics of 1250 publications extracted from WOS (2006-2025)

Total Publications	Journals	Authors	Institutions	Countries/Regions
1250	174	2723	2500	296

3.2. Authors.

According to the data collected from the WOS database, a total of 2723 scholars have contributed to publications in the field of DHH language ability research. According to academic norms, a network density below 0.1 generally indicates loose collaboration [24].The density of this research is 0.0094 (below 0.1). Based on the results, although a large number of scholars have participated in the research, cooperation among them remains limited.

However, there were some highly prolific authors identified. The top five most productive authors in the field of DHH individuals' language ability research---Marschark, Marc (14 publications); Easterbrooks, Susan R. (13); Miller, Paul (12); Nittrouer, Susan (12); and Gillis, Steven (12)---have shaped the understanding of DHH language and literacy development. Marschark et al. challenged the "visual learner" stereotype of DHH individuals [25, 26], emphasizing that print exposure and early visual language access (e.g., sign language) better predict reading outcomes than phonological awareness [27, 28], and noted DHH college students often overestimate their speech skills. Easterbrooks et al. validated targeted early literacy interventions and found bimodal (spoken + sign) or spoken-only communication modes outperform sign-only groups in reading; they also identified that 43% of young DHH children have reading fluency deficits, with sign-only children showing the weakest self-correction abilities [29]. Miller refuted the primacy of phonological awareness, showing DHH readers can develop efficient word recognition via orthographic knowledge [30], and that fingerspelling facilitates preschoolers' orthographic learning, with this conclusion holding across multiple orthographies [31]). Nittrouer et al. noted persistent phonological and verbal working memory deficits in cochlear implant (CI) users [32], identifying bimodal stimulation as a protective factor and nonword repetition as a clinical marker of language delays [33, 34]. Gillis et al. reported that CI children catch up in Intraword Variability by age 5 [35], but auditory brainstem implant (ABI) users lag in speech production accuracy and intelligibility [36, 37], while caregivers adapt input via fine lexical tuning to support DHH language acquisition [38].

Table 2. Top five productive authors (2006-2025)

R	P	Author
1	14	Marschark, Marc
2	13	Easterbrooks, Susan R
3	12	Miller, Paul
4	12	Nittrouer, Susan
5	12	Gillis, Steven

Furthermore, the top five most cited authors in this field---Geers AE (367 citations), Marschark M (298 citations), Moeller MP (228 citations), Mayberry RI (225 citations), and Lederberg AR (187 citations)---have laid the empirical foundation for understanding DHH individuals' language and literacy development. Geers focused on cochlear implant (CI) outcomes, confirming that early implantation (12-24 months) and cumulative auditory experience significantly improve DHH children's oral language and reading skills [39]. The second most cited author, Marschark M, is also the most productive author we mentioned earlier. Moeller et al. explored early language development, finding DHH children show "delayed but parallel" speech development, with caregiver conversational interaction predicting language outcomes,

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and advocating for family-centered intervention [40, 41]. Mayberry highlighted the language acquisition critical period, revealing DHH individuals accessing their first language after age 9 face persistent syntax and semantic difficulties [42]. Lederberg AR et al. validated explicit instruction (e.g., phonological training) and bilingual education for early literacy, noting teacher strategies like sentence reformulation boost DHH children's vocabulary and syntax [11].

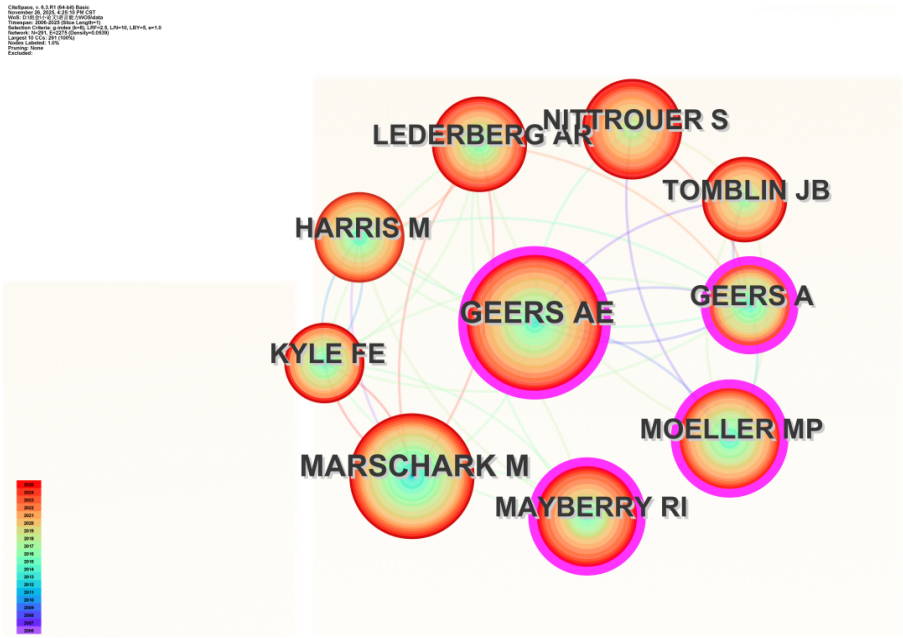

Figure 2. Top 10 cited authors

3.3. Countries or regions.

A total of 296 countries or regions contributed to the research of DHH language ability from 2006 to 2025. The top 10 most productive regions are led by the USA (599 publications), far exceeding other countries. England ranks second with 109 publications, followed by England (109), Australia (82), the Netherlands (71), Spain (67), Peoples R China (61), Israel (60), Canada (59), Italy (53), and Germany (49).

