



movements support physical growth while laying the groundwork for the development of sensorimotor skills (Treewong, 2022). In early life, children respond to the music they hear with rhythmic movements, and the ability to synchronize with the rhythm of music emerges at a very early age (Ilari, 2014). Musical development, which begins in the prenatal period, diversifies until the preschool period and manifests itself with skills such as musical hearing, singing, playing, rhythm, and movement (Yıldız & Nacakçı, 2016). It is known that babies in the womb respond to the mother's heartbeat and environmental sounds, and are calmed by lullabies and songs sung by the mother (Schellenberg, 2012; Yıldız & Nacakçı, 2016). Musical interactions that take place between caregivers and babies are called "communicative musicality," and the bond established through this music strengthens social interaction (Malloch & Trevarthen, 2009; Rabinowitch, Cross & Burnard, 2013). Children who are properly supported with music at an early age are positively influenced in their development; musical experiences support other areas of development, increasing children's future success and happiness (Deleş & Kaytez, 2020). Movement and rhythm activities are appropriate to children's interests, abilities, and developmental levels and hold an important place in music education (Treewong, 2022). Recent studies have shown that music and rhythm contribute positively to children's personality development (Rosati, 2024). It has been observed that babies who receive music education are more successful in skills such as body movements and vocal imitation in harmony with music compared to those who do not (Lecanuet et al., 1999; Werner & VandenBos, 1993; Ilari, 2002; Chang & Trehub, 1997; Trehub et al., 1984; Gruhn, 2002, cited in Özmenteş, 2006).

Music and rhythm have long been recognized as crucial for child development, yet the literature on the topic is scattered among different disciplines like education, neuroscience, and developmental psychology. While many research works address specific developmental outcomes (e.g. language or motor skills), little is known about the overall structure of the field, the interconnections among research topics, and the trends that have emerged

over time. As a result, besides reviewing what is known, this paper intends to explore the field by bibliometric analysis, not only tracing publication growth but also discovering the intellectual bases, thematic groups, and collaborations defining early childhood rhythm research. Music and rhythm, though very closely intertwined, are indeed different. This article views rhythm as the temporal arrangement of sound and movement, including the abilities to perceive patterns, synchronize, and produce rhythms. In contrast to the larger notion of music which involves melody harmony timbre, and cultural expression rhythm is a more basic and quantifiable element, one that is most closely linked with the brain's timing functions, motor skills, and speech processing.

Focusing on rhythm gives a sharper look at how it shapes learning and growth. Studies in this review had to clearly talk about rhythmic skills, perception, production, or rhythm-based treatments. Those that just covered general music without stressing rhythm were left out to keep the focus tight. Early childhood - ages zero to eight - was picked because research shows it's when brains form fast, language kicks in, motor control builds, and executive functions start taking root. Beat tracking, timing sense, and the link between sound and movement show strong development during those years. That makes early childhood a key window for rhythm studies. From a data standpoint, this work maps how rhythm research is organized in young children's education. It doesn't just say rhythm matters, and it tracks how the field is built through patterns of thought and topic grouping.

- **Keywords and co-occurrence patterns** (revealing dominant research themes such as rhythm-language, rhythm-motor coordination, and rhythm-based interventions),
- **Authorship and collaboration networks** (identifying leading scholars and research clusters),
- **Citation structures** (highlighting influential publications and knowledge bases).

These elements form the conceptual axes of the bibliometric mapping - enabling a systematic grasp of how rhythm sits in early childhood research

across fields. And the study probably adds more than just theory. It has real-world value. By spotting key themes, new areas, and strong research groups, the results offer a clear foundation for: teacher education, Mostly where rhythm skills are most often stressed in published work, curriculum design, Mainly around common rhythm-based activities and support zones, and intervention studies, which show patterns in using rhythm to help with language growth and learning challenges. This isn't just about confirming rhythm matters, it's about showing exactly where and how rhythm research happens, which might help guide what comes next in teaching and practice.

### Music and Rhythm in Early Childhood

Music is defined as the expression of emotions and thoughts through rhythm, sound, and melodies, and for children, singing and keeping rhythm are innate, instinctive behaviors like speaking (Deleş & Kaytez, 2020). Used as an important tool throughout history, especially in the field of education, music is a cultural phenomenon and an integral part of every human culture; therefore, it should have a natural place in the experiences of young children (Blacking, 1967; Campbell, 2010). Early childhood music education is one of the fundamental components of the early childhood education and care curriculum by integrating various forms of expression that support children's interests and learning areas (Ruokonen, Tervaniemi & Reunamo, 2021). In this context, while music and singing occupy a central position in the daily educational processes of toddlers, the role of these activities in education remains more limited in children aged four to six (Ruokonen, Tervaniemi & Reunamo, 2021).

Recent research has increasingly emphasized the role of rhythmic abilities in early cognitive and linguistic development. For instance, studies have shown that rhythm perception and synchronization are closely linked to phonological awareness and reading readiness (Frischen et al., 2022; Gordon et al., 2021). Moreover, rhythm-based interventions have gained attention as effective tools for supporting children with developmental disorders, particularly dyslexia and language impairments (Habib et al., 2016; Ladányi et al., 2020). More recent work has also explored the role of digital and technology-supported

rhythm learning environments in early childhood education (Williams, 2021; Rosati, 2024).

