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## Music and Children's Language Development: A Bibliometric Analysis of Research Trends and Intellectual Structures (2021-2025)

Chen Lingyan 

Lincoln University College  
Selangor, Malaysia

Lim Seong Pek\* 

Lincoln University College, Selangor,  
Malaysia & INTI International University,  
Negeri Sembilan, Malaysia

**Abstract.** Research on music as a pedagogical tool for children's language development has expanded rapidly, yet scholarly knowledge remains fragmented across disciplines and methodological traditions. This study aims to map research trends, intellectual structures, and thematic developments in music-based language development research through a bibliometric approach. A total of 224 journal articles published between 2021 and 2025 were retrieved from the Scopus database following PRISMA guidelines. Performance analysis, co-citation analysis, and co-occurrence analysis were conducted using bibliometric mapping techniques. Findings reveal steady publication growth and five major intellectual clusters encompassing auditory neuroscience, rhythm-based literacy interventions, early language acquisition, cognitive transfer, and neurodiversity-focused applications. Keyword analysis highlights emerging themes related to early childhood learning, music therapy, and inclusive education. The results demonstrate that music functions as a multidimensional scaffold supporting linguistic, cognitive, and socio-emotional development. Despite increasing scholarly attention, gaps remain in cross-cultural representation and in the long-term implementation of education. Aligned with Sustainable Development Goal 4, this study provides a consolidated evidence base and future research directions for integrating music into children's language learning practices.

**Keywords:** music-based learning; language development; early childhood; inclusive education; bibliometric analysis

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\*Corresponding author: Lim Seong Pek; [limseongpek@gmail.com](mailto:limseongpek@gmail.com)

## 1. Introduction

Music has long been regarded as a potent medium for human communication and learning, particularly during early childhood when linguistic, cognitive, and socio-emotional systems are quickly developing (Pino et al., 2023). In recent decades, considerable scholarly attention has been devoted to integrating music into educational settings, especially as a pedagogical tool to enhance children's language development (Huang, 2023). Music-based language acquisition comprises activities such as singing, rhythmic dancing, musical storytelling, and sound-based play, all of which give rich auditory input and significant communication experiences (Lefterov & Mantovani, 2025). As educational research continues to cross interdisciplinary boundaries, a thorough evaluation of how music has been used to improve children's language outcomes is both pertinent and necessary (Sinn et al., 2022).

The value of music in language development resides in its tight neurological, structural, and functional alignment with linguistic processes (Zhao et al., 2022). Musical activities naturally engage phonological awareness, prosody, rhythm, and memory, which indicate the core components of early language learning (Pino et al., 2023). Through frequent exposure to melodies and lyrics, children can enhance vocabulary acquisition, pronunciation accuracy, listening comprehension, and expressive fluency (Ngadni & Hui, 2025a). Music also boosts motivation and emotional engagement, producing low-anxiety learning conditions that stimulate verbal participation (Smith et al., 2023). For young learners and children with diverse learning needs, music offers an inclusive, multimodal approach to language development that extends beyond traditional text-based education (MacDonald-Prégent et al., 2023).

Despite its acknowledged benefits, integrating music into language teaching poses several hurdles (Ngadni & Hui, 2025b). In many education systems, music is typically neglected due to curriculum limits, assessment-driven goals, and limited instructional time (Donn et al., 2024). Teachers may lack formal training or confidence in using music-based language techniques, while access to musical materials and digital tools remains inconsistent across contexts (Ngadni & Hui, 2025b). Furthermore, existing research in this sector is fragmented and varies greatly in theoretical underpinnings, research methodologies, age groups, and intervention types, making it difficult to draw cohesive conclusions about long-term effectiveness and pedagogical scalability (Sinn et al., 2022). Against this backdrop, bibliometric analysis aims to provide a comprehensive picture of how music has been conceptualised, applied, and evaluated as a language-learning tool for children.

Although previous studies have demonstrated the benefits of music for children's linguistic and cognitive development, existing research remains dispersed across psychological, educational, and clinical domains. To date, limited studies have systematically examined how scholarly knowledge in this field has evolved, what intellectual foundations shape current research, and which thematic directions dominate contemporary investigations. The absence of an updated bibliometric synthesis covering recent literature (2021-2025) creates a gap in understanding the

structure and trajectory of music-based language development research. Therefore, this study aims to map publication trends, intellectual structures, and thematic developments in research examining music and children's language development using bibliometric analysis.

1. What are the publication and citation trends in music and children's language development research between 2021 and 2025?
2. What intellectual structures underpin this research field?
3. What thematic patterns and emerging research directions can be identified?

## 2. Method

This study employed a bibliometric analysis to comprehensively assess scholarly studies on the use of music to boost children's language development (Klarin, 2024). Bibliometric analysis is particularly beneficial for synthesising vast amounts of literature in an objective and replicable manner, enabling scholars to uncover intellectual structures, research trends, and thematic evolutions within a field (Bernatović et al., 2021).

Unlike traditional narrative evaluations, bibliometric methodologies focus on quantitative indicators derived from publication metadata, providing a comprehensive perspective on research production, influence, and knowledge advancement over time (Ellili, 2022). Given the interdisciplinary character of music and language studies, bibliometric analysis provides a suitable methodological approach for tracing their growth and scholarly impact (Zou et al., 2025). The analysis had three primary components: performance analysis, co-citation analysis, and co-occurrence analysis (Prasad et al., 2025).

