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MUSIC INTERVENTION ENHANCING LANGUAGE DEVELOPMENT IN CHILDREN AGED 0 TO 6 IN EDUCATIONAL SETTINGS: A SYSTEMATIC REVIEW

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ABSTRACT

Aim/Purpose	The relationship between music and language is well established in developmental psychology and educational research. Nevertheless, important questions remain, particularly concerning children aged 0-6 years, the educational setting, and the extent to which music training supports the early development of linguistic abilities.
Background	This systematic review addressed these issues by examining studies on typically developing children within the 0-6 age range in educational services.
Methodology	The methodology comprised a search strategy across five databases, a screening process, data extraction, quality appraisal, assessment of risk of bias, and narrative synthesis of the results. The eligibility criteria for the review included studies involving typically developing 0-6-year-olds that implemented music training conducted in nursery and kindergarten settings, did not include comparisons with older age groups, and reported outcomes related to language. Only evidence-based studies published in English were selected.
Contribution	This systematic review contributes to the body of knowledge on music-based interventions for the development of linguistic skills in educational services.
Findings	Thirteen studies were included in the final review, involving participant samples ranging from 25 to 201 individuals. The selected studies included journal articles and master's and doctoral theses from various countries. Most of the studies reported that music training positively influenced the development of language in preschoolers in educational services.

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Recommendations for Practitioners	Given the results, educational professionals should consider this systematic review when designing music-based interventions to enhance the growth and well-being of children and their communities within an integrated 0-6-year perspective.
Recommendations for Researchers	However, some limitations emerged. Researchers need to implement music-based interventions for the 0-3 age group and focus on specific language aspects, such as their use.
Impact on Society	Despite the limitations, this systematic review has an impact on the growth and well-being of children and communities, informing the design of educational programs.
Future Research	Finally, this systematic review focused on a typical 0-6 age population. Future research should focus on children with atypical developmental trajectories to provide a clearer overview of existing evidence on music-based interventions in educational services.
Keywords	systematic review, music-based interventions, language development, toddlers and preschoolers, quality education, educational services

INTRODUCTION

The relationship between music and language is well known and has been extensively studied in the literature, in particular in the fields of pedagogy and the psychology of music. The first branch emerged as a specific topic within general pedagogy in the mid-17th century. From this period onwards, reflections on music pedagogy began to develop, starting with the work of Fénelon, a pedagogue who believed that music should be included among the disciplines useful for the education of girls (Ielmini & Pivetti, 2020). From this moment on, voices in favour of the need to include music in individual education multiplied, with authors such as Rousseau, Herbart, Fröbel, and Montessori. As a result, an “active” music pedagogy emerged, in which the child’s participation was placed at the centre of the knowledge acquisition process, stimulating not only the senses but also motor skills. Through sensorimotor experience, children are enabled to internalise, rework, and finally reproduce specific musical content independently. This perspective has its theoretical roots in authors such as Dewey, but finds its greatest methodological realisation in Kodály, Orff, and Gordon. In particular, they proposed music-based interventions with a focus on improvisation, active listening, movement, rhythm, and singing activities, programs that are still used today (Ielmini & Pivetti, 2020).

The psychology of music emerged in the 19th century, with Stumpf as a key figure, who was mainly interested in sound perception. The experimental phase and the perception of forms can be largely attributed to the work of Seashore and the Gestalt psychologists, culminating in studies on musical cognition and expectations with Meyer and colleagues (Haumann, 2015). Today, the topic is still central, with the integration of neurosciences, emotional regulation, and language, as seen in the work of authors such as Patel (Schön et al., 2007).

Given these premises, studying the relationship between music and language offers not only a historical perspective but also a way to engage with ongoing questions that remain highly relevant in today’s world.

By ‘music’ we mean the creation and intentional listening to sound effects produced by the voice or by various musical instruments, articulating sound in space (tones, harmony) and time (melody and rhythm), generally to communicate, express oneself, or derive aesthetic sensations (Proverbio, 2019, p. 1). Music is an artistic and emotional form with repercussions and influences in various fields, sharing a series of cognitive and functional elements with areas of development such as language.

By “language” we refer to a complex, symbolic system employed for communication and the representation of thought (D’Amico & Devescovi, 2018; Guasti, 2004; Majorano, 2015; Owens, 2020). It is also characterised by considerable inter-individual variability, which makes any developmental model extremely arbitrary, especially in the early stages of life (Majorano, 2015). Moreover, different theoretical approaches, such as interactionist/cognitive-functionalist (Bates et al., 1988; Rumelhart & McClelland, 1986) and innate-modularist/neuro-constructivist theory (Chomsky, 1957; Elman et al., 1996; Fodor, 1983; Johnson, 2001; Locke, 1993; Macchi Cassia et al., 2004), have investigated the various components of language, giving them different meanings depending on the underlying theoretical framework. However, they agree on the basic elements of language. Its structural analysis is traditionally organised around three interrelated components: the dimensions of form (comprising phonology, morphology, and syntax), the content (semantics or lexicon), and the use (pragmatics) (Bloom & Lahey, 1978; Owens, 2020). These core components underpin crucial metalinguistic skills, such as phonological awareness (essential for alphabetisation and reading acquisition) and morpho-syntactic awareness (essential for text comprehension), representing primary domains of inquiry in research on language development and specific language disorders (Justice & Ezell, 2011).