### The Importance of Music and Rhythm in Early Childhood

Music plays a role in children's lives in various ways; While some children prefer simply listening to music, others enjoy singing, humming, whistling, or reciting rhymes. Still others engage in physical responses such as playing an instrument alone or in a group, or dancing to the music. These diverse musical experiences allow children to express themselves and contribute to their social and emotional development (Campbell, 2010; Campbell & Kasner, 2014).

Scientific research has shown that music has significant effects on brain development. It has been shown that the brain structure and functions of musicians differ from those of individuals who are not involved with music (Habibi, 2018). Historically, educational thinkers have also highlighted the importance of music in child development; Piaget, in particular, considered music one of the fundamental tools supporting a child's cognitive development (Franklin et al., 2008). Music is known to provide comprehensive support to children in linguistic, motor, and social-emotional areas, in addition to cognitive development (Aral & Can Yaşar, 2015; Gordon, 2000; Wimpory & Nash, 1999). Therefore, the inclusion of music in educational programs is of great importance. Music is considered a universal experience that reveals different aspects of children and is an integral part of their lives. The connection that individuals of different ages and cultures establish with music in both school and extracurricular settings proves the continuity and universality of music. The benefits it provides to children are explained as follows:

**Emotional Expression:** This is the process of outwardly expressing emotions and feelings. Children can express their sadness through singing and their happiness through dancing.

**Aesthetic Pleasure:** This is the deep emotional and intellectual pleasure derived from music, used to experience the beauty of life in artistic and nonverbal ways. The music children listen to or create can touch emotions they find difficult to express in words.

**Entertainment:** This is the use of music for fun and leisure. Children enjoy music presented through media, from current pop music to background music for films and television programs; this music is easily accessible and enjoyable for them.

**Communication:** This is the transmission of shared emotions and thoughts through music within a particular culture. Children learn and express emotions and thoughts through musical styles that hold meaning within their families and communities.

**Symbolic Representation:** This refers to the cultural meanings of symbols and lyrics used in music. Children find certain musical tones and rhythms more meaningful than others thanks to the musical culture of their family and community.

**Physical Response:** This refers to the use of music in dance and other active activities. Children respond physically to the music they hear by dancing, jumping, and swaying; calming music can facilitate their transition to sleep.

**Social Conformity:** This involves using music to teach social behaviors. Young children, in particular, learn social etiquette rules through songs and rhymes used by adults (e.g., saying “please” or washing hands before meals).

**Supporting Social and Religious Rituals:** This is the use of music in religious ceremonies and formal events. Children incorporate music into their games, sing songs to choose group members, and reinforce their sense of belonging through songs that address themes such as patriotism and religious devotion.

**Continuity of Culture:** Music plays a significant role in the transmission of cultural values from generation to generation. It is a very effective tool in the transmission of history, literature, and traditions, raising children’s awareness of cultural continuity and stability.

**Social Unity:** This involves using music to bring people together. Through music, children socialize and feel a sense of group belonging through shared musical experiences. For example, school songs or games involving songs strengthen children’s social bonds (Campbell and Kasner, 2014).

## **The Impact of Music on Children’s Developmental Areas**

Over the past twenty years, the effects of learning to play a musical instrument on cognitive development, socio-emotional maturation, and brain structure and functions in school-age children have been studied in detail. Music performance not only activates the auditory, somatosensory, and visual systems, but also necessitates the interaction of these sensory systems with motor, executive functions, and emotional processes (Habibi, 2018).

### **Cognitive Development**

Interaction with music in early childhood is one of the fundamental elements supporting cognitive development. Musical stimuli, in particular, strengthen the neural connections of the brain and contribute to the development of higher-level cognitive skills such as attention, memory, and problem-solving (Isenberg & Jalongo, 2001; Wan & Schlaug, 2010). Various studies have shown that children who receive instrument training at an early age exhibit positive differences in their academic performance (Brody, 2016). Furthermore, it has been reported that significant improvements in children’s mathematical and linguistic competencies are observed in environments where rhythm and movement-based music activities are conducted (Franklin et al., 2008; Williams, 2018). These findings demonstrate that music education has significant and multifaceted effects on cognitive development in early childhood.

### **Language Development**

Various studies have shown that music education received at an early age has significant and multifaceted effects on children’s language development. Listening skills and phonological awareness, which develop through musical activities, form the basic building blocks of early language acquisition (Anvari et al., 2002; Kaviani et al., 2014; McDonel, 2013; Moreno et al., 2009; Tai, 2010, cited in Kandır & Türkoğlu, 2015). Through rhythmic songs, sound games, and melodic repetitions, children have the opportunity to improve both their understanding and expression skills of language. This process facilitates vocabulary expansion, familiarity with syntactic structures, and awareness of speech rhythm; thus, it supports the

development of basic language skills such as reading and writing (Buğdaycığıl, 2023). In this context, music education enriches the language acquisition process at the cognitive and affective levels, directly contributing to children’s communication competencies.

### **Physical Development**

In early childhood, music education plays a significant role in children’s physical development. Through musical activities, children are taught how to use their gross motor skills and how to make these skills functional in interacting with their environment (Treewong, 2022). Rhythm-based activities contribute to children’s development of bodily coordination, control of movements, and physical awareness. It has been observed that children can correctly repeat a certain number of sound sequences, especially during rhythm activities with percussion instruments. It is stated that age and level of musical experience are decisive in the development of this skill. These rhythmic repetitions are thought to be related not only to motor development but also to children’s working memory capacity, attention span, and numerical processing skills (Habegger, 2010). In this context, music education, beyond supporting physical development, creates a holistic interaction between motor skills and cognitive functions.