First, performance analysis was conducted to measure the productivity and influence of literature. This analysis allows for the identification of highly cited works that have changed scholarly understanding of music-based language learning, as well as insights about the temporal growth and academic importance of the study topic (Mee et al., 2025). Second, co-citation analysis was utilised to evaluate the intellectual roots of the area (Pham et al., 2022).

By examining how frequently pairs of references were cited together, this technique revealed clusters of significant works and theoretical viewpoints that support research on music and language development (Zou et al., 2025). Third, a co-occurrence analysis of author keywords was conducted to identify theme patterns and to develop research trends (Zhou et al., 2021). This methodology assessed the frequency and relational proximity of terms appearing together within publications, identifying primary issues, methodological emphases, and emerging areas of interest (Chew et al., 2025).

The bibliometric workflow comprised four stages: data extraction from Scopus, metadata cleaning via spreadsheet processing, network mapping with VOSviewer, and interpretation of bibliometric indicators. Threshold values were applied to ensure meaningful clustering and visual clarity during co-citation and co-occurrence analyses. To ensure methodological consistency, all retrieved documents were screened for relevance to music and children's language

development, peer-review status, and alignment with the study's scope. Articles focusing solely on unrelated musical outcomes or adult populations were excluded. This quality appraisal ensured that the selected dataset comprised empirically grounded, thematically relevant studies suitable for bibliometric analysis.

## 2.1 Search Strategy

The search strategy (Table 1) was designed to systematically retrieve relevant literature on the use of music in children's language development from the Scopus database. Scopus was selected for its broad coverage of high-quality, peer-reviewed journals across education, psychology, and interdisciplinary research. The search was conducted within the TITLE-ABS-KEY fields to ensure that music, children, and language constituted the core focus of the retrieved studies. The search string "music" AND "child\*" AND "language" was applied to capture variations of the term child. The search was limited to English-language, open-access journal articles published between 2021 and 2025, ensuring contemporary relevance, accessibility, and methodological rigour.

**Table 1: Inclusion and Exclusion Criteria for Bibliometric Analysis**

Scopus Database	Included Items	Excluded Items
Time period	2021 to 2025	Before 2021
Search field	TITLE-ABS-KEY	-
Search keywords	"music" AND "child*" AND "language"	-
Document Types	Article	Conference papers, reviews, book chapters
Language	English	Non-English
Open Access	All Open Access	Non-Open Access

In addition, the study selection process (Figure 1) followed the PRISMA guidelines to ensure transparency and methodological rigour. An initial search of the Scopus database identified 1,759 records. After applying the publication year filter, 1,187 records outside the 2021-2025 timeframe were excluded. During the screening stage, 572 records were assessed by document type, leading to the removal of 185 non-research articles. Subsequently, 387 full-text articles were evaluated for eligibility. Of these, 163 articles were excluded because they did not meet the English-language or open-access criteria. Ultimately, 224 studies satisfied all inclusion requirements and were retained for bibliometric analysis.