Table 3 presents the top five productive countries/regions in two stages (2006-2015 and 2016-2025). In the first stage (2006-2015), the United States (USA) took the leading position with 250 publications, far exceeding other countries/regions, demonstrating its long-standing dominance in this field. England ranked second with 49 publications, followed by the Netherlands (34), Israel (32), and Canada (28), reflecting the active participation of European and North American countries in early research. In the second stage (2016-2025), the USA maintained its prominent status with 349 publications, further consolidating its leading role. Notably, China (Peoples R China) emerged as a rising star, jumping from an unlisted position in the first stage to the fourth place with 50 publications, indicating rapid development and increased investment in DHH language ability research. Australia also showed strong growth, ranking third with 55 publications, while England (60) and Spain (47) remained in the top five, sustaining their research momentum.

Overall, North American and European countries have long been core contributors to this field, with the USA consistently leading in publication output. The significant rise of China and Australia in the second stage reflects the global expansion of research focus, suggesting that DHH language ability research has gained increasing attention beyond traditional research powerhouses. The total number of publications in the second stage also shows a marked increase compared to the first stage, indicating the growing global interest in this important research area.

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Table 3. Top five productive countries or regions (2006-2025)

2006-2015		2016-2025	
Countries/Regions	P	Countries/Regions	P
USA	250	USA	349
ENGLAND	49	ENGLAND	60
NETHERLANDS	34	AUSTRALIA	55
ISRAEL	32	PEOPLES R CHINA	50
CANADA	28	SPAIN	47

Notes: P: Publications. R: Rank.

3.4. Journals.

The 1250 selected publications are distributed across 174 SSCI-indexed journals in the Web of Science database. Table 4 lists the top 10 journals with the highest number of publications related to DHH language ability research, including their publication counts and percentage of the total output.

Among these journals, Journal of Deaf Studies and Deaf Education leads with 887 publications, accounting for 70.96% of the total output, making it the core journal in this field. Journal of Speech, Language, and Hearing Research ranks second with 827 publications (66.16%), followed by Ear and Hearing with 743 publications (59.44%). These three journals collectively contribute over half of the total research output, indicating their central role in disseminating cutting-edge findings on DHH language ability. Other prominent journals include American Annals of the Deaf (45.44%), Volta Review (39.28%), and Child Development (38%), which cover interdisciplinary themes such as deaf education, speech-language pathology, and child development.

Notably, the top journals in this field are predominantly focused on deaf education, speech-language pathology, and otorhinolaryngology, aligning with the interdisciplinary nature of DHH language ability research. These journals serve as key platforms for scholars worldwide to exchange research on language development mechanisms, intervention strategies, and educational practices for DHH individuals, playing a pivotal role in advancing the field.

Table 4. Top 10 journals (2006-2025)

R	C	P	Journals
1	887	70.96%	J DEAF STUD DEAF EDU
2	827	66.16%	J SPEECH LANG HEAR R
3	743	59.44%	EAR HEARING
4	568	45.44%	AM ANN DEAF
5	491	39.28%	VOLTA REV
6	475	38%	CHILD DEV
7	431	34.48%	INT J PEDIATR OTORHI
8	430	34.4%	COGNITION
9	416	33.28%	APPL PSYCHOLINGUIST
10	399	31.92%	AM J PSYCHOL

Notes: R: Rank, C: Count, P: Percentage.

3.5. Keywords.

Keywords, as a significant indicator, can clearly reflect the core ideas of research articles, proving to be vital for decoding themes of a specific discipline to some extent [43]. To illustrate the evolution of DHH language ability research from 2006 to 2025, the CiteSpace software was

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used to create a timeline map (Fig. 4) by applying the cluster year-by-year function [44]. According to their inherent connections, these keywords are categorized into 15 clusters. The three largest clusters are: #0 impairment, #1 age, and #2 cochlear implant.

The keywords with the highest frequency in each cluster are as follows: (#0) cochlear implants, impairment, skills, children; (#1) age, children; (#2) segmental speech, grammatical; (#3)production, phonological processing, sign language; (#4) phonology, support; (#5) phonological, short-term memory; (#6) phonological awareness, reading fluency, orthographic knowledge, word recognition, vocabulary predictors; (#7) attention, hearing children, lexical processing;(#8) speech production, language development, vocabulary size; (#9) speech perception; recognition, literacy; (#10) working memory, phonological awareness, spoken language; (#11) technology, english language learner, other languages, duallanguage; (#12) awareness, reading instruction, cued speech; (#13) sign language, community collaboration, individual differences, 2nd language, eye movements; (#14) ability, pragmatic language ability, bimodal bilingualism, long-term effect.

The cluster that scholars paid earliest attention to is #0 impairment, which is also one of the longest-lasting research focuses. The initial keywords of #0 are “hearing” and “spoken language”, both of which appeared in foundational studies in the field [39]. Another keyword cluster, #12 awareness, gained prominent attention from 2007 to 2014 and then gradually stabilized, emerging as a key hotspot during that period [4].

The clusters that remained active until 2025 include #2 cochlear implant, #5 language development, and #10 working memory. By examining the latest keywords in these clusters and their node details, it can be observed that recent studies are increasingly focused on cognitive mechanisms and multimodal communication. The latest keyword in #10 working memory is “cognitive development,” which was highlighted in Pesnot Lerousseau et al. [45]. The keyword “bimodal communication” in #13 sign language was explored in Mastrantuono et al.[23], which found that prelingually profoundly deaf participants with early cochlear implants (CIs) achieved comprehension levels equivalent to hearing peers across communication modes, while native sign language users only matched hearing peers’ comprehension when using their native sign language.