### **Social-Emotional Development**

Music is an important tool in the social-emotional development of children. In environments where

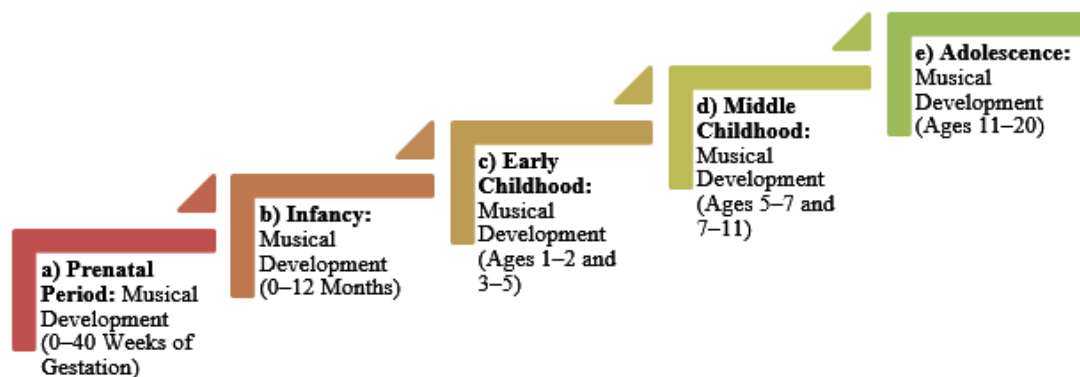
music and singing are used intensively, children show longer and uninterrupted active participation, develop positive emotions, and strengthen their social adaptation. In addition, significant increases are observed in the social interactions of these children with adults (Ruokonen, Tervaniemi & Reunamo, 2021). When multiple individuals adapt to the same musical rhythm, their breathing rates, heart rates, brainwaves, attention, and movements become coordinated; this biological adaptation creates a sense of “togetherness” in individuals and supports the development of empathy, cooperation, and social adaptation (Cross, Laurence & Rabinowitch, 2012; Kirschner & Tomasello, 2010). In this context, music activities are considered an effective method that strengthens children’s social relationships, improves their ability to express and share their emotions, and reinforces empathy and a sense of belonging.

### **Early Childhood Musical Development Stages**

Tillman (2001) stated that musical abilities progress over time and that musical development occurs in certain patterns (cited in Gooding and Standley, 2009). Gooding and Standley (2009) grouped the musical development stages as follows and explained the characteristics of the stages:

#### **Rhythm**

Rhythm is a fundamental element of music and develops from infancy (Thompson et al., 2015; Winkler et al., 2009). Recent research has shown



**Fig.1: Musical Development**

a positive correlation between rhythmic skills and cognitive abilities such as language, motor, and executive functions (Anvari et al., 2002; Degé et al., 2015; Flaugnacco et al., 2014). In particular, rhythm-based music education supports the development of language and executive functions in both typically developing children and those with developmental dyslexia (Frischen et al., 2019; Moritz et al., 2013). Rhythmic abilities are divided into two categories: perception (recognizing and distinguishing rhythms) and production (repeating movements and patterns in accordance with the rhythm) (Thackray, 1969; Tierney & Kraus, 2015). These abilities are closely linked to development and cognitive functions (Frischen, 2022). In the link between rhythm and cognitive-motor processes, predictive mechanisms play a significant role. Children begin to predict regularities in their environment at an early age (Nagai, 2019; Köster et al., 2020). In music, this means predicting the timing of rhythmic patterns and can be critical in explaining the relationship between cognitive functions and rhythmic abilities. Rhythmic activities are generally studied in two main groups: static bodily movements (such as head tilting, arm swinging, stretching) and actions involving movement from one point to another (such as dancing, jumping, running) (Gordon, 2001; Lougher, 1997; Treewong, 2022). The relationship between music and movement is very strong; individuals synchronize their body movements to the rhythm of the music. This harmony is called coordinated rhythmic movement or rhythmic drift and occurs through the synchronization of voices and bodies within a common rhythmic tempo (Clayton et al., 2004; Merker et al., 2009; Phillips-Silver et al., 2010). This synchronization forms the basis of group music performance (Ilari, 2014).

Children also respond to rhythm with natural movements such as finger snapping, hand clapping, foot tapping, and jumping; these movements support the development of both fine and gross motor skills (Orff, 1977). Rhythm development, however, goes through distinct stages, especially from infancy to approximately seven years of age. Since motor control is not yet fully developed in infants, rhythm perception develops before the ability to produce rhythm. Electroencephalogram (EEG) studies of newborn babies have shown that they respond

to changes in the duration of sounds in a manner similar to adults; This shows that babies are sensitive to rhythmic stimuli (Kushnerenko et al., 2001). Furthermore, it has been scientifically proven that newborns have the ability to recognize repetitive sound patterns and react to skipped beats (Frischen, 2022; Stefanics et al., 2007; Winkler et al., 2009).