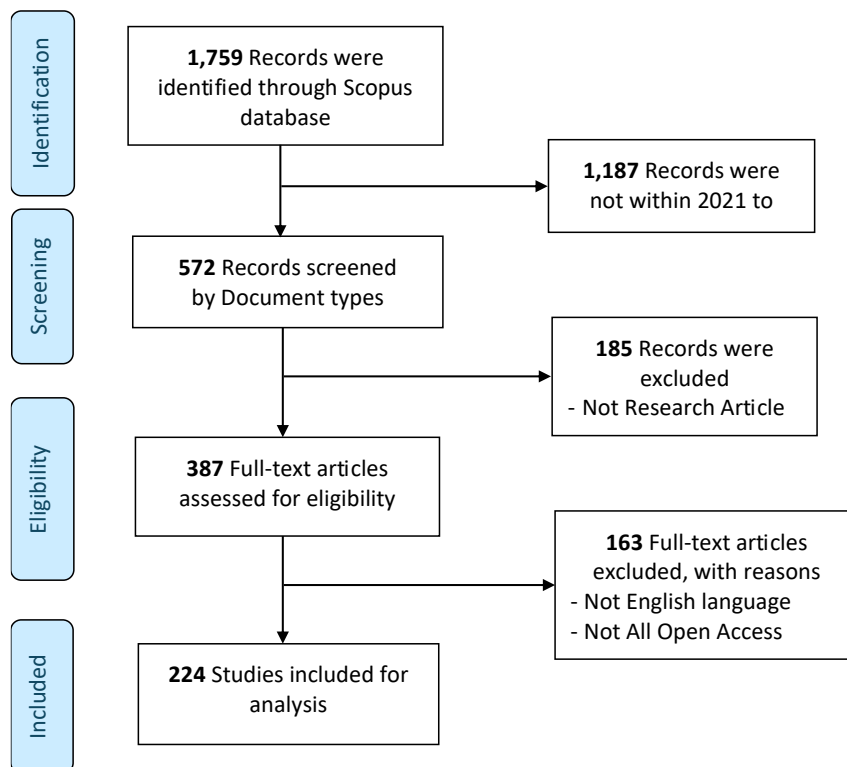


Figure 1: PRISMA Flowchart

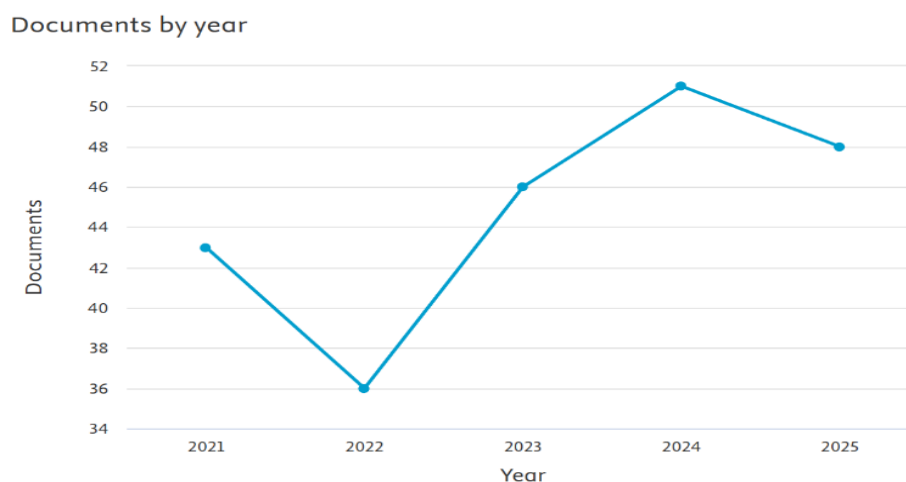
### 3. Results

#### 3.1 Performance Analysis

Performance analysis is a basic component of bibliometric research used to measure the productivity and academic impact of a topic of study. It evaluates quantitative measures like publication output, citation counts, document kinds, and highly cited publications to assess how knowledge creation has evolved over time. In the context of music-based language development research, performance analysis enables the identification of key studies that have affected scholarly discourse and indicates trends in study growth and impact. This approach provides an empirical framework for analysing the maturity, visibility, and intellectual significance of the area.

##### 3.1.1 Performance by Year

The performance by year in Figure 2 demonstrates a typically higher trajectory in scholarly output on the use of music to aid children's language development between 2021 and 2025, suggesting growing academic interest in this interdisciplinary topic. In 2021, a total of 43 publications were reported, creating a relatively robust platform for further scientific effort. This was followed by a dramatic reduction in 2022, with output dropping to 36 documents, which may be linked to disruptions in research efforts and publishing cycles during the post-pandemic transition.

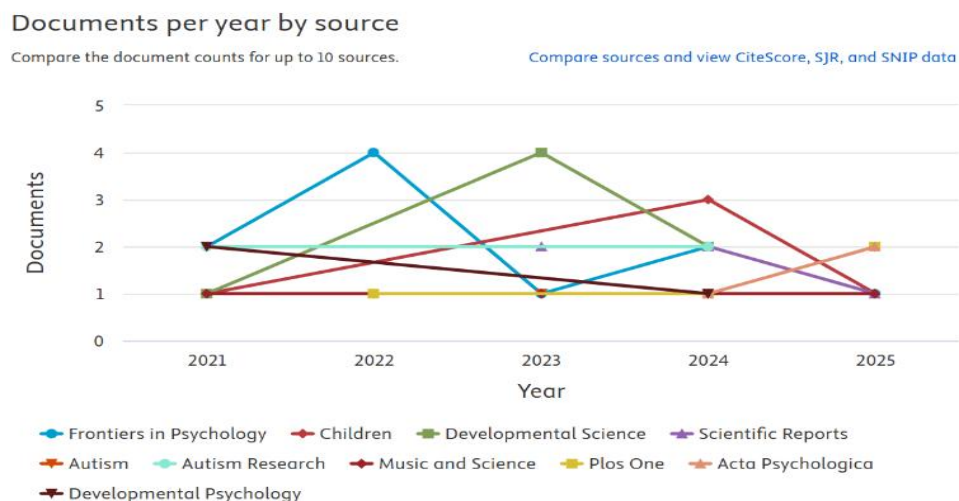


**Figure 2: Publications by Year**

From 2023 onwards, the field displayed a notable comeback and expansion. Publications grew to 46 documents in 2023, demonstrating renewed momentum and ongoing research commitment. The trend peaked in 2024, with the highest output of 51 articles, demonstrating heightened scholarly attention and the consolidation of music-based language acquisition as a research emphasis. Although 2025 shows a slight reduction to 48 documents, the figure remains fairly high, suggesting continued productivity and stability.

### 3.1.2 Performance by Sources

The performance by sources in Figure 3 reveals the academic emphasis and journal preferences within research on music-enhanced children's language development between 2021 and 2025. *Frontiers in Psychology* emerges as the most prolific source, with 10 papers, suggesting the prominence of this topic within psychological and cognitive-developmental research. Its production shows swings throughout the years, showing periodic thematic emphasis rather than continuous annual dominance.