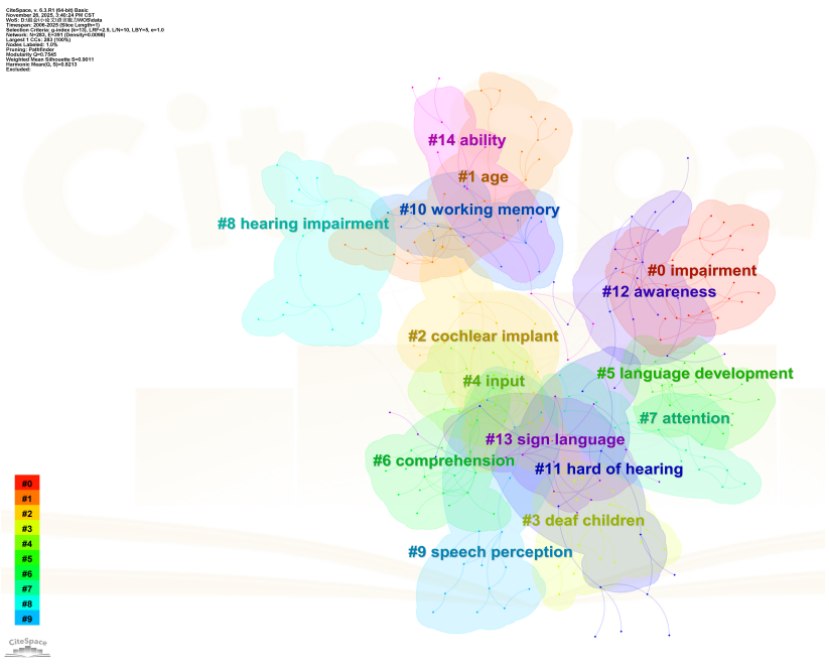

Figure 3. Cluster map of keywords

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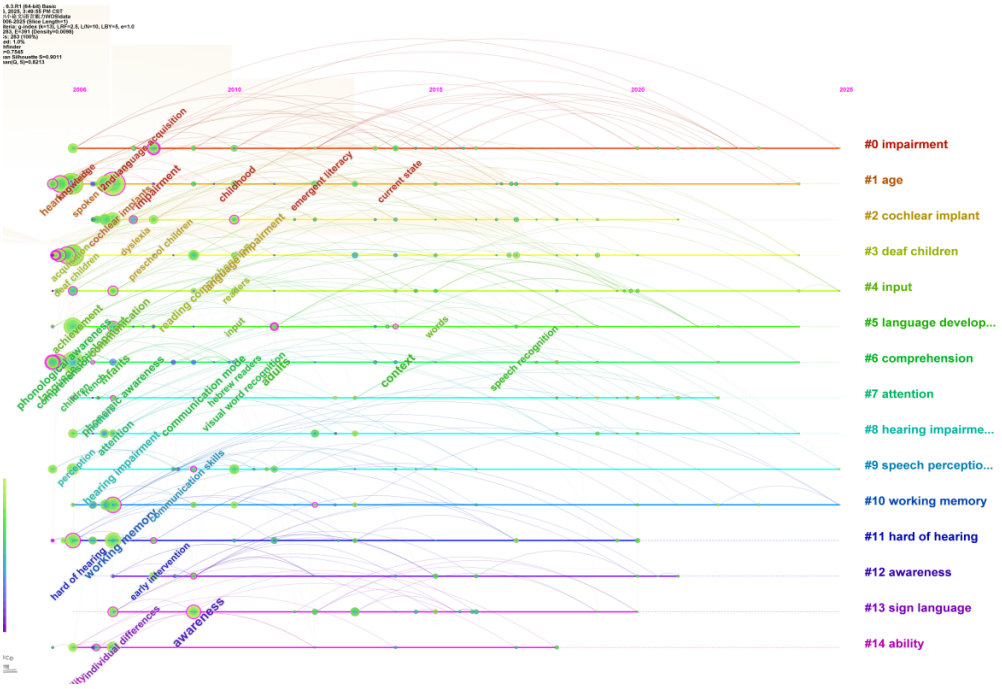

Figure 4. The timeline map of keywords year-by-year (2006-2025)

CiteSpace's citation burst analysis identifies keywords that experience a sudden surge in citations, a critical tool for detecting research fronts and emerging trends in DHH language ability studies. Fig. 5 presents the top 30 keywords with the strongest citation bursts from 2006 to 2025, where "Strength" indicates the intensity of scholarly attention and "Begin-End" marks the duration of the burst. These keywords not only reflect the field's dynamic focus but also align with key technological, policy, and empirical milestones.

The keyword with the highest burst strength is "phonemic awareness" (Strength = 9.99, 2007-2014), highlighting its central role in early debates about DHH reading development. This burst coincides with meta-analyses [4]. The long burst duration (7 years) underscores the field's prolonged exploration of how phonological skills interact with other factors (e.g., vocabulary, sign language) in DHH populations.

Another impactful keyword is "normal hearing" (Strength = 5.09, 2013-2017), which reflects the field's emphasis on comparative studies between DHH and hearing peers. This period saw a rise in research validating intervention efficacy by contrasting receptive vocabulary development between deaf children with CIs and normal-hearing children, providing critical benchmarks for assessing progress [46].

Notably, keywords with burst periods extending to the 2020s indicate recent trends: "cognitive development" (Strength = 4.41, 2020-2021) aligns with the growing focus on cognitive mechanisms (e.g., working memory) in DHH language learning [45]; "predictors" (Strength = 3.8, 2020-2023) reflects the field's shift toward identifying modifiable factors (e.g., age at implantation, family input) for personalized intervention; "sensitivity" (Strength = 3.53, 2022-2023) suggests emerging interest in fine-grained skills (e.g., auditory sensitivity to speech cues) as potential targets for intervention.