### **The Importance of Rhythm Training in Early Childhood**

Rhythm training in early childhood supports the development of areas such as motor coordination, sense of direction, spatial organization, language, reading, logical thinking, and socialization. Rhythmic training is vital, especially for children with learning disabilities and neurodevelopmental disorders. Therefore, rhythm training plays a fundamental role in children's cognitive and motor development (Liparoti & Minino, 2021). Movement- and rhythm-based activities play a fundamental role in early development by supporting bodily coordination and sensorimotor integration (Phillips-Silver & Trainor, 2005; Treewong, 2022; Zentner & Eerola, 2010). Music, on the other hand, plays an important role in children's daily lives; Children frequently encounter music in games, television, and daily interactions. Therefore, educators and parents should be aware of and support the contribution of music to child development. Musical skills progress in parallel with cognitive development; rhythmic activities have been shown to be related to language and reading skills in infancy (Gooding & Standley, 2009; Gordon, 2000). Children's learning and stress relief through movement improves their social skills and group cooperation.

Furthermore, artistic freedom of expression supports listening and following skills (Bennett, 1995; Hannaford, 1995; Treewong, 2022). Rhythmic and active activities increase children's motor skills, self-confidence, and social adaptation. In this process, children develop both their gross motor skills and musical abilities while reducing stress and supporting their imagination (Pongprasit, 1996; Treewong, 2022). Rhythm-based group activities in preschool positively influence the development of motor, auditory, and self-regulation skills (Williams, 2018). Consequently, children respond to rhythms naturally

and acquire more complex rhythmic abilities over time (Frischen, 2022). Therefore, rhythm studies in early childhood are critically important for both individual development and social integration.

Over the past two decades, research on music and rhythm in early childhood has expanded significantly, reflecting growing interdisciplinary interest across fields such as education, developmental psychology, neuroscience, and musicology. As highlighted in the literature, rhythm is not only a fundamental component of musical experience but also closely associated with children's cognitive, linguistic, motor, and socio-emotional development. This expanding body of research has produced a diverse and fragmented knowledge base, making it increasingly difficult for researchers to identify major trends, influential studies, and emerging research directions.

Previous bibliometric studies in education and music-related fields have demonstrated the effectiveness of this method in identifying research trends and mapping knowledge structures. Recent research indicates a growing shift toward interdisciplinary and technology-enhanced approaches in areas such as music education, arts-based learning, and early childhood development. However, comprehensive bibliometric analyses focusing specifically on rhythm research in early childhood remain limited, highlighting the originality and contribution of the present study.

In this context, a bibliometric analysis covering the period from 2000 to 2025 is both timely and necessary. First, the early 2000s mark a turning point in the field, coinciding with advances in neuroimaging technologies and cognitive science, which enabled more systematic investigation of the relationship between rhythm, brain development, and learning processes. Since then, studies have increasingly demonstrated the link between rhythmic abilities and key developmental domains such as language acquisition, executive functioning, and motor coordination. Mapping this period allows for a comprehensive understanding of how the field has evolved in response to these scientific and technological developments.

Second, despite the recognized importance of rhythm in early childhood education, existing studies

are often dispersed across different disciplines and publication outlets. This fragmentation limits the visibility of research patterns and reduces the potential for cumulative knowledge building. A bibliometric approach enables the systematic identification of publication trends, key journals, influential authors, and collaborative networks, thereby providing a structured overview of the intellectual landscape of the field.

Third, the increasing emphasis on evidence-based educational practices highlights the need to synthesize existing research in a systematic and quantitative manner. Bibliometric analysis offers objective tools to evaluate the impact and development of research outputs, complementing traditional literature reviews. By identifying highly cited works and dominant research themes, such an analysis can guide educators, policymakers, and researchers in making informed decisions about curriculum design and future research priorities.

Finally, the period up to 2025 allows for the inclusion of the most recent studies, capturing emerging topics such as digital music environments, rhythm-based interventions for developmental disorders, and the integration of music technologies in early childhood education. These developments reflect a shift toward more applied and innovative uses of rhythm in educational contexts, further underscoring the need for a comprehensive mapping of the field.

In sum, conducting a bibliometric study on rhythm and early childhood between 2000 and 2025 is essential to (1) trace the evolution of the field, (2) identify key contributors and research clusters, (3) reveal gaps and underexplored areas, and (4) provide a foundation for future interdisciplinary research. Such an analysis will contribute to a more coherent and accessible understanding of how rhythm-related research informs early childhood development and education.

## **METHODOLOGY**

### **Research Design**

This study employs a bibliometric research design to systematically examine scientific publications related to rhythm in early childhood. Bibliometric analysis is a quantitative approach used to evaluate academic literature, identify research trends, and map the

intellectual structure of a field through statistical and network-based techniques. This method is particularly suitable for analyzing large bodies of interdisciplinary research.

Bibliometric analysis is widely used to map the intellectual development of scientific fields (Donthu et al., 2021; Aria & Cuccurullo, 2017). Through co-authorship, co-citation, and keyword co-occurrence analyses, it enables the identification of collaboration patterns, influential publications, and thematic clusters (van Eck & Waltman, 2010). VOSviewer software was used to construct and visualize bibliometric networks due to its capacity to process large datasets and generate interpretable visual maps.

### Data Collection

The data were obtained from the Web of Science (WoS) Core Collection, which is widely recognized for indexing high-quality peer-reviewed publications. Web of Science was selected due to its extensive coverage and suitability for citation analysis. A systematic search was carried out with a set of keywords associated with rhythm and early childhood. The search query was iteratively refined to ensure both high recall and precision. The search terms included combinations of keywords such as “rhythm,” “rhythmic,” “early childhood,” “preschool,” “kindergarten,” and “young children.”