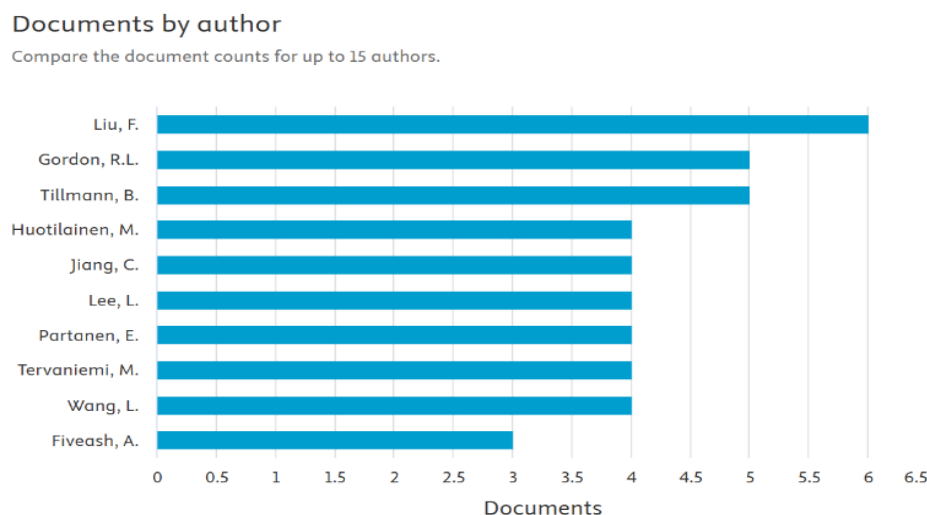


**Figure 3: Top Sources**

Developmental Science follows with 7 papers, suggesting consistent scientific interest in the developmental pathways linking music and language acquisition. Journals such as *Children* and *Scientific Reports* (each with 5 publications) further demonstrate the field's interdisciplinary scope, including education, health, and broader scientific investigation. Specialised outlets, including *Autism*, *Autism Research*, *Music and Science*, and *PLOS ONE* (4 publications each), imply a growing focus on neurodiversity, clinical populations, and empirical music research. Meanwhile, *Acta Psychologica* (3 publications) indicates a more focused yet emerging contribution.

### 3.1.3 Performance by Authors

The performance by authors in Figure 4 features a group of extremely engaged and renowned researchers who contributed to research on music and children's language development between 2021 and 2025. Liu, F., emerges as the most prolific author with six publications, suggesting sustained participation and leadership in advancing empirical and theoretical work on this topic. Close behind are Gordon, R. L., and Tillmann, B., each contributing five papers, indicating their substantial influence in music cognition and language processing studies.



**Figure 4: Author Productivity**

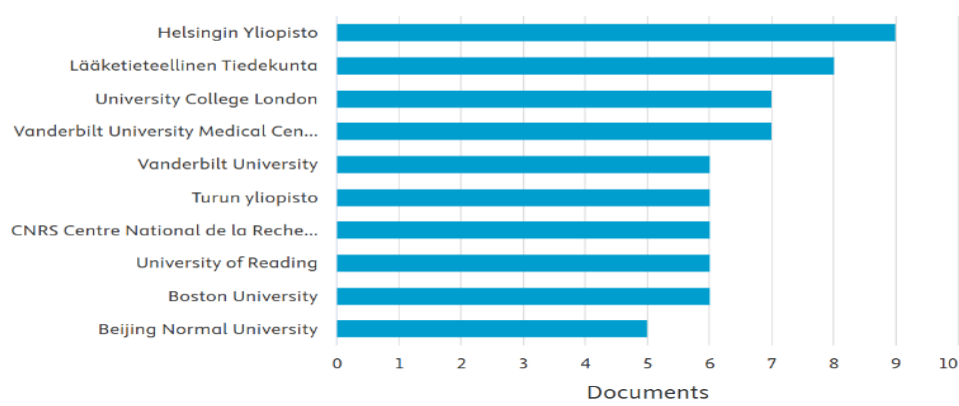
A second layer of productive authors, including Huotilainen, M., Jiang, C., Lee, L., Partanen, E., Tervaniemi, M., and Wang, L., published four documents, demonstrating collaborative networks and topic coherence across investigations. The distribution implies that the area is driven by a relatively concentrated set of scientists with interdisciplinary competence encompassing music cognition, developmental neurobiology, and language instruction. This pattern shows a growing research topic marked by recurring authorship, collaborative production, and cumulative knowledge creation.

### 3.1.4 Performance by Organisations

The organisation's performance in Figure 5 demonstrates that research on music-enhanced children's language development is predominantly conducted by research-intensive universities and medical neuroscience institutions, reflecting the field's strong base in cognitive and developmental science. The University of Helsinki emerges as the most productive institution, with nine publications, underscoring its recognised strength in auditory neuroscience and music-language research. Closely following is the Faculty of Medicine, University of Helsinki, with eight articles, highlighting the medical and neurodevelopmental orientation of the topic.

#### Documents by affiliation

Compare the document counts for up to 15 affiliations.



**Figure 5: Organisation Contribution**

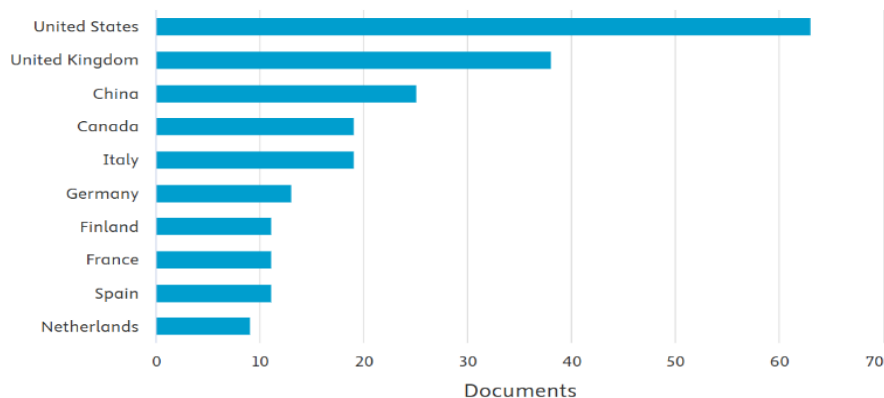
Internationally, University College London and Vanderbilt University Medical Center each provided seven documents, demonstrating strong multidisciplinary collaborations between psychology, education, and health sciences. Vanderbilt University, the University of Turku, the CNRS, and the University of Reading (six papers each) further highlight Europe-US dominance in this study area. Meanwhile, Beijing Normal University highlights the growing contributions of Asians.