Finally, the absence of long bursts for traditional topics (e.g., "cochlear implant" itself) suggests that while assistive technology remains foundational, the field now prioritizes how to optimize its effects rather than just whether it works---a sign of maturity in DHH language ability research.

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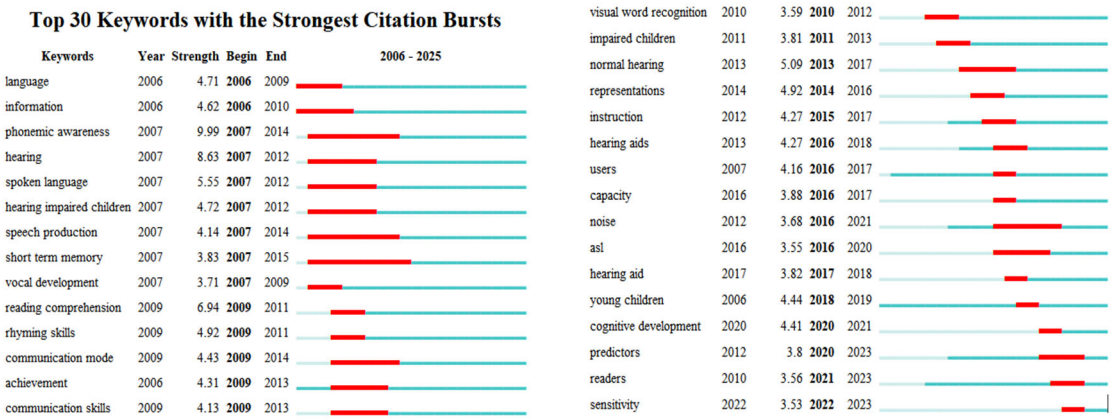

Figure 5. Top 30 keywords with the strongest citation bursts

3.6. Citation.

Citation analysis enables researchers to identify the most influential publications in a specific research field [44].

As shown in the cluster map (Fig. 6), CiteSpace filters out clusters with fewer than 10 references, leaving six core thematic clusters: #0 deaf individual, #1 hearing loss, #2 narrative skill, #3 sign language, #4 literacy skill, and #6 executive function skill. Each cluster aggregates the most influential cited references in its respective domain, reflecting key research focuses in DHH language ability studies (e.g., cluster #4 literacy skill centers on foundational literacy research, while #3 sign language links to studies of sign-based communication).

Nodes in the map represent high-impact references (marked with authors and publication years); for example, Mayberry RI (in cluster #0) and Lederberg AR (in cluster #2) are pivotal works in this field [4, 11].

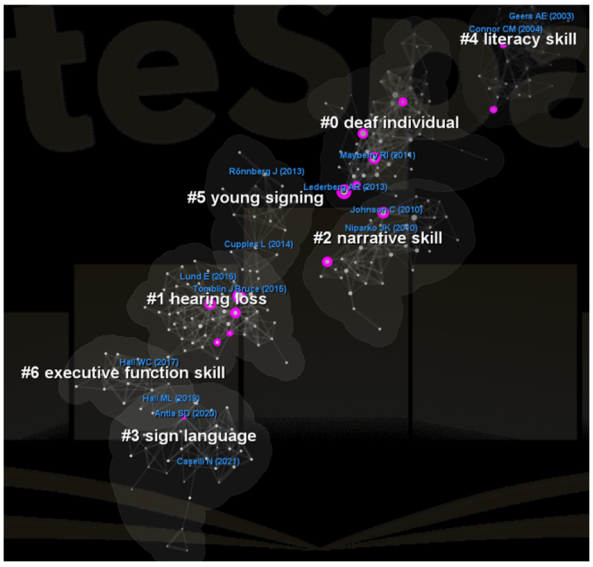

Figure 6. Cluster map of highly cited references

Fig. 7 presents the top 10 references with the strongest citation bursts in DHH language ability research. Among these, Tomblin et al. (2015) exhibits the highest burst strength (18.97) and a relatively long duration (2017-2020), highlighting its prominent and sustained influence in this field. This reference belongs to cluster #0 deaf individual (in Fig. 6), underscoring its role as a foundational work in studying DHH language development. Notably, Lund (2016) (burst 2018-

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2021) is one of the references with a later burst end time; it aligns with cluster #1 hearing loss (from the cluster map) and is also among the high-impact literature, reflecting its lasting relevance. Additionally, Mayberry et al. (2011) (burst 2012-2016) and Lederberg et al. (2013) (burst 2014-2018)---both part of the top five highly-cited authors---correspond to clusters #0 and #2 (in the cluster map), respectively, linking their citation bursts to the core themes of their research clusters.