The time frame for the search was January 2000 to January 2025 to ensure transparency and reproducibility. The search query was formulated using Boolean operators as follows: (TS = (rhythm OR rhythmic) AND TS = (“early childhood” OR preschool OR kindergarten OR “young children”)). The “TS” field tag indicates that the search was performed within the titles, abstracts, and author keywords of the publications. This approach ensured comprehensive coverage of relevant studies while maintaining accuracy. The following WoS indexes were considered in the search: Social Sciences Citation Index (SSCI), Science Citation Index Expanded (SCI-EXPANDED), Arts & Humanities Citation Index (A&HCI), Emerging Sources Citation Index (ESCI).

### Inclusion and Exclusion Criteria

The dataset includes different document types indexed in the Web of Science database, including journal

articles, proceeding papers, and other publication types. However, journal articles constitute the majority of the dataset. Studies were included if they focused on rhythm, rhythmic skills, or rhythm-based activities in early childhood (0-8 years). Studies were excluded if they did not explicitly address rhythm, focused on populations outside early childhood, or were not indexed in the Web of Science database. After applying these criteria, duplicate records were removed and the final dataset was prepared for analysis.

### Data Extraction and Preparation

Bibliographic data, including authors, titles, abstracts, keywords, publication years, journals, citations, and references, were exported from Web of Science in plain text and CSV formats. The data were then cleaned and standardized to ensure consistency (e.g., merging synonymous keywords, unifying author names).

### Data Analysis

The bibliometric data were analyzed using a software called VOSviewer, which is a specialized tool for building and visualizing bibliometric networks. VOSviewer helped to analyze the structural relationships within the data and to spot main literature patterns. The tool was mainly used for doing co-authorship, co-occurrence (keyword), citation, and co-citation analyses. By doing the co-authorship analysis, one can explore the collaboration networks not only between authors but also express their institutions and countries to show up their scientific cooperation patterns. To find main research themes and topics, the co-occurrence analysis of keywords was performed. Citation analysis is a way to find the most influential publications, authors, and journals based on citation counts. Besides that, co-citation analysis is a method to reveal the intellectual structure of the field by seeing the frequency of the pair of documents being cited together. The network visualization maps created by VOSviewer illustrate the relationships between the various bibliometric elements. In these maps, nodes stand for items like authors or keywords, while links show relationships between them, and the size and closeness of nodes indicate the intensity of these connections. With these

analyses, the paper offers a thorough background of the evolution, trends, and knowledge structure of research on rhythm in early childhood.

### Reliability and Validity

Some steps have been implemented to ensure that the bibliometric analysis be “reliable” and “valid”. First, the selection of the “data source” greatly enhances reliability. The “Web of Science” (WoS) Core Collection was selected for its strict indexing standards and for being the most “commonly used” source in bibliometric research. Secondly, the search strategy was not only carefully crafted but also tested. Through iterative testing went the search strings, composed of the main terms related to the rhythm and early childhood topics, to finding a balance between recall and precision. Early in the research phase, pilot searches have been carried out in order to check if the query retrieved really relevant studies. Very few modifications have been made for the sake of better coverage.

Relying on the “TS” (topic) field ensured that not only titles but also abstracts and keywords were included in the search process. Third, after that, data cleaning and preprocessing routines were methodically carried on. Besides removing the duplicates, a standardizing of author names (e.g. initials spelling differences) was performed to enable us to perform a more exact co-authorship analysis. Likewise, different keywords referring to the same concept (e.g. “early childhood, “ “preschool, “ “kindergarten”; “rhythm, “ “rhythmic skills”) were combined in order to achieve more reliable co-occurrence analysis results. These decisions were documented and applied consistently across the dataset.

Fourth, in order to increase the trustworthiness of the examination, the dataset and the choices related to coding were revisited several times during the analysis. When it was really necessary, the difficult cases (e.g. the relevancy of the borderline studies or decisions on merging keywords) were double-checked in order to maintain the highest level of consistency. Lastly, employing VOSviewer, a recognized bibliometric analysis software, enhances the methodological soundness factor.

This program uses the same algorithms that have been standardized for constructing and visualizing networks, which makes the findings reliable and at the same time allows their comparison with other bibliometric investigations. However, even though the authors of this article followed those steps, bibliometric analyses by their nature depend on the coverage of the database, choice of search terms, and preprocessing of the data. These aspects should be considered the drawbacks of the current research.

## FINDINGS

### Descriptive Findings

**Publication Trends Over Time: Examining yearly publication outputs shows that research on rhythm and young children has steadily increased from 2000 to 2025. According to the data visualization in Figure 2, during the first few years of the decade the number of publications remained quite low before there was a slow increase after 2010. The sharp increase in publications after 2015 suggests a structural shift in the field, likely driven by advances in cognitive neuroscience and growing interest in evidence-based early childhood education. This trend indicates that rhythm research is no longer treated as a peripheral topic within music education, but has evolved into a distinct interdisciplinary domain integrating developmental psychology, neuroscience, and educational research.**