The form domain (phonology, morphology, syntax, alphabetisation, and reading skills) refers to the structure and grammatical rules of language. There are different possible examples: in phonology, the ability to distinguish minimal pairs such as “but” and “put”; in syntax, correct gender and number agreement or the construction of passive sentences; in alphabetisation, the breakdown of a written word into the individual letters (graphemes) that compose it; in reading skills the ability to decode words and non-words accurately. The content domain (lexicon, semantics, and text comprehension) refers to the meaning of words and phrases, as well as the organisation of knowledge about the world. Possible examples are: in lexicon, knowing that “apple” refers to a fruit and not an animal; in semantics, understanding the hierarchy between “dog” and “animal” or the opposition between “hot” and “cold”; in text comprehension, the ability to extract the overall meaning of a passage beyond simple mechanical reading. The use domain (pragmatics) concerns the function that language serves in social and communicative contexts. It defines the “why” and “when” an expression is used to achieve an intersubjective purpose. A possible example is: the statement “it’s cold in here”, which, in the correct context, is not a simple meteorological observation but a pragmatic request to close a window or adjust the heating.

Not only language, but also the relationship between music and language can be assessed at various levels, which can be categorised in terms of form, content, and use of language (Bloom & Lahey, 1978; Owens, 2020), as well as underlying shared mechanisms and observable behavioural outcomes. Regarding the linguistic macro-categories, the most robust evidence connecting music and language lies within the dimension of form. Music is closely related to prosody, the musicality of speech (Magne et al., 2005), to the extent that the rhythmic structure of a culture’s language seems to influence the musical culture itself (Patel & Daniele, 2003). Musicians have been shown to outperform non-musicians in syllable discrimination (Zuk et al., 2014) and speech detection in noisy contexts (Du & Zatorre, 2017; Parbery-Clark et al., 2009). The benefits extend to phonemic awareness (Anvari et al., 2002), the acquisition of the sound structures of a foreign language (Milovanov et al., 2008, 2010; Slevc & Miyake, 2006), and are consistently associated with reading skills (Anvari et al., 2002; Corrigall & Trainor, 2011). Concerning the dimension of content, evidence supports a relationship with the development of lexicon/semantics. Music correlates with verbal memory (Ho et al., 2003; Magne et al., 2006) and is related to vocabulary development (Forgeard et al., 2008), suggesting an enhancement of the cognitive resources for word learning and retrieval. Conversely, direct evidence concerning the dimension of use (pragmatics) is often less represented in these foundational studies, despite the critical role of music in promoting interpersonal synchrony, cooperation, and emotional regulation (Cirelli et al., 2014; Dissanayake, 2000), which constitute the fundamental prerequisites for the development of pragmatic skills and communicative turn-taking (Trevarthen, 1999).

At a neural level, musical and linguistic abilities share essential auditory, motor, mnemonic, and temporal competencies (Fedorenko et al., 2009; Nayak et al., 2022). The early abilities related to spoken language development (such as segmentation, discrimination of vowels and consonants, and analysis of the rhythmic patterns of one's native language) largely overlap with musical listening skills (Brandt et al., 2012). This connection is reflected in the neurobiological structure, where musical practice can significantly alter a musician's brain (P. Schneider et al., 2002), subsequently impacting a wide range of non-musical skills, including fine auditory discrimination, auditory attention, language processing abilities, and auditory memory (Linnavalli et al., 2021). This is because, from a neural perspective, music and language share numerous elements (Maess et al., 2001), which extend to both the right and left hemispheres (Proverbio, 2019) and Broca's area (Schön et al., 2007).

With regard to the first element (i.e., hemispheric involvement), a study by Proverbio et al. (2013) found, using electromagnetic neuroimaging and EEG/ERP recording, that when analysing alphabetical symbols, people with no musical knowledge activated only the left region, located in the fusiform gyrus of the occipitotemporal cortex, while in musicians these regions were activated in both hemispheres, doubling the cortical volume involved. Musicians, therefore, use the visual cortices of both cerebral hemispheres, giving rise to a neural mechanism that is partly common to the analysis of words and notes on the staff (Proverbio, 2019). As for the second, Patel et al. (2008) demonstrated that aphasic patients with non-fluent aphasia, caused by a lesion in Broca's area, indeed have a disorder in understanding musical syntax.

Thanks to this strong relationship starting in early developmental stages (Politimou et al., 2019), the principles of musical intervention have been widely integrated into programmes for the preschool and early school ages, often based on recognised pedagogical approaches such as the Gordon Method (Gordon, 2007), Orff-Schulwerk (Orff & Keetman, 1976), Kodály (Kodály, 1974), or specific rhythmic training in educational settings (e.g., Williams & Bentley, 2026). These interventions aim to impact a range of children's developmental competencies, including language, by means of musical approaches focused on play, vocal and sonic experimentation, improvisation, creativity, movement, and rhythm.

Despite the unquestionable value of such musical interventions in the educational domain, they often remain restricted to the three-to-six age range and do not present clear and synthesisable quantitative results concerning the development of linguistic components. Moreover, to our knowledge, there is a lack of systematic reviews on the effect of music-based interventions on linguistic skills in 0-6-year-olds conducted in educational settings. From our preliminary literature research on the Open Science Framework (OSF) to identify other systematic reviews on this topic, only one was found: V. Schneider and Rohmann (2021). However, it did not investigate the effect of music intervention on language. Rather, it focused on the role of arts education in educational programming.

To fill this research gap, this systematic review examines the role of music training in fostering the development of linguistic skills in typically developing children aged 0 to 6 years in educational settings. The more salient linguistic components we sought to investigate were knowledge and abilities in phonology, morphology, and syntax, as well as the ability to discriminate and select appropriate linguistic content to achieve various communicative intentions.