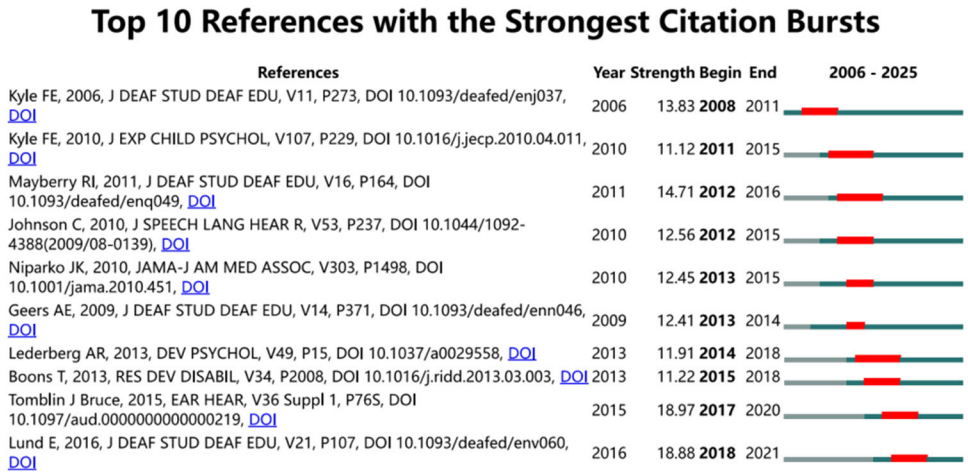

Figure 7. Top 10 references with the strongest citation bursts

Table 5 lists the top 10 most-cited references in the field of language ability research on deaf and hard-of-hearing individuals.

Lund (2016) and Tomblin et al.(2015) tie for first with 44 citations each. Lund's meta-analysis shows children with cochlear implants have significantly lower expressive and receptive vocabulary than normal-hearing peers, with a more obvious gap in tightly matched control groups [47]. Tomblin et al. finds that mild to severe hearing loss places children at risk for delays in language development. Risks are moderated by the provision of early and consistent access to well-fit hearing aids that provide optimized audibility [48]. Mayberry et al. (2011) ranks third with 42 citations. Its meta-analysis reveals phonological coding and awareness (PCA) explains only 11% of deaf readers' reading variance, while language ability accounts for 35%, indicating that PCA skills are a low to moderate predictor of reading achievement in deaf individuals and that other factors, most notably language ability, have a greater influence on reading development [4]. Lederberg et al. takes fourth with 35 citations. This review highlights sign language as a first language, quality family language input, and bilingual education (sign + spoken language) all boost deaf children's language and literacy development [11]. Johnson & Goswami secures fifth with 30 citations, showing early cochlear implantation (before 30 months) enhances phonological awareness, which indirectly affects reading comprehension via vocabulary [49]. Harris et al (2017) (29 citations) and Kyle & Harris (2010) (28 citations) rank sixth and seventh. Harris et al identifies that "phonological awareness was a concurrent predictor of reading, but the longitudinal predictors of reading were English vocabulary and speechreading" [50]. Kyle & Harris's 3-year study finds that vocabulary strongly predicts deaf children's long-term reading outcomes, speechreading forecasts early reading growth, and phonological awareness develops through reading (unlike hearing children) [51]; their reading development shares similarities with hearing children but differs in speechreading's role and phonological awareness' non-precursor status. Niparko et al. (2010) (27 citations) ranks eighth. This large-scale multicenter study confirms that "age at implantation and residual hearing are variables associated with growth rates for the acquisition of spoken language and environmental factors significantly associated with performance on measures of spoken

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language after CI [1]". Boons et al. (2013) (26 citations) and Kyle & Harris (2006) (24 citations) complete the top 10. Boons et al. notes significant delays in expressive vocabulary, morphology, syntax and narrative skills, but around half reached age-appropriate levels with no greater variability, and their main issues are insufficient morphological and syntactic knowledge rather than vocabulary skills [52]. Kyle & Harris finds that controlling for hearing loss and nonverbal intelligence, productive vocabulary and speechreading predict 7-8-year-old deaf children's reading (matched to hearing children by reading age), while spelling is unrelated to other indicators (age is key for hearing children) [53].

As revealed in the aforementioned analysis, the 3rd and 4th most-cited studies (Mayberry et al., 2011; Lederberg et al., 2013) are authored by Mayberry RI and Lederberg AR, which are fully consistent with the 4th and 5th most-cited authors (Mayberry RI with 225 citations; Lederberg AR with 187 citations) in Fig. 2. In addition, Kyle is the core author of 2 studies among the top-cited references, and also a co-author of another highly cited reference, resulting in a total of 3 top-cited studies associated with Kyle. As shown in Fig. 2, Kyle ranks 10th among the top-cited authors, and the correlation between the aforementioned literature and authors further validates the rationality of this ranking.

Table 5. Top 10 highly cited references

R	C	References	Title
1	44	Lund E, 2016, J DEAF STUD DEAF EDU, V21, P107, DOI 10.1093/deafed/env060	Vocabulary Knowledge of Children With Cochlear Implants: A Meta-Analysis
2	44	Tomblin J Bruce, 2015, EAR HEAR, V36 Suppl 1, P76S, DOI 10.1097/aud.0000000000000219	Language Outcomes in Young Children with Mild to Severe Hearing Loss
3	42	Mayberry RI, 2011, J DEAF STUD DEAF EDU, V16, P164, DOI 10.1093/deafed/enq049	Reading Achievement in Relation to Phonological Coding and Awareness in Deaf Readers: A Meta-analysis
4	35	Lederberg AR, 2013, DEV PSYCHOL, V49, P15, DOI 10.1037/a0029558	Language and literacy development of deaf and hard-of-hearing children: successes and challenges
5	30	Johnson C, 2010, J SPEECH LANG HEAR R, V53, P237, DOI 10.1044/1092-4388(2009/08-0139)	Phonological awareness, vocabulary, and reading in deaf children with cochlear implants
6	29	Harris M, 2017, J DEAF STUD DEAF EDU, V22, P233, DOI 10.1093/deafed/enw101	Concurrent and Longitudinal Predictors of Reading for Deaf and Hearing Children in Primary School
7	28	Kyle FE, 2010, J EXP CHILD PSYCHOL, V107, P229, DOI 10.1016/j.jecp.2010.04.011	Predictors of reading development in deaf children: a 3-year longitudinal study
8	27	Niparko JK, 2010, JAMA-J AM MED ASSOC, V303, P1498, DOI 10.1001/jama.2010.451	Spoken language development in children following cochlear implantation
9	26	Boons T, 2013, RES DEV DISABIL, V34, P2008, DOI 10.1016/j.ridd.2013.03.003	Expressive vocabulary, morphology, syntax and narrative skills in profoundly deaf children after early cochlear implantation
10	24	Kyle FE, 2006, J DEAF STUD DEAF EDU, V11, P273, DOI 10.1093/deafed/enj037	Concurrent correlates and predictors of reading and spelling achievement in deaf and hearing school children