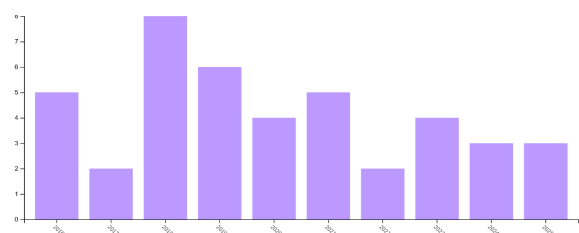
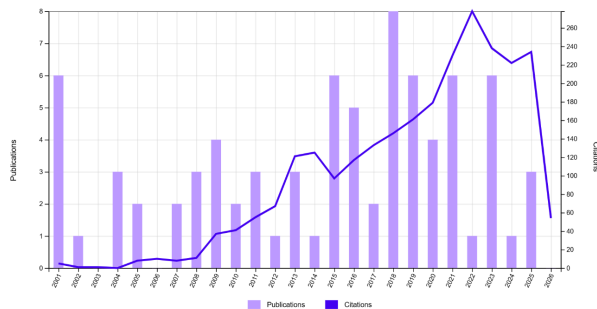


Fig. 2: Publication Trends over Years

**Citation Trends Over Time:** As (Fig. 3) depicts, citation pattern demonstrates a consistent and notable rise in the academic influence of research on rhythm and early childhood from 2000 to 2025. Citation numbers during the initial years (2000-2008) were very low, signaling the limited presence and scholarly interaction of the topic at that time. From approximately 2009, citations started gradually to

rise, pointing to a growing awareness of the research domain. This increase in citations gets a bit stronger from 2013 onwards, implying publications in this theme were receiving more attention and influence among scholars. The increase in citations is especially noticeable between 2018 and 2021, when the citation numbers reach a maximum. This time frame probably stands for a period of significant research and broad dissemination of impactful papers, especially those exploring the relationship between rhythm, language acquisition, and cognition. Despite a minor dip and downturn in measures visible towards the latest times, the cause of these changes is most probably the citation delay effect, a phenomenon where recent works have had fewer opportunities to gather citations. In general, the figure illustrates that although the production of works has been going up steadily, the recognition and prominence of the area have been advancing even faster, particularly over the most recent ten years.



**Fig. 3: Citation Trends**

Table 1 shows how the papers that were studied are divided up among the different Web of Science (WoS) indexes. The results reveal that most of the papers are found in the Social Sciences Citation Index (SSCI) with 42 papers which are 54.545% of the entire dataset. This means that the papers about rhythm in young children are mostly considered to be part of the social sciences area. Also, the Arts & Humanities Citation Index (A&HCI) and the Emerging Sources Citation Index (ESCI) both contain 17 publications, so each one makes up 22.078%. This is a sign of the field being interdisciplinary and covering arts, humanities, and new scholarly venues. The smallest percentage of the papers comes from the Science Citation Index Expanded (SCI-EXPANDED), with 13 papers (16.883%),

showing that scientific and experimental research viewpoints have a modestly proportion. Indices of conference proceedings, including the Conference Proceedings Citation Index Social Science & Humanities (CPCI-SSH) and Conference Proceedings Citation Index Science (CPCI-S), are responsible for 9 (11.688%) and 2 (2.597%) papers respectively which indicate a rather limited presence of conference-based outputs.

Finally, only 1 publication (1.299%) is indexed in the Book Citation Index – Social Sciences & Humanities (BKCI-SSH), suggesting that book-based contributions are minimal in this dataset. Overall, the distribution highlights that while the field is primarily rooted in the social sciences, it demonstrates a notable interdisciplinary spread across humanities and scientific domains.

**Table 1. Distribution of Publications Across Web of Science Indexes**

Web of Science Index	Record Count	% of 79
Arts & Humanities Citation Index (A&HCI)	17	22.078
Book Citation Index -		
Social Sciences & Humanities (BKCI-SSH)	1	1.299
Emerging Sources Citation Index (ESCI)	17	22.078
Conference Proceedings Citation Index -		
Social Science & Humanities (CPCI-SSH)	9	11.688
Conference Proceedings Citation Index -		
Science (CPCI-S)	2	2.597
Science Citation Index Expanded (SCI-EXPANDED)	13	16.883
Social Sciences Citation Index (SSCI)	42	54.545

**Note.** Percentages may exceed 100% because a single publication can be indexed in more than one Web of Science category simultaneously. Therefore, the percentages reflect the proportion of records within each index rather than mutually exclusive categories.

Table 2 lists the number of publications by document type. Results strongly show that journal articles are the main type of publication in the dataset with 64 items accounting for 83.117% of the total. Such a predominance reveals that dissemination of work on rhythm in early childhood mostly happens via peer-reviewed journal articles, which signifies that the field is well developed and subjected to academic scrutiny. Besides articles, 11 records (14.286%) represent proceeding papers, which implies that conferences also contribute to the dissemination of developing research, though at a smaller level. Few other document types exist including book reviews that have 3 records (3.896%), meeting abstracts 2 records (2.597%), and book chapters is represented by only 1 record (1.299%). In short, the spread indicates a very strong leaning towards journals as a publication medium while other ways of scholarly communication remain fairly minor in this research domain.