### 3.1.5 Performance by Countries

The performance by country in Figure 6 demonstrates a distinct geographical concentration of research on music-enhanced children's language development, with domination from Western and high-income nations. The United States leads strongly with 63 publications, highlighting its great research capacity in psychology, neurology, and educational studies. The United Kingdom follows with 38 documents, demonstrating continued scholarly engagement, particularly in developmental science and education-focused research.

### Documents by country or territory

Compare the document counts for up to 15 countries/territories.



**Figure 6: Country Distribution**

China comes third with 25 papers, demonstrating increased interest and expanding research investment in music and language development within Asian contexts. This is followed by Canada and Italy, each contributing 19 research, demonstrating active European and North American participation. Other noteworthy donors include Germany (13), Finland, France, and Spain (11 each), as well as the Netherlands. The distribution suggests that research on this topic is driven primarily by countries with strong traditions in cognitive science, music education, and child development.

### 3.2 Co-Citation Analysis

The top 10 most cited publications in Table 2 illustrate the intellectual depth and topic diversity of research on music and children's language development, highlighting both basic theory and applied intervention studies. At the forefront is Hilton et al. (2022), with 106 citations, which presents cross-cultural evidence that infant-directed speech and song exhibit universal acoustic regularities. Its popularity highlights the rising acknowledgement of music as a biologically grounded framework for early language acquisition. Several widely referenced studies focus on cognitive and auditory systems. Longitudinal and experimental investigations by Nie et al. (2022) and Tervaniemi et al. (2022) reveal that music training enhances auditory working memory and auditory brain processing, often outperforming foreign language training alone.

**Table 2: Co-citations (Top 10 Articles)**

No.	Author(s)	Title	No. of Citations
1.	Hilton et al. (2022)	Acoustic regularities in infant-directed speech and song across cultures	106
2.	Nie et al. (2022)	Effects of Music Training on the Auditory Working Memory of Chinese-Speaking School-Aged Children: A Longitudinal Intervention Study	22
3.	Nitin et al. (2023)	Exploring individual differences in musical rhythm and grammar skills in school-aged children with typically developing language	20
4.	Tervaniemi et al. (2022)	Improved Auditory Function Caused by Music Versus Foreign Language Training at School Age: Is There a Difference?	20
5.	Shaw (2021)	Read, speak, sing: Promoting early literacy in the health care setting	18
6.	Kirby et al. (2023)	Music Uses in Preschool Classrooms in the U.S.: A Multiple-Methods Study	16
7.	Gustavson et al. (2021)	Musical Instrument Engagement in Adolescence Predicts Verbal Ability 4 Years Later: A Twin and Adoption Study	15
8.	Morini & Blair (2021)	Webcams, Songs, and Vocabulary Learning: A Comparison of In-Person and Remote Data Collection as a Way of Moving Forward with Child-Language Research	14
9.	Zanto et al. (2024)	Digital rhythm training improves reading fluency in children	12
10.	Chen et al. (2024)	Language learning through music on the academic achievement, creative thinking, and self-esteem of the English as a foreign language (EFL) learner	11

Similarly, Nitin et al. (2023) relates musical rhythm sensitivity to grammatical skills, emphasising the common processing pathways between music and language. Applied and contextual studies also appear strongly. Shaw (2021) and Kirby et al. (2023) exemplify how music helps early literacy in healthcare and preschool settings, while Morini and Blair (2021) emphasise the applicability of music-based language research in distant and digital environments. More recent contributions by Zanto et al. (2024) and Chen et al. (2024) move toward digital rhythm training and EFL applications, suggesting a growing emphasis on technology-enhanced and socio-emotional outcomes.

### 3.2.1 Co-Citation Analysis by Clusters

Cluster 1, as in Figure 7 and Table 3, represents a core collection of research relating music, language, and neurodevelopmental diversity, with a heavy emphasis on autism spectrum disorder (ASD) and auditory processing abnormalities. Seminal research on congenital amusia (Ayotte et al., 2002) and

spectrotemporal sensitivity (Albouy et al., 2020) demonstrates brain dissociations and overlaps between music and speech perception. Clinical and applied features are visible in works addressing minimally verbal children with ASD (Tager-Flusberg & Kasari, 2013) and large-scale intervention trials such as the TIME-A research (Bieleninik et al., 2017), which illustrate the therapeutic potential of music-based approaches. Methodological rigour is strengthened by frequent co-citation of statistical references (Barr et al., 2013; Bates et al., 2015), demonstrating that this cluster also upholds analytic norms for empirical research in the field.