This study adopts an educationally integrated perspective, focusing on children within nursery and kindergarten settings, as well as the broader community (e.g., educators, teachers, and headteachers) that contributes to their development (Bondioli & Savio, 2021; Guerra & Luciano, 2009; Malavasi & Zoccatelli, 2018; Ripamonti & Tosi, 2010). This is because we firmly believe in the importance of establishing an integrated, unique educational system for both toddlers and preschoolers, as in the Italian context. In particular, in Italy, what were previously two different systems (nurseries as institutions that support working parents during the child's first three years, and kindergartens as the initial stage of formal education) were integrated in 2017 through the National Guidelines issued by the Italian Ministry of Education. Therefore, the effort consists of attempting to standardise two

systems, created with different purposes (care and education), into a single educational proposal that allows children to enter the school world smoothly at the end of kindergarten. Succeeding in this endeavour is essential to promote children's growth, well-being, inclusion, and quality of education. In this sense, music-based interventions are fundamental to achieving these objectives, particularly in developing high-quality and equally accessible educational offers for every child, as outlined in the United Nations' Sustainable Development Goals (United Nations, 2015).

METHODS

This systematic review followed an eight-step process in accordance with the Open Science Framework (<https://osf.io>) pre-registered protocol comprising: (1) registration, (2) preparation, (3) database search, (4) screening, (5) pre-registration update, (6) extraction, (7) quality appraisal and risk of bias assessment, and (8) synthesis. The research process was documented following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021).

ELIGIBILITY CRITERIA

The research strings were constructed using the PICO model (Saiq & Ashraf, 2017). Studies were included if they addressed:

- P (Population): 0-6-year-old population.
- I (Intervention): music training in educational services.
- C (Comparison): no comparisons with older populations, no neurodivergence, disabilities, disorders, or impairments.
- O (Outcomes): relationship with language.

Only documents published in English and evidence-based were included.

Studies were excluded if they involved populations older than 6 years or with diagnosed developmental disorders, if music training was conducted outside of educational services, or if they investigated variables unrelated to language. Additionally, studies were excluded if they were written in a language other than English or lacked an evidence-based methodology.

INFORMATION SOURCES

To search the literature on the topic and gather information on the included studies, we applied different strategies:

- Published literature: Scopus, PsycINFO, Web of Science, ERIC (with ProQuest).
- Grey literature: Bielefeld Academic Search Engine (BASE) focusing on bachelor's, master's, and doctoral theses and unpublished studies.
- Open Science Framework: searching for similar systematic reviews.
- Contacting the University Library.
- Contacting the authors of selected studies.

SEARCH STRATEGY

First, two screeners (A. N. and M. U.) constructed search strings to apply to Scopus, PsycINFO, Web of Science, ERIC, and BASE. To ensure consistency, uniform search terms were employed across all databases, although the availability of advanced search features varied. The search strings utilised are reported in Table 1.

Table 1. Search strategy used in different databases

Databases	Search terms
PsycINFO	mp = (infant* or toddler* or pupil* or “nursery child*” or “0-3-year*” or preschool* or “3-6-year*” or “kindergarten child*” or “young* child*” or “early* child*” or “0-6 year*”) and (“music* training*” or “music laborator*” or “music workshop*” or “music* intervention*” or “music-based intervention*” or “music* education*” or “music* program*” or “music-based program*”) and (“nursery” or “daycare*” or “kindergarten” or “education* service*”) not (“school-age child*” or adolescent* or adult* or “atypic* population” or disabilit* or neurodiversit* or disorder or impairment) and (language* or “language* development*” or “language* skill*” or “linguistic* skill*” or “oral* language*” or “expressive* language*” or “receptive* language*”)
Scopus	TITLE-ABS-KEY((infant* OR toddler* OR pupil* OR “nursery child*” OR “0-3-year*” OR preschool* OR “3-6-year*” OR “kindergarten child*” OR “young* child*” OR “early* child*” OR “0-6 year*”) AND (“music* training*” OR “music laborator*” OR “music workshop*” OR “music* intervention*” OR “music-based intervention*” OR “music* education*” OR “music* program*” OR “music-based program*”) AND (“nursery” OR “daycare*” OR “kindergarten” OR “education* service*”) AND NOT (“school-age child*” OR adolescent* OR adult* OR “atypic* population” OR disabilit* OR disorder OR impairment OR neurodiversit*) AND (language* OR “language* development*” OR “language* skill*” OR “linguistic* skill*” OR “oral* language*” OR “expressive* language*” OR “receptive* language*”))
Web of Science	TS = ((infant* OR toddler* OR pupil* OR “nursery child*” OR “0-3-year*” OR preschool* OR “3-6-year*” OR “kindergarten child*” OR “young* child*” OR “early* child*” OR “0-6 year*”) AND (“music* training*” OR “music laborator*” OR “music workshop*” OR “music* intervention*” OR “music-based intervention*” OR “music* education*” OR “music* program*” OR “music-based program*”) AND (“nursery” OR “daycare*” OR “kindergarten” OR “education* service*”) NOT (“school-age child*” OR adolescent* OR adult* OR “atypic* population” OR disabilit* OR neurodiversit* OR disorder OR impairment) AND (language* OR “language* development*” OR “language* skill*” OR “linguistic* skill*” OR “oral* language*” OR “expressive* language*” OR “receptive* language*”))
ERIC (with ProQuest)	noft((infant* OR toddler* OR pupil* OR “nursery child*” OR “0-3-year*” OR preschool* OR “3-6-year*” OR “kindergarten child*” OR “young* child*” OR “early* child*” OR “0-6 year*”) AND (“music* training*” OR “music laborator*” OR “music workshop*” OR “music* intervention*” OR “music-based intervention*” OR “music* education*” OR “music* program*” OR “music-based program*”) AND (“nursery” OR “daycare*” OR “kindergarten” OR “education* service*”) NOT (“school-age child*” OR adolescent* OR adult* OR “atypic* population” OR disabilit* OR neurodiversit* OR disorder OR impairment) AND (language* OR “language* development*” OR “language* skill*” OR “linguistic* skill*” OR “oral* language*” OR “expressive* language*” OR “receptive* language*”))