4. Discussion

This discussion addresses the three research questions by linking the bibliometric findings to the study's objectives and existing knowledge.

4.1. General publication trend.

On the whole, research in this area has progressed steadily, and the number of publications has increased. From 2006 to 2011, the number of publications in the field of DHH language ability

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showed a slow fluctuating upward trend; the period 2012 to 2020 witnessed rapid growth; while the number of publications declined slightly from 2021 to 2025, it remained stably at a relatively high level of 56-80 articles per year. Two distinct peaks emerged in the development of this field: technological innovation drove the first peak (60 articles in 2012), followed by sustained rapid growth in publications, which reached the pinnacle of research activity in 2020 (104 articles). Notably, the number of recent publications remains significantly higher than that in the initial stage, a characteristic indicating that research on DHH language ability has gradually matured.

4.2. The most contributing authors, countries or regions, journals and articles.

Although 2723 scholars have participated in the research, inter-author cooperation remains limited. However, several prolific authors stand out---including Marschark, Marc; Easterbrooks, Susan R.; Miller, Paul; Nittrouer, Susan; and Gillis, Steven---each with over ten publications in this field. The top five most cited authors in this field were Geers AE, Marschark M , Moeller MP, Mayberry RI , and Lederberg AR, and Geers AE ranked first with 367 citations.The U.S. dominated (599 publications, ~48% of total), with Europe (e.g., England, 109 articles) as a consistent partner. Notably, China and Australia emerged post-2016, reflecting global interest expansion. Core journals (e.g., Journal of Deaf Studies and Deaf Education [J Deaf Stud Deaf Edu], with 887 articles) focused on deaf education and speech pathology, serving as key knowledge hubs. The top 10 cited references (e.g., Lund, 2016; Tomblin et al., 2015) centered on CI outcomes and language predictors, confirming their foundational role.

4.3. Hotspots in different periods and the emerging trend.

The keyword with the highest burst strength is “phonemic awareness” (Strength=9.99), which also has the logest burst duration (7 years, 2007-2014). In the period from 2012 to 2020, the keyword with the highest burst strength shifted to “normal hearing” (2013-2017), which reflects the field’s emphasis on comparative studies. And keywords with burst periods extending to the 2020s include “cognitive development” (2020-2021), “predictors” (2020-2023) and “sensitivity” (2022-2023). These keywords reflect the growing focus on cognitive mechanisms (e.g., working memory) in DHH language learning, identifying modifiable factors (e.g., age at implantation, family input) for personalized intervention and taking fine-grained skills (e.g., auditory sensitivity to speech cues) as potential targets for intervention, which reflects a move toward holistic, individual-focused intervention.

Limitations include fragmented author collaboration (density = 0.0094) and potential WOS database bias. Furthermore, this study is limited to SSCI-indexed journals, potentially excluding relevant research from other databases (e.g., Scopus). Additionally, keyword clustering did not account for synonym integration, which may have affected the accuracy of thematic analysis. Future research should integrate cognitive development mechanisms (e.g., working memory) into personalized language intervention for DHH children. Additionally, international collaborative studies are needed to compare the effectiveness of different educational policies across countries (e.g., China’s rising research output vs. the U.S.’s long-standing dominance).

5. Conclusion

This study systematically analyzes DHH language ability research over the past two decades through bibliometric methods, addressing the three core research questions. First, the publication trend reflects the field’s maturation: technological innovations and policy expansions drove the 2012 turning point, and subsequent growth was fueled by cognitive mechanism research, leading to stable high-quality output in recent years. Second, the U.S. maintains a leading position in contributions, with China and Australia emerging as rising powers; Core contributors are dominated by the U.S., with prolific authors including Marschark,

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M. and Easterbrooks, S. R., and high-impact journals such as Journal of Deaf Studies and Deaf Education. The top-cited references focus on cochlear implant (CI) outcomes and language predictors. Third, research hotspots have shifted from deficit-focused exploration to holistic, individual-centered intervention, with cognitive development, personalized predictors, and fine-grained skills becoming key frontiers.

Limitations of this study include limited author collaboration and potential Web of Science database bias. Future research should strengthen cross-disciplinary and international cooperation, focus on long-term tracking of CI outcomes, and deepen exploration of personalized intervention strategies. Overall, this study provides a comprehensive overview of DHH language ability research, offering insights for scholars, practitioners, and policymakers to advance the field toward more inclusive and effective language support for DHH individuals.

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References

[1] Niparko, J. K., Tobey, E. A., Thal, D. J., et al. Spoken language development in children following cochlear implantation. JAMA, 2010, 303(15), 1498-1506.

[2] Bachman, L. F., & Palmer, A. S. Language Testing in Practice. Oxford University Press, 1996.

[3] Marschark, M., & Hauser, P. C. (Eds.). Deaf cognition: Foundations and outcomes. Oxford University Press, 2008.