**Table 2: Document Type Distribution**

Document Types	Record Count	% of 79
Article	64	83.117
Book Chapters	1	1.299
Book Review	3	3.896
Meeting Abstract	2	2.597
Proceeding Paper	11	14.286

Table 3 lists the most prolific authors in the field. Out of these, Franziska Dege stands as the top contributor with 7 papers (8.861%), next is Gudrun Schwarzer with 6 papers (7.595%), and Erin Hannon is the third with 5 papers (6.329%). These authors seem to be critical in developing the rhythm and early childhood research scene. Other significant contributors are Sandra Trehub with 4 publications (5.063%) and Reyna Gordon with 3 publications (3.797%), both recognized for their studies in music cognition and developmental processes. A group of authors including Devin McAuley, Daniel Mullensiefen, A. Tsapakidou, Hsiao-Lan Wang, and Evridiki Zachopoulou each contributed 2 publications (2.532%), which points to a wider pool of regularly contributing authors. This pattern is indicative that, whereas a few eminent scholars command the field, the authorship structure is quite scattered, with

several contributors making minor but consistent contributions. This trend mirrors a research area that is evolving, collaborative, and experiencing an increase in scholarly engagement.

**Table 3. Most Productive Authors**

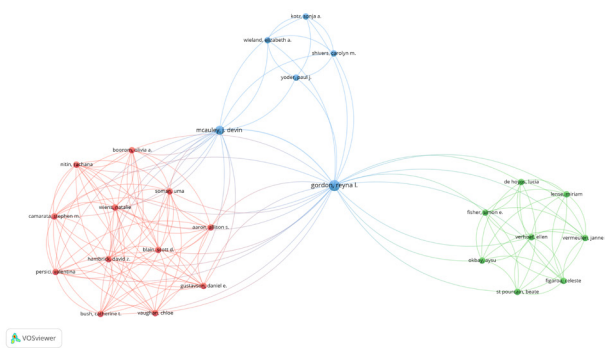
Researcher Profiles	Record Count	% of 79
Dege, Franziska	7	8.861
Gudrun Schwarzer	6	7.595
Hannon, Erin	5	6.329
TREHUB, S	4	5.063
Gordon, Reyna	3	3.797
McAuley, Devin	2	2.532
Mullensiefen, Daniel	2	2.532
Tsapakidou, A	2	2.532
Wang, Hsiao-Lan	2	2.532
Zachopoulou, Evridiki	2	2.532

### Knowledge Visualization through Bibliometric Analysis

The VOSviewer visualization (Figure 4) depicts the co-author network in the area of rhythm and children, showing three separate collaborative groups interconnected by only a few major researchers. The design depends on the closeness and lines to indicate how often these authors collaborate on publications. On the left side of the graph, the red cluster stands for a very compact and highly interconnected clique. This bunch, which features the authors such as Stephen M. Camarata, Olivia A. Boorum, David Z. Hambrick, and Scott D. Blain, consists of researchers who nearly all co-author one another. Such a high level of internal relations usually means one university department, a large laboratory, or a tightly-knit group working on shared grants. On the right side, the green cluster is another highly interconnected group, with the researchers like Simon E. Fisher, Aysu Okbay, Beate St Pourcain, and Ellen Verhoef. Although they also collaborate very much among themselves like the red group, they do not partner directly with anyone in the red cluster. Connecting these two largely independent groups is a central blue cluster that acts as the network's anchor. This central hub includes figures like Sonja A. Kotz, Paul J. Yoder, and Elizabeth A. Wieland, but more importantly, it

contains the network's crucial "bridge" authors. Reyna L. Gordon stands out as the most central figure in the entire visualization. She serves as the exclusive link connecting the green cluster to the rest of the network; without her, the green group would appear completely isolated. Similarly, J. Devin McAuley acts as the primary bridge linking the central blue group to the dense red cluster on the left.

Ultimately, the graph depicts a research field characterized by two tightly-knit, distinct teams that operate somewhat independently of each other but are united through the collaborative efforts of a central hub, driven largely by the bridging work of Gordon and McAuley.



**Fig. 4. Coauthorship Network**

## DISCUSSION

The present bibliometric study set out to chart the evolution and intellectual foundation of rhythm in early childhood research between 2000 and 2025. Results have demonstrated a distinct and ongoing increase in both the number of publications and citation impact, implying that the topic is garnering more and more academic attention over time. That the positive trend continues to get stronger post-2015 may be explained by the promotion of cross-disciplinary research involving education, neuroscience, and developmental psychology. Also, the significant increase of the citation figures in the last couple of years indirectly points to the fact that the discipline is improving not just in quantity but also in academic influence and visibility. That most of the papers are indexed because of the Social Sciences Citation Index (SSCI) supports that the studies dealing with rhythm in early childhood are centering more on educational and developmental contexts. The dominance of

SSCI-indexed publications indicates that rhythm research in early childhood is primarily framed within educational and developmental paradigms rather than purely artistic or performance-based perspectives. This suggests a conceptual shift from viewing rhythm as a musical skill toward understanding it as a developmental and cognitive construct. Nonetheless, the fact that research papers indexed in the Arts & Humanities Citation Index (A&HCI) and Science Citation Index Expanded (SCI-EXPANDED) exist points out the inherently interdisciplinary nature of the field. Such a spread fits the theoretical consideration given in the introduction where emphasis is laid on the multiple facets of rhythm that impact cognitive linguistic motor, and socio-emotional development.

Type-wise, most journals dominate the geography of the publishing landscape in this area. It's a clear indication it is a field that has attained a fair level of academic depth, with the primary mode of sharing knowledge being journal articles that have gone through peer review. Conference papers and other document types coming in at far fewer numbers, on the other hand, might point towards a situation where the spotlight is still on research pieces that have undergone thorough review and validation, while on the other hand, there might be some new and at least partially untested ideas out there. Top authors being a handful of most productive ones and the rest being only occasional contributors, this almost certainly is production of the field by a few leading researchers while the majority contributes only from time to time. Typical for a partly consolidated research system, these top scholars command considerable authority for the direction of the field while possibilities for growth and changes still exist. In fact, the network of co-authors complements this notion exactly showing different research groups linked by just a few key figures, the so called 'bridge' authors. These bridge people, as the name suggests, are extremely important to breaking down barriers and allowing different research communities (which might otherwise be separate) to have a dialogue and share knowledge.