Databases	Search terms
BASE	All Fields(infant* OR toddler* OR pupil* OR “nursery child*” OR “0-3-year*” OR preschool* OR “3-6-year*” OR “kindergarten child*” OR “young* child*” OR “early* child*” OR “0-6 year*”) AND (“music* training*” OR “music laborator*” OR “music workshop*” OR “music* intervention*” OR “music-based intervention*” OR “music* education*” OR “music* program*” OR “music-based program*”) AND (“nursery” OR “daycare*” OR “kindergarten” OR “education* service*”) NOT (“school-age child*” OR adolescent* OR adult* OR “atypic* population” OR disabilit* OR neurodiversit* OR disorder OR impairment) AND (language* OR “language* development*” OR “language* skill*” OR “linguistic* skill*” OR “oral* language*” OR “expressive* language*” OR “receptive* language*”)

Note: All retrieved records were exported in RIS format for processing and uploaded to Rayyan (<https://www.rayyan.ai/>), a web-based reference management tool for collaborative systematic reviews.

SELECTION AND DATA COLLECTION PROCESS

The screening process was conducted by two screeners (A. N. and M. U.), with a third (G. M.) only contacted in case of discrepancies, using Rayyan’s blind function (i.e., a method where each reviewer screens the studies independently, without seeing the other’s decisions, allowing for comparison only after the process is complete). For studies where full texts were not available (n = 2), the authors were contacted directly.

DATA EXTRACTION

All three reviewers read the included studies, with one reviewer (A. N.) responsible for completing the data extraction in Excel. The extracted data were subsequently checked for accuracy by the other two. The following information was collected: *bibliographic information* (Title; Author; Year; Country), *methodology* (Study Type; Setting; N tot; N Experimental; N Control; Mean Age; % Male; Test/Instrument; Intervention; Duration; Frequency; Session Length; Control; Duration; Frequency; Session Length; Follow-up); and *analysis* (Main Outcome; Mean Experimental; SD Experimental; Mean Control; SD Control; p-value; Dropout).

QUALITY AND RISK OF BIAS ASSESSMENT

The methodological quality of the included studies was assessed using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018). This instrument was selected because it allows for a systematic and comparable appraisal of studies employing diverse methodological designs, including quantitative, qualitative, and mixed-methods research, all represented in this review (even if we considered mixed-methods research as quantitative, given our focus on the quantitative aspects of the studies). Moreover, the MMAT enables the evaluation of key methodological quality aspects, such as the appropriateness of the study design, the relevance of the data collection and analysis methods, and the internal coherence between the research questions, findings, and conclusions. Although not explicitly designed as a risk-of-bias assessment tool, the MMAT incorporates criteria that help identify potential methodological limitations that may affect the trustworthiness of the results. One reviewer (A. N.) conducted the assessment, while the other two verified its accuracy.

To minimise the risk of reporting bias, the protocol of this systematic review was pre-registered on OSF prior to data extraction and analysis.

EFFECT MEASURES

To synthesise the findings quantitatively, Standardised Mean Differences (SMDs) were used as the primary effect measure. This enables the comparison of results across studies that employed different scales to measure linguistic outcomes. To isolate the specific impact of the musical interventions

while accounting for initial group differences, the net effect size (d) was calculated. This measure represents the difference between the intervention and control groups at the post-test, adjusted for baseline variability. This approach was chosen because standardising by the pre-test variability ensures that the effect size reflects the intervention gain without being biased by any changes in variance that might occur during the intervention itself. This provides a more stable and comparable metric across diverse experimental settings. For studies that did not directly report means and standard deviations, the effect sizes (SMDs) were computed from other inferential statistics (Borenstein et al., 2021). Specifically, F values (derived from two-group ANOVAs) and t statistics (from independent samples t -tests) were converted into SMDs using standardised conversion formulae (Lipsey & Wilson, 2001). This step ensures that all findings, regardless of how they were originally reported, are expressed on the same scale, allowing for a comprehensive synthesis of the evidence.

Recognising that many studies in the field of musical intervention involve small sample sizes, which can lead to an overestimation of the effect, the Hedges' correction factor (J) was applied. This transformed the initial net d into Hedges' g . Following methodologically recommended practices (Borenstein et al., 2021; Hedges, 1981), Hedges' g provides a more conservative and less biased estimate, ensuring that the findings are not disproportionately influenced by smaller trials. These parameters quantify the precision of each study's findings. Furthermore, 95% confidence intervals (CI95%) and Z statistics were computed to determine the statistical significance of the effects and to test the null hypothesis (i.e., that the musical intervention had no average effect on language skills) (Borenstein et al., 2021).