Cluster 2 centres on music training as a facilitator of language processing, notably syntax, pitch perception, and auditory discrimination. Influential research shows that rhythmic, temporally regular musical input primes syntactic processing in children with language difficulties (Bedoin et al., 2016; Canette et al., 2020). Research by Besson and colleagues underlines transfer effects between musical ability and linguistic pitch processing, reinforcing common brain resources across domains. This cluster also includes developmental risk perspectives, such as preterm birth and early environmental impacts (Bhutta et al., 2002; Cheong et al., 2020), suggesting that music may function as a protective or compensatory factor in susceptible populations. Early intervention research (Gerry et al., 2012) further positions music as a catalyst for communicative and social development from infancy.



**Figure 7: Bibliographic Coupling by Clusters (VOSviewer Visualisation)**

Cluster 3 is strongly geared toward rhythm-based musical interventions and their impact on phonological awareness, reading fluency, and brain plasticity. Studies repeatedly suggest that rhythmic training improves literacy outcomes, notably among poor readers and children with developmental dyslexia (Bhide et al., 2013; Flaughnacco et al., 2015). Neurophysiological data (Chobert et al., 2014; Benasich et al., 2014) further support the role of active auditory engagement in influencing prelinguistic and linguistic processing. The inclusion of socioeconomic perspectives (Bradley & Corwyn, 2002) demonstrates knowledge of

environmental implications on intervention success, whereas behavioural research, such as rhythmic clapping and entrainment (Bonacina et al., 2018), highlights embodied pathways to language development.

Cluster 4 contains studies focused on early development, researching how musical exposure supports core language skills such as speech segmentation, phonological awareness, and grammar learning. Seminal conceptual work (Brandt et al., 2012) establishes theoretical links between music and early language learning, while empirical studies demonstrate the benefits of rhythmic entrainment and musical training for children with speech and language impairments (Corriveau & Goswami, 2009; Degé & Schwarzer, 2011). Highly influential studies by Gordon et al. (2015) and François et al. (2013) provide robust evidence that rhythm discrimination and musical training affect grammatical sensitivity and speech segmentation abilities. More recent work on infants' affective responses to lullabies (Bainbridge et al., 2021) widens the cluster to include emotional control and attentiveness.

Cluster 5 offers a broader cognitive perspective, exploring how musical skills relate to phonological processing, executive function, working memory, and bilingualism. Classic studies (Anvari et al., 2002; Baddeley, 2003) establish essential linkages between music, phonology, and memory systems. Research on musicianship and bilingualism (Bialystok & DePape, 2009; Bidelman et al., 2013) reveals bidirectional transfer effects and better cognitive control. Socioeconomic considerations are addressed by intervention research targeting underprivileged groups (Barbaroux et al., 2019), while cross-lingual rhythm-reading relationships (Bekius et al., 2016) reinforce the universality of rhythmic processing in literacy. A recent theoretical synthesis (Bigand & Tillmann, 2022) critically assesses near and distant transmission, placing music as a specialised yet context-dependent cognitive enhancer.

**Table 3: Co-citation Clusters**

Cluster No and Colour	Cluster Labels	No. of Articles	Representative Publications
Cluster 1 (Red)	Neurodiversity, Autism, and Methodological Foundations	24	Albouy et al. (2020); Ayotte et al. (2002); Barr et al. (2013); Bates et al. (2015); Costa-Giomi & Benetti (2017); Tager-Flusberg & Kasari (2013); Beileninik et al. (2017)
Cluster 2 (Green)	Musical Training, Syntax, and Auditory-Linguistic Transfer	22	Bedoin et al. (2016); Besson et al. (2007); Banai & Ahissar (2013); Canette et al. (2020); Cheong et al. (2020); Bhutta et al. (2002); Gerry et al. (2012)
Cluster 3 (Blue)	Rhythm-Based Interventions and Literacy Development	16	Bhide et al. (2013); Chobert et al. (2014); Besson et al. (2011); Benasich et al. (2014); Bradley & Corwyn

Cluster 4 (Yellow)	Early Language Acquisition and Musical Foundations	15	(2022); Flaugnacco et al. (2015); Bonacina et al. (2018) Brandt et al. (2012); Corriveau & Goswami (2009); Gordon et al. (2015); François et al. (2013); Cahrdes et al. (2016); Bainbridge et al. (2021); Degé & Schwarzer (2011)
Cluster 5 (Purple)	Cognitive Transfer, Executive Function, and Individual Differences	14	Anvari et al. (2002); Bidelman et al. (2013); Bialystok & DePape (2009); Barbaroux et al. (2019); Bekius et al. (2016); Baddeley (2003); Bigand & Tillmann (2022)

### 3.3 Co-Occurrence Analysis

The co-occurrence analysis of the top 15 keywords (Table 4), measured by both frequency (occurrences) and Total Link Strength (TLS), provides a clearer picture of the thematic centrality and relational intensity within studies on music and children's language development. Keywords such as "human" (128 occurrences; TLS = 1487), "article" (106; TLS = 1337), and "child" (111; TLS = 1277) illustrate the strong dominance of human-centred, child-focused empirical research and reflect conventional indexing techniques in health, psychology, and education databases. Core conceptual notions demonstrate both high frequency and strong connection. "Music" (96 instances; TLS = 1079) and "language" (54; TLS = 643) display high link strength, indicating their prominent significance in connecting different study issues across developmental, cognitive, and educational domains.