[4] Mayberry, R. I., del Giudice, A. A., & Lieberman, A. M. Reading achievement in relation to phonological coding and awareness in deaf readers: A meta-analysis. The Journal of Deaf Studies and Deaf Education, 2011, 16(2), 164-188.

[5] Soleymani, Z., Mahmoodabadi, N., & Nouri, M. M. Language skills and phonological awareness in children with cochlear implants and normal hearing. International journal of pediatric otorhinolaryngology, 2016, 83, 16-21.

[6] Holzinger, D., Dall, M., Sanduvete-Chaves, S., et al., The Impact of Family Environment on Language Development of Children With Cochlear Implants: A Systematic Review and Meta-Analysis. Ear and hearing, 2020, 41(5), 1077-1091.

[7] Balkany, T. J., Hodges, A. V., Eshraghi, A. A., et al., Cochlear implants in children--a review. Acta oto-laryngologica, 2002, 122(4), 356-362.

[8] Nittrouer, S., Caldwell-Tarr, A., & Lowenstein, J. H. Working memory in children with cochlear implants: problems are in storage, not processing. International journal of pediatric otorhinolaryngology, 2013, 77(11), 1886-1898.

[9] Bunta, F., Douglas, M., Dickson, H., et al. Dual language versus English-only support for bilingual children with hearing loss who use cochlear implants and hearing aids. International journal of language & communication disorders, 2016, 51(4), 460-472.

[10] Chen, P. H., & Liu, T. W. Does Parental Education Level Matter? Dynamic Effect of Parents on Family-Centred Early Intervention for Children with Hearing Loss. International Journal of Disability, Development and Education, 2019, 68(4), 457-478.

[11] Lederberg, A. R., Schick, B., & Spencer, P. E. Language and literacy development of deaf and hard-of-hearing children: successes and challenges. Developmental psychology, 2013, 49(1), 15-30.

[12] Chen, C. CiteSpace: A practical guide for mapping scientific literature. Springer, 2006.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202605_9(5).0017

[13] Xiao, G., & Zhang, M. Knowledge Mapping of Blended Learning Classroom Environment Studies (1996-2023): A Bibliometric Analysis. International Journal of Emerging Technologies in Learning (iJET), 2024, 19(1), 68-85.

[14] Mou, J., Cui, Y., & Kurcz, K. Bibliometric and visualized analysis of research on major e-commerce journals using CiteSpace. Journal of Electronic Commerce Research, 2019, 20, 219-237.

[15] Chen, C. A glimpse of the first eight months of the COVID-19 literature on Microsoft Academic Graph: Themes, citation contexts, and uncertainties. Frontiers in Research Metrics and Analytics, 2020, 5, 607286.

[16] Cochlear. The Cochlear™ Baha® System Continues to Shape the Future of Bone Conduction Implant Technology, 2012.

[17] Cochlear. Sound redefined: the Cochlear Nucleus System evolution, 2024.

[18] Nittrouer, S., Caldwell-Tarr, A., Sansom, E., et al. Nonword repetition in children with cochlear implants: a potential clinical marker of poor language acquisition. American journal of speech-language pathology, 2014, 23(4), 679-695.

[19] Trussell, J. W., & Easterbrooks, S. R. The effect of enhanced storybook interaction on signing deaf children's vocabulary. Journal of deaf studies and deaf education, 2014, 19(3), 319-332.

[20] Verhoeven, J., Hide, O., De Maeyer, S., et al. Hearing impairment and vowel production. A comparison between normally hearing, hearing-aided and cochlear implanted Dutch children. Journal of communication disorders, 2016, 59, 24-39.

[21] Nittrouer, S., Caldwell-Tarr, A., & Lowenstein, J. H. Working memory in children with cochlear implants: problems are in storage, not processing. International journal of pediatric otorhinolaryngology, 2013, 77(11), 1886-1898.

[22] Morrison, C., Marschark, M., Sarchet, T., et al. Deaf students' metacognitive awareness during language comprehension. European Journal of Special Needs Education, 2012, 28(1), 78-90.

[23] Mastrantuono, E., Saldaña, D., & Rodríguez-Ortiz, I. R. An Eye Tracking Study on the Perception and Comprehension of Unimodal and Bimodal Linguistic Inputs by Deaf Adolescents. Frontiers in psychology, 2017, 8, 1044.

[24] Newman, M. E. J. The structure of scientific collaboration networks. Proceedings of the National Academy of Sciences of the United States of America, 2001, 98(2), 404-409.

[25] Marschark, M., Morrison, C., Lukomski, J., et al. Are Deaf Students Visual Learners?. Learning and individual differences, 2013, 25, 156-162.

[26] Marschark, M., Paivio, A., Spencer, L. J., et al., Don't Assume Deaf Students are Visual Learners. Journal of developmental and physical disabilities, 2017, 29(1), 153-171.

[27] Marschark, M., Sarchet, T., Convertino, C. M., Borgna, G., Morrison, C., & Remelt, S. Print exposure, reading habits, and reading achievement among deaf and hearing college students. Journal of deaf studies and deaf education, 2012, 17(1), 61-74.

[28] Knoors, H., & Marschark, M. Language planning for the 21st century: revisiting bilingual language policy for deaf children. Journal of deaf studies and deaf education, 2012, 17(3), 291-305.

[29] Easterbrooks, S. R., & Lederberg, A. R. Reading Fluency in Young Elementary School Age Deaf and Hard-of-Hearing Children. Journal of deaf studies and deaf education, 2021, 26(1), 99-111.