To ensure the preservation of the independence of the unit of analysis, which requires that each set of participants contributes only one data point to the analysis to avoid artificially inflating the statistical power, specific guidelines were adopted for managing dependent outcomes and interventions (Borenstein et al., 2021):

- Multiple outcomes within the same domain: where a single study reported multiple g values for the same outcome domain (e.g., phonology, measured via rhyming and segmentation), only the g value corresponding to the highest-level hierarchical outcome (e.g., phonemic segmentation over rhyming) was extracted.
- Multiple interventions within the same study: the methodological challenge presented by studies testing two distinct intervention conditions (e.g., Converse Richards, 2011, with pitch and rhythm) against a single control group necessitated the extraction of a single representative effect size (g) to maintain statistical independence. Since the primary focus of this systematic review is on musical intervention and its impact on language development, the rhythm condition was selected as the representative measure. Consequently, the g value corresponding to the rhythm condition was exclusively extracted for inclusion in the quantitative synthesis.

These data will be presented in Appendix A and B to facilitate narrative synthesis and the evaluation of the strength of the evidence.

SYNTHESIS METHODS

To describe the study's characteristics and synthesise the results, we created a tabular structure and inserted the authors, year of publication, country, research design, number of participants, sample age, duration, type of intervention, control intervention, assessment tasks, and results (Appendix A). To report on the effect sizes of the studies, we created another table to compare the data synthesis of studies for which it was possible to calculate them (Appendix B). Not all the included studies were eligible for quantitative synthesis because there were problems with the reported number of participants (intervention or control groups). In these cases, we examined the data reported in each study to understand the differences between condition groups. Finally, we created a graph to better illustrate the sample size and the effect size of the conditions for each study. In this way, it became clear that

the data synthesis across studies was highly heterogeneous, which prevented the use of a meta-analysis, also due to the large variety in measurement instruments and the differing durations and structure of the music interventions.

RESULTS

STUDY SELECTION

The PRISMA flow diagram (Figure 1) describes the process for including and excluding studies. The total number of studies exported from databases to Rayyan was 508 (81 from Scopus, 9 from PsycINFO, 31 from Web of Science, 375 from ERIC, and 12 from BASE). With the help of Rayyan, we detected 199 duplicates and removed them manually, leaving 393 studies eligible for the screening process.

PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases, registers and other sources

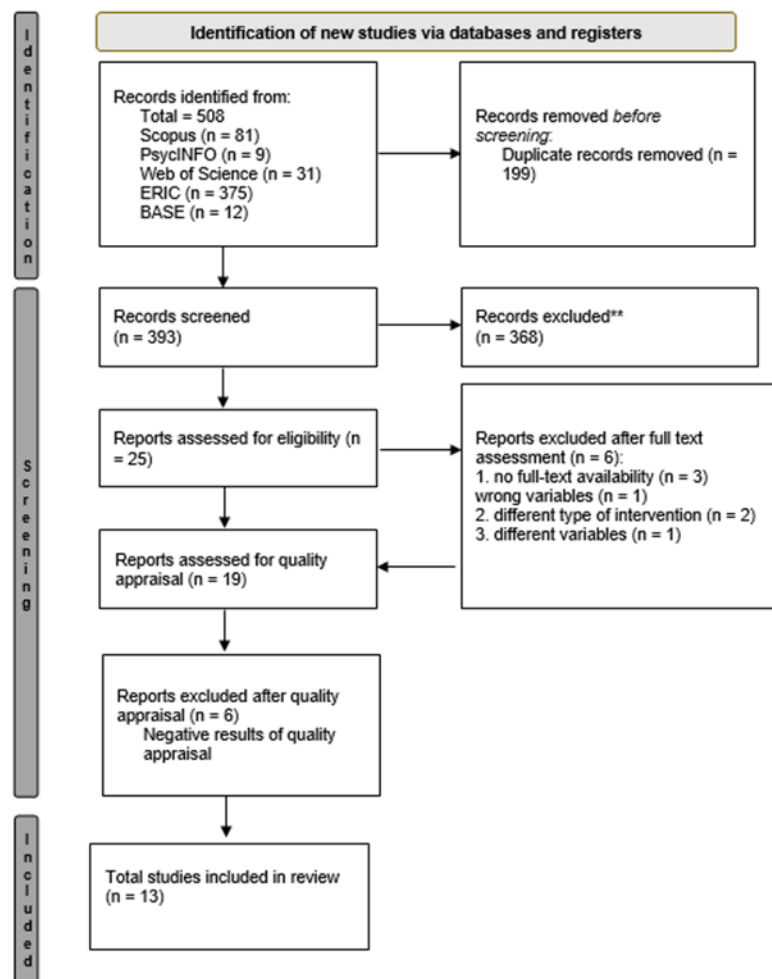


Figure 1. PRISMA flow diagram

From the title-abstract screening (8-11 August 2025), 368 studies were excluded, and the screeners agreed on 25 studies. They were eligible for the full-text screening (11 August - 16 September 2025). In this phase, the screeners excluded six other studies for different reasons:

- *No full-text availability:* Augustine (2015) and Colwell (1994) were excluded because the authors did not respond to our request for the full text. Natati et al. (2025) were excluded because it was only an abstract presented to a conference, with no full-text available.
- *Different types of intervention:* Carlson (2003) was excluded because it was not an experimental study but a list of possible interventions, and Caracci et al. (2022) because the musical training was conducted on a digital platform.
- *Different variables:* Van Zee (1976) was excluded because it focused on musical language and not on the linguistic domain.