**Table 4: The 15 Most Frequent Keywords in the Co-Occurrence Analysis**

Rank	Keyword	Occurrences	Total Link Strength
1	Human	128	1487
2	Child	111	1277
3	Article	106	1337
4	Music	96	1079
5	Female	89	1194
6	Male	86	1182
7	Language	54	643
8	Controlled study	48	711
9	Adult	43	560
10	Music therapy	39	397
11	Preschool child	38	540
12	Clinical article	33	448
13	Autism	33	404
14	Language development	32	431
15	Adolescent	32	401

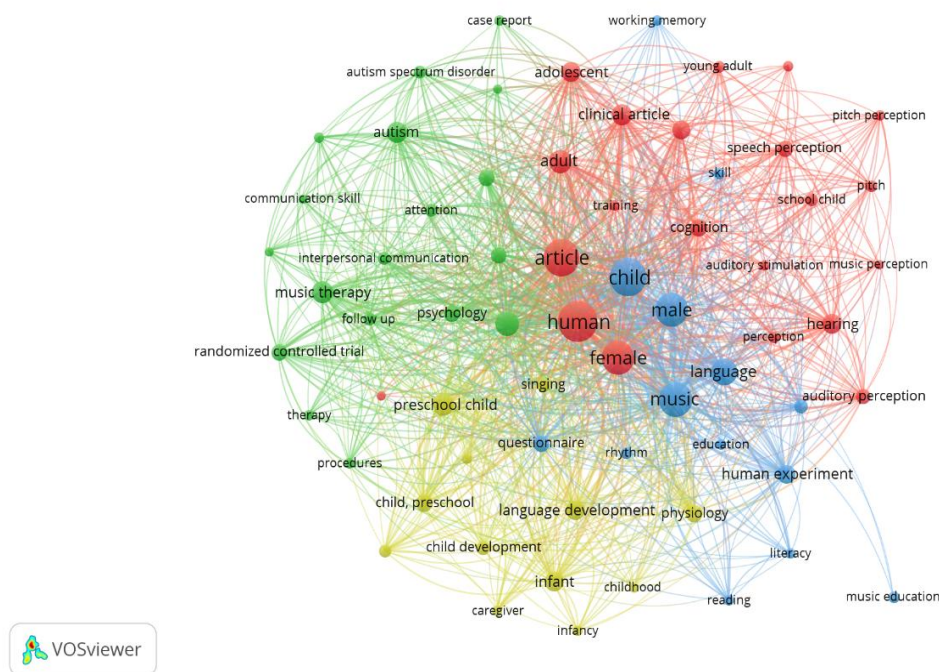
Demographic keywords such as "female" (89; TLS = 1194) and "male" (86; TLS = 1182) show frequent gender-based reporting and balanced participant representation, whereas "preschool child" (38; TLS = 540) highlights a significant

early childhood focus. Methodological robustness is reflected through “controlled study” (48; TLS = 711) and “clinical article” (33; TLS = 448), demonstrating a prevalence of experimental and clinical research designs. Notably, “music therapy” (39; TLS = 397) and “autism” (33; TLS = 404) demonstrate moderate frequency but relatively high TLS, indicating their strong conceptual linkage to multiple research strands. Overall, the combined frequency-TLS pattern reveals a field that is methodologically rigorous, developmentally grounded, and increasingly oriented toward inclusive and clinical applications.

### *3.3.1 Co-Occurrence Analysis by Clusters*

Cluster 1 represents the foundational and descriptive layer of the study field, typified by general indexing and demographic keywords such as human, female, adult, adolescent, and article, as seen in Figure 8 and Table 5. The predominance of clinical articles and hearing indicates a strong biomedical and auditory scientific emphasis, with many investigations located within health, neurology, and clinical psychology contexts. This cluster demonstrates how music-language research is commonly structured through human-subject experiments, aural perception, and clinical observation across age ranges. Rather than representing a specific intervention focus, this cluster provides the structural backbone of the literature, supporting empirical rigour, participant classification, and methodological transparency. Its central position in the network suggests substantial connectedness with other clusters, underscoring its role as a shared conceptual underpinning across developmental, educational, and therapeutic studies.

Cluster 2 is strongly geared toward clinical and intervention-based research, as evidenced by phrases such as 'autism,' 'music therapy,' 'controlled study,' and 'significant clinical study.' This cluster promotes the implementation of music-based interventions to support language development and psychological well-being, particularly among children with neurodevelopmental disorders. The co-occurrence of psychological and linguistic abilities indicates an integrative focus encompassing cognitive, emotional, and communicative outcomes. This cluster underscores the significance of music not simply as an educational enrichment tool, but as a therapeutic modality grounded in controlled, evidence-based research. Its importance reflects increased scientific and practical interest in inclusive education and clinical rehabilitation, placing music-based language therapies as a viable tool for tackling communication issues in neurodiverse groups.



**Figure 8: Co-Occurrence Analysis (VOSviewer Visualisation)**

Cluster 3 represents the main conceptual intersection of the area, with high-frequency keywords such as child, music, language, learning, music education, and talent. This cluster represents mainstream educational research studying how musical involvement enhances language development and skill growth in youngsters. The use of male alongside general learning phrases implies attention to participant characteristics while retaining a strong pedagogical focus. Research within this cluster often examines classroom-based practices, curricular integration, and the role of music in developing linguistic competencies, such as vocabulary, grammar, and listening skills. As the most conceptually central cluster, it integrates significantly with both developmental and clinical clusters, indicating its relevance in translating theoretical findings into practical educational applications.