[30] Miller, P. Phonological, Orthographic, and Syntactic Awareness and their Relation to Reading Comprehension in Prelingually Deaf Individuals: What Can We Learn from Skilled Readers?. J Dev Phys Disabil. 2010, 22, 549-580.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202605_9(5).0017

[31] Miller, P., Banado-Aviran, E., & Hetzroni, O. E. Developing Reading Skills in Prelingually Deaf Preschool Children: Fingerspelling as a Strategy to Promote Orthographic Learning. Journal of deaf studies and deaf education, 2021, 26(3), 363-380.

[32] Nittrouer, S., Caldwell-Tarr, A., Low, K. E., et al. Verbal Working Memory in Children With Cochlear Implants. Journal of speech, language, and hearing research : JSLHR, 2017, 60(11), 3342-3364.

[33] Nittrouer, S., Muir, M., Tietgens, K., et al. Development of Phonological, Lexical, and Syntactic Abilities in Children With Cochlear Implants Across the Elementary Grades. Journal of speech, language, and hearing research : JSLHR, 2018, 61(10), 2561-2577.

[34] Nittrouer, S., Sansom, E., Low, K., et al. Language structures used by kindergartners with cochlear implants: relationship to phonological awareness, lexical knowledge and hearing loss. Ear and hearing, 2014, 35(5), 506-518.

[35] Faes, J., & Gillis, S. Intraword Variability in Children With Cochlear Implants: The Long-Term Development up to 5 Years of Age and a Comparison With Children With Normal Hearing. American journal of speech-language pathology, 2018, 27(2), 706-720.

[36] Faes, J., De Maeyer, S., & Gillis, S. Speech intelligibility of children with an auditory brainstem implant: A triple-case study. CLINICAL LINGUISTICS & PHONETICS, 2022a, 36(12), 1067-1092.

[37] Faes, J., Gillis, J., & Gillis, S. Speech production accuracy of children with auditory brainstem implants: A comparison with peers with cochlear implants and typical hearing using Levenshtein Distance. FIRST LANGUAGE, 2022b, 42(1), 22-50.

[38] Odijk, L., & Gillis, S. Tailoring the Input to Children's Needs: The Use of Fine Lexical Tuning in Speech Directed to Normally Hearing Children and Children With Cochlear Implants. Frontiers in psychology, 2021, 12, 676664.

[39] Nicholas, J. G., & Geers, A. E. Effects of early auditory experience on the spoken language of deaf children at 3 years of age. Ear and hearing, 2006, 27(3), 286-298.

[40] Moeller, M. P., Gale, E., Szarkowski, A., et al. Family-Centered Early Intervention Deaf/Hard of Hearing (FCEI-DHH): Foundation Principles. JOURNAL OF DEAF STUDIES AND DEAF EDUCATION, 2024a, 29(SI, I), SI53-SI63.

[41] Moeller, M. P., Szarkowski, A., Gale, E., et al. Family-Centered Early Intervention Deaf/Hard of Hearing (FCEI-DHH): Guiding Values. JOURNAL OF DEAF STUDIES AND DEAF EDUCATION, 2024b, 29(SI, I), SI8-SI26.

[42] Cheng, Q., & Mayberry, R. I. When event knowledge overrides word order in sentence comprehension: Learning a first language after childhood. Developmental science, 2021, 24(5), e13073.

[43] Chen, X., Chen, J. , Wu, D., et al. Mapping the research trends by co-word analysis based on keywords from funded project, Procedia Computer Science, 2016, vol. 91, pp. 547-555.

[44] Chen, C. Science mapping: A systematic review of the literature, Journal of Data and Information Science, 2017, vol. 2, no. 2, pp. 1-40.

[45] Pesnot Lerousseau, J., Denis, M., Roman, S., et al. Working Memory Deficits in School-Age Children With Cochlear Implants Are Primarily Explained by Deficits in the Processing of Auditory and Lexical Information. Journal of speech, language, and hearing research : JSLHR, 2025, 68(3), 1225-1235.

[46] Hayes, H., Geers, A. E., Treiman, R., et al. Receptive vocabulary development in deaf children with cochlear implants: achievement in an intensive auditory-oral educational setting. Ear and hearing, 2009, 30(1), 128-135.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202605_9(5).0017

[47] Lund E. Vocabulary Knowledge of Children With Cochlear Implants: A Meta-Analysis. Journal of deaf studies and deaf education, 2016, 21(2), 107-121.

[48] Tomblin, J. B., Harrison, M., Ambrose, S. E., et al. Language Outcomes in Young Children with Mild to Severe Hearing Loss. Ear and hearing, 2015, 36 Suppl 1(0 1), 76S-91S.

[49] Johnson, C., & Goswami, U. Phonological awareness, vocabulary, and reading in deaf children with cochlear implants. Journal of speech, language, and hearing research : JSLHR, 2010, 53(2), 237-261.

[50] Harris, M., Terlektsi, E., & Kyle, F. E. Concurrent and Longitudinal Predictors of Reading for Deaf and Hearing Children in Primary School. Journal of deaf studies and deaf education, 2017, 22(2), 233-242.

[51] Kyle, F. E., & Harris, M.Predictors of reading development in deaf children: a 3-year longitudinal study. Journal of experimental child psychology, 2010, 107(3), 229-243.

[52] Boons, T., De Raeve, L., Langereis, M., et al. Expressive vocabulary, morphology, syntax and narrative skills in profoundly deaf children after early cochlear implantation. Research in developmental disabilities, 2013, 34(6), 2008-2022.

[53] Kyle, F. E., & Harris, M. Concurrent correlates and predictors of reading and spelling achievement in deaf and hearing school children. Journal of deaf studies and deaf education, 2006, 11(3), 273-288.