After this, we extracted the data (16-25 September 2025) and checked the quality and risk of bias of the included studies (26-30 September 2025). The quality appraisal process revealed several challenges, particularly in determining whether studies adequately addressed the questions posed by the MMAT. For some contributions, clarification was sought directly from the authors. Studies were included if at least three specific questions were clearly addressed in the manuscript. Attempts to contact Kempert et al. (2016) were unsuccessful due to an incorrect email address reported in the article; for Brown et al. (1981), even though it was a journal article, no email address was provided; Bowen (2010), St. Clair (2014), and Taylor (2012) could not be contacted because, being dissertations, no contact information was available. Bolduc (2009) and Linnavalli et al. (2018) were the only two authors to whom we were able to send an email. Linnavalli replied on 30 September and clarified our doubts. We excluded Bolduc (2009) because he did not respond. As a result, the number of studies included was reduced to 13.

Among the RCTs (Baek, 2009; Carson-Swift, 2022; Converse Richards, 2011; Hunt, 2012; Nelson, 2016; Newland, 2013; Reeves Montgomery, 1997; Vidal et al., 2020; Vinuales del Egado, 2023), three responded positively to all MMAT questions (Baek, 2009; Nelson, 2016; Newland, 2013). Among the non-RCTs (Lehman, 2019; Linnavalli et al., 2018; Moritz, 2007; Walton, 2014), none responded positively to all the specific questions of MMAT. Issues related to the other studies (Carson-Swift, 2022; Converse Richards, 2011; Hunt, 2012; Lehman, 2019; Linnavalli et al., 2018; Moritz, 2007; Reeves Montgomery, 1997; Vidal et al., 2020; Vinuales del Egado, 2023; Walton, 2014) are reported in Table 2.

Table 2. Reasons and MMAT score

Study	Reasons for the score	Responses	MMAT score
Baek (2009)			5
Carson-Swift (2022)	2.2. Are the groups comparable at baseline? 2.4. Are outcome assessors blinded to the intervention provided?	Can't tell Can't tell	3
Converse Richards (2011)	2.3. Are there complete outcome data? 2.5 Did the participants adhere to the assigned intervention?	Can't tell Can't tell	3
Hunt (2012)	2.4. Are outcome assessors blinded to the intervention provided?	Can't tell	4
Lehman (2019)	3.5. During the study period, was the intervention administered (or exposure occurred) as intended?	Can't tell	4
Linnavalli et al. (2018)	3.3. Are there complete outcome data?	No	4
Moritz (2007)	3.5. During the study period, was the intervention administered (or exposure occurred) as intended?	Can't tell	4
Nelson (2016)			5
Newland (2013)			5

Study	Reasons for the score	Responses	MMAT score
Reeves Montgomery (1997)	2.1. Is randomization appropriately performed? 2.2. Are the groups comparable at baseline?	Can't tell Can't tell	3
Vidal et al. (2020)	2.3. Are there complete outcome data? 2.5 Did the participants adhere to the assigned intervention?	No No	3
Vinuales del Egidio (2023)	2.1. Is randomization appropriately performed? 2.4. Are outcome assessors blinded to the intervention provided?	No No	3
Walton (2014)	3.5. During the study period, was the intervention administered (or exposure occurred) as intended?	Can't tell	4

In some cases, there were concerns regarding randomisation, participants' adherence to the assigned intervention, and the comparability of the intervention and control groups at baseline. However, the main critical aspects were adherence to the training protocol, blinding of the assessors, and the completeness of outcome data. Specifically, we set the dropout percentage to 15%, acknowledging the ongoing debate on this topic, with authors accepting anywhere from 80% (Thomas et al., 2004; Zaza et al., 2000) to 95% completeness of data (Higgins et al., 2016); and dropout rates from 5% (de Vet et al., 1997; MacLehose et al., 2000), 20% (Sindhu et al., 1997; van Tulder et al., 2003) to 30% for a follow-up of at least one year (Viswanathan & Berkman, 2012). Figures 2 and 3 present the graphs of the quality assessment scores divided into RCT and non-RCT studies.

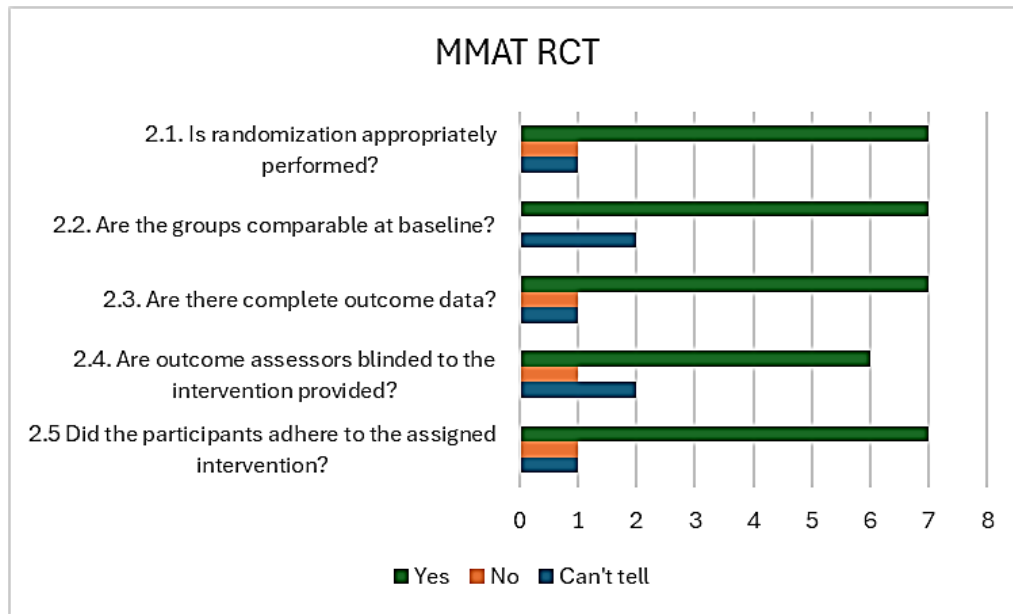


Figure 2. Assessment of methodological quality of the randomised controlled trials (RCTs) using the MMAT

The chart displays, for each of the five key criteria (appropriate randomisation, baseline comparability of groups, completeness of outcome data, blinding of outcome assessors, and adherence to the assigned intervention), the number of studies rated as “Yes”, “No”, or “Can’t tell”.