The keyword and thematic trends revealed in the paper correspond with the existing research at large, focusing on the influence of rhythm on several

developmental domains, including language skills, cognitive development, and motor abilities. The discovery of some fresh topics, such as rhythm-based interventions and technology-enhanced learning environments, point to a transition to practical and innovative research methods. This progression is consistent with the rising focus on evidence-based practices in early childhood education. On the other hand, while acknowledging the positive aspects of these changes, our paper also points to some limitations in the area. The scattered form of collaboration networks leads to the idea that interdisciplinary and international cooperation might be a way to improve knowledge integration. Besides, the geographic and academic concentration of research might restrain the diversity of viewpoints and implementations.

The findings of this study are consistent with recent research emphasizing the growing importance of rhythm in early childhood development, particularly in relation to language acquisition and executive functioning. Similar trends have been identified in recent empirical and review studies (e.g., Frischen et al., 2022; Ladányi et al., 2020), suggesting that rhythm is increasingly positioned as a core component of early learning processes. Additionally, the emergence of technology-supported rhythm learning aligns with broader trends in digital early childhood education highlighted in recent literature highlighted in recent studies on technology integration in early childhood education.

## CONCLUSION

This study provides a comprehensive bibliometric overview of research on rhythm in early childhood from 2000 to 2025. The findings demonstrate that the field has experienced substantial growth in both productivity and impact, evolving into an increasingly interdisciplinary area of study. Key research themes have centered on the role of rhythm in supporting children's cognitive, linguistic, motor, and socio-emotional development, confirming its significance as a fundamental component of early childhood education.

The study also highlights the presence of influential authors and core research clusters that shape the intel-

lectual structure of the field, while revealing the need for stronger collaboration across research communities. Emerging topics, particularly those related to digital technologies and intervention-based approaches, indicate promising directions for future research.

From a practical perspective, the results underscore the importance of integrating rhythm-based activities into early childhood education programs, given their documented benefits for holistic child development. For researchers, the study provides a roadmap of key contributors, journals, and themes, facilitating more informed and targeted investigations.

However, this study is limited by its reliance on a single database (Web of Science) and English-language publications, which may exclude relevant research from other sources and cultural contexts. Future studies could expand the scope by incorporating multiple databases and conducting comparative analyses across regions.

In conclusion, this bibliometric mapping contributes to a clearer and more structured understanding of the field, offering valuable insights for researchers, educators, and policymakers. It also lays the groundwork for future studies aimed at deepening and broadening research on rhythm and its critical role in early childhood development.

## LIMITATIONS

It should be noted that the inclusion of multiple document types (e.g., proceeding papers and meeting abstracts) may influence the distribution of publication types and citation patterns; however, the main reason for the adoption of this approach was to allow the provision of a field overview that is as comprehensive as possible.

## Implications for Education and Teaching

In particular, the results of this bibliometric research point to the fact that early childhood education can be enhanced in several ways such as through teacher training, curriculum development, intervention design, and incorporation of new technologies.

## Implications for Teacher Training

The emphasis that rhythm-language and rhythm-cognitive development topics have been given, clearly

points towards the need for early childhood teacher education programs to have a portion dedicated to training on rhythm-based pedagogies. In order to realize synchronization, recognition of rhythmic patterns, and movements, teachers must be well prepared with the skills to create and carry out such learning tasks. Besides, it is essential for training courses to focus on how rhythm is a multidisciplinary element, showing the relationships of rhythm to language learning, executive functioning, and motor skill development.

### Implications for Curriculum Development

The focus of research on developmental results led to the suggestion that rhythm-based activities become an essential part of the preschool curriculum rather than be considered as additional music exercises. Therefore, curriculum designers could decide that: rhythm and movement activities to support motor coordination, rhythmic storytelling and songs to enhance language development, structured group rhythm activities to foster social interaction and self-regulation. These uses are in line with major themes highlighted by the bibliometric study.

### Implications for Intervention and Special Education

The development of research on rhythm-based interventions reveals the importance of this approach in some groups of children, especially those with language delays, dyslexia, and developmental coordination difficulties. Rhythm-based training is a supportive tool in early intervention programs, primarily for enhancing timing, attention, and auditory processing skills. The rising prominence of this topic in recent publications indicates that rhythm is being more and more acknowledged as a therapeutic and educational resource.

### Multicultural and Inclusive Education

Rhythm exists everywhere but takes on different forms across cultures. Teachers can use songs and beat-based games from various traditions to help kids feel seen and part of their heritage. Research from around the world supports this approach, showing how music connects to learning in many areas. New

tools like interactive apps and movement sensors are appearing in classrooms. Children respond better when they move to rhythm with digital support. Some platforms adjust difficulty based on performance. This lets each child work at their own pace. Data from these systems tracks how well children keep time or sync with beats. Rhythm isn't just about playing instruments anymore. It's part of math, language, motor skills, and emotional growth too. A child learns patterns by clapping or dancing to a beat. That kind of activity helps build focus and social awareness in early education.

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