Cluster 4 focuses explicitly on early childhood and infancy, with sample keywords including preschool child, newborn, singing, language development, and child development. This cluster underscores the role of music, particularly singing and vocal interaction, in promoting foundational language processes during crucial developmental periods. The inclusion of physiology demonstrates an interest in biological and sensory mechanisms that influence early auditory and language development. Research in this cluster generally explores pre-linguistic skills, phonological awareness, and early communicative behaviours, establishing music as a natural and developmentally appropriate stimulus for young learners. This cluster highlights music's role as an early developmental scaffold, underscoring its importance in early intervention, preschool education, and parent-child contact.

**Table 5: Co-Occurrence Analysis of Keywords**

Cluster No and Colour	Cluster Label	Number of Keywords	Representative Keywords
Cluster 1 (Red)	Human-Centred and Clinical Research Foundations	21	'human', 'female', 'article', 'adult', 'clinical article', 'hearing', 'adolescent'
Cluster 2 (Green)	Clinical Interventions and Neurodevelopmental Conditions	18	'autism', 'controlled study', 'music therapy', 'language ability', 'psychology', 'major clinical study'
Cluster 3 (Blue)	Core Educational and Learning-Oriented Themes	14	'child', 'music', 'language', 'male', 'learning', 'music education', 'skill'
Cluster 4 (Yellow)	Early Childhood and Developmental Processes	12	'preschool child', 'singing', 'language development', 'physiology', 'child development', 'infant', 'physiology'

#### 4. Discussion

This bibliometric analysis provides a comprehensive overview of research on the use of music to enhance children's language development, revealing a field that has evolved from theoretical exploration toward applied and interdisciplinary practice. The findings suggest that music serves as a powerful scaffold for language development, supporting cognitive, linguistic, and socio-emotional growth. The concentration of studies in Western contexts and controlled research environments points to the need for broader cultural representation and more longitudinal, classroom-based investigations. As Smith et al. (2023) noted, addressing these gaps will be essential to translating research insights into scalable, inclusive educational practices.

The co-citation analysis indicates that the literature is structured around several interconnected intellectual traditions rather than fragmented lines of inquiry. Core theoretical work on rhythm, auditory processing, and neural plasticity establishes a strong cognitive foundation linking music and language, while applied research clusters focus on early phonological development, rhythm-based interventions, and literacy-related outcomes. The substantial representation of autism and neurodevelopmental studies further demonstrates the expanding role of music in inclusive and therapeutic language interventions, underscoring its adaptability across diverse learner populations (Pino et al., 2023).

Results from the co-occurrence analysis reinforce this integrated research trajectory. Frequently co-occurring keywords related to music, language development, early childhood, and intervention signal a coherent thematic focus, while the presence of terms associated with therapy, autism, and empirical study designs reflects increasing methodological rigour and practical applicability. The emphasis on infancy and preschool stages aligns with evidence from Zhao et al.'s (2022) study, which highlights music's effectiveness during sensitive periods of auditory and linguistic development.

Beyond the analysed dataset, the findings have broader international relevance, demonstrating transferable pedagogical insights applicable across diverse educational systems. The convergence of neuroscience, education, and therapeutic research suggests that music-based language approaches can be adapted across cultural and institutional contexts, supporting inclusive and developmentally responsive learning environments worldwide.

## 5. Conclusion

This bibliometric analysis presents a thorough synthesis of contemporary scholarly research on the use of music to boost children's language development, highlighting the field's intellectual structure, research trends, and applied significance. The performance analysis reveals a steady rise in publications from 2021 to 2025, suggesting continued academic interest and the growing recognition of music as a substantial contributor to language learning. Co-citation and co-occurrence studies further indicate a well-established yet developing research landscape, anchored in theories of shared auditory processing, rhythm-based learning, and neuroplasticity, while moving toward inclusive, therapeutic, and technology-enhanced applications.

The identification of five intellectual clusters and dominant thematic keywords provides empirical evidence supporting the evolving interdisciplinary integration of music within language development research. The findings jointly position music as a varied developmental scaffold, facilitating linguistic, cognitive, and socio-emotional growth across varied learner populations, including typically developing youngsters and those with neurodevelopmental problems. The popularity of early childhood, literacy, and intervention-focused studies underscores the importance of musical involvement during sensitive developmental periods. At the same time, the focus of research within Western and clinical contexts underscores the necessity for larger cross-cultural and school-based enquiries.

This study has several limitations. First, the analysis relied solely on the Scopus database, potentially excluding relevant studies indexed elsewhere. Second, only English-language open-access publications were included, potentially limiting global representation. Third, bibliometric analysis focuses on publication patterns rather than measuring causal educational effectiveness. Future studies may integrate systematic review or meta-analytic approaches to complement bibliometric findings. The studies should prioritise scalable, culturally appropriate, and policy-aligned music-language interventions to strengthen educational practice and advance holistic child development globally. Thus, aligned with Sustainable Development Goal 4: Quality Education, this study stresses music's ability to enhance inclusive, equitable, and engaging learning experiences for children.

### Conflict of Interest

The authors declare no conflict of interest.

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