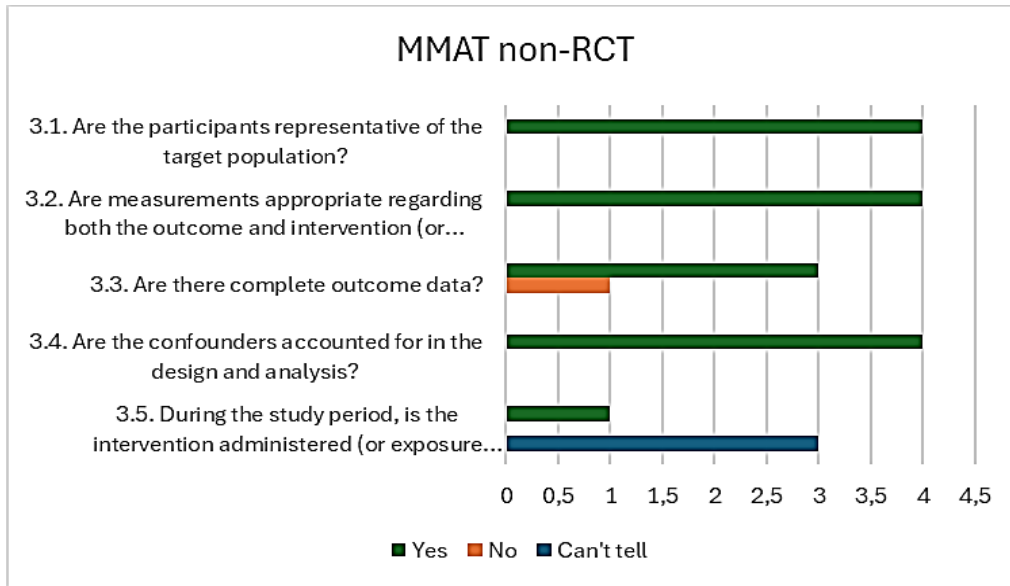


Figure 3. Assessment of methodological quality of the non-randomised studies (non-RCTs) using the MMAT

STUDY CHARACTERISTICS

Most included studies were dissertations (10), and three were articles (Linnavalli et al., 2018; Vidal et al., 2020; Walton, 2014). This disproportion in favor of the thesis could be explained by the fact that conducting interventions in educational services is a typical topic for a bachelor’s, master’s, or PhD thesis. Moreover, there is limited literature on the relationship between music interventions in educational settings and language in 0-6-year-olds, so the number of articles on this topic remains limited.

Many of the selected contributions were conducted in the United States (Carson-Swift, 2022; Converse Richards, 2011; Lehman, 2019; Moritz, 2007; Nelson, 2016; Newland, 2013; Reeves Montgomery, 1997; Vinales del Egado, 2023). Other geographical locations included Canada (Walton, 2014), Finland (Linnavalli et al., 2018), Wales (Hunt, 2012), South Korea (Baek, 2009), and Portugal (Vidal et al., 2020). Figure 4 illustrates the distribution of the studies selected.

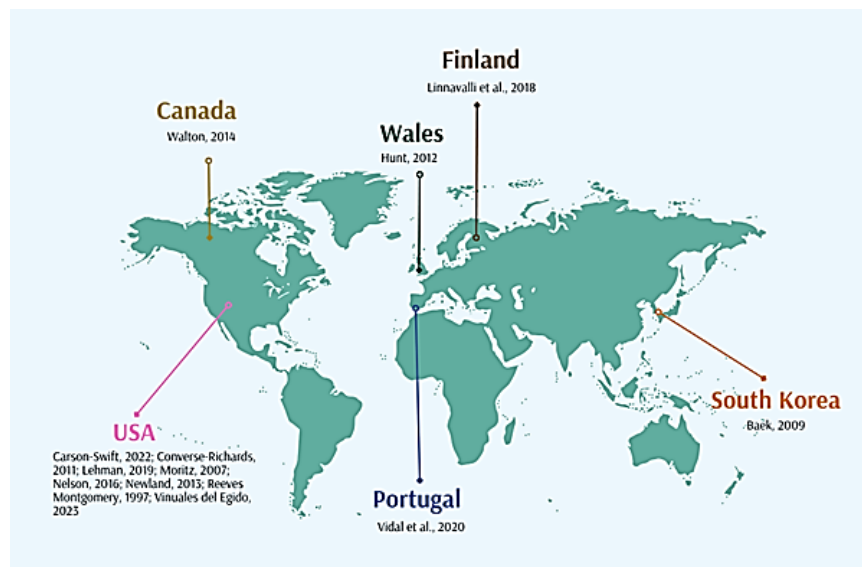


Figure 4. Distribution of studies by country

The sample sizes ranged from 25 participants (Vinales del Egado, 2023) to 201 (Newland, 2013). They included children aged 0-6 years (particularly 3-6-year-olds), parents, educators, teachers, and headteachers.

The main characteristics of the included studies, such as participant demographics, study design, and specific settings, are summarised in Appendix A.

SYNTHESIS OF RESULTS

The main characteristics of the included contributions are reported in Appendix A. The results of these studies were also statistically analysed, and their effect sizes are reported in Appendix B for the studies where this calculation was possible. Figure 5 describes the effect size of each study.

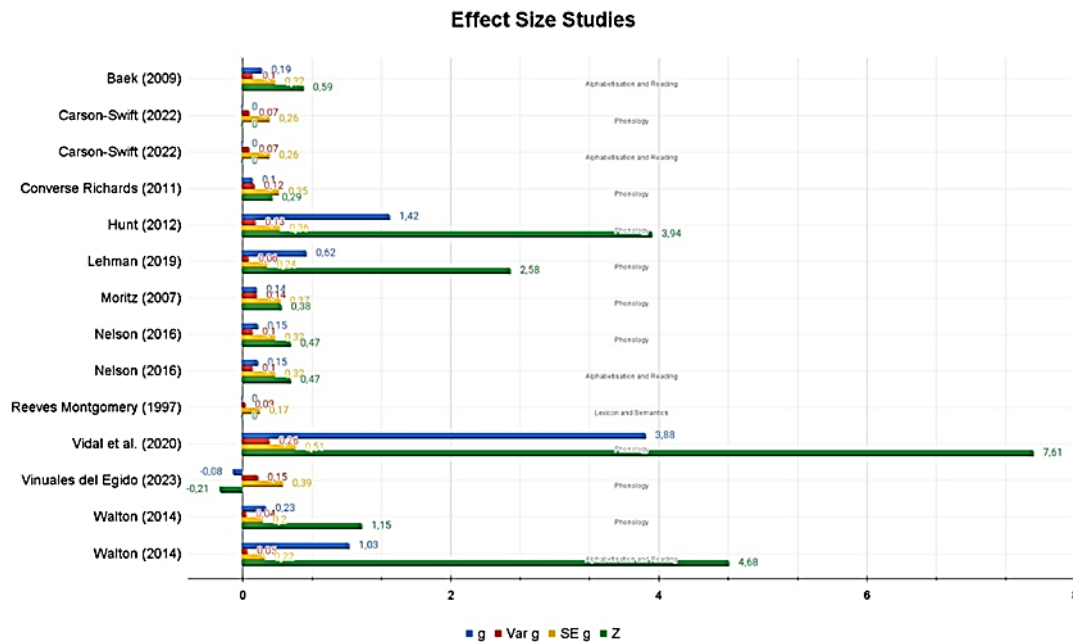


Figure 5. Effect size of the studies in the language domain (phonology, alphabetisation and reading, lexicon and semantics)

Many of them (10 studies) focused on the form dimension, with phonology as the most investigated aspect, followed by alphabetisation and reading skills (5 studies). When considered collectively, the phonology studies yielded a weighted mean effect size of medium magnitude ($g \approx 0.45$). The overall precision of the estimates was moderate. However, this aggregated result conceals substantial variability at the individual-study level. Only three out of nine studies (excluding Linnavalli et al. (2018), due to inability to extract statistical data) reported statistically robust effects, with Z values exceeding 1.96 and confidence intervals that did not include zero (Hunt, 2012; Lehman, 2019; Vidal et al., 2020). A particularly notable finding was reported by Vinales del Egado (2023), which produced an exceptionally large effect size ($g = 3.88$) accompanied by a narrow confidence interval [2.88, 4.88] and a highly significant Z statistic ($Z = 7.61$). Five studies examined early alphabetisation skills, including reading abilities, yielding a weighted mean effect size of moderate magnitude ($g \approx 0.63$). Only one study out of four (excluding Newland, 2013, due to data extraction difficulties), Walton (2014), reported a clearly significant effect, with a relatively large effect size ($g = 1.03$) and a narrow confidence interval [0.64, 1.42], supported by a Z value of 4.68.

Regarding the content dimension, encompassing lexicon/semantics and text comprehension, only two studies addressed lexical and semantic outcomes, and effect size data could be extracted from a

single study (Reeves Montgomery, 1997), while Linnavalli et al. (2018) was excluded due to uncertainty regarding participant numbers. This study reported a null effect ($g = 0.00$), with a confidence interval spanning zero $[-0.33, 0.33]$, and a non-significant Z value. Similarly, text comprehension was investigated in only one study (Newland, 2013), but data extraction was not possible due to insufficient information about group allocation following participant attrition (the author reported $N = 214$ initial participants, reducing to $N = 201$ without detailing the distribution across intervention conditions).

No studies appeared in the use of language dimension.

DISCUSSION

INTERPRETATION

The review included 13 studies focusing on the efficacy of music-based language intervention in preschool children in educational services, covering two out of the three primary outcome domains described by Owens' model (2020): form and content, while no study investigated language use. Contributions were identified within the subdomains of phonology, alphabetisation and reading, lexicon/semantics, and text comprehension. Findings were interpreted based on the magnitude of the effects (Hedges' g) and their precision ($CI95\%$).

Overall, the strongest evidence emerged within the macro-category of language form, encompassing phonology, alphabetisation and reading. Although moderate effect sizes were observed at the aggregated level, findings across individual studies were heterogeneous and often lacked statistical significance, warranting cautious interpretation. With respect to phonology, these studies suggest a potentially meaningful association between musical training and phonological development. Vinuales del Egado (2023) showed a precise and robust effect estimate, though its markedly higher magnitude compared to the other studies raises concerns about generalisability. Taken together, the phonology findings suggest a trend toward positive effects of music-based interventions, but the limited number of statistically significant results prevents firm conclusions regarding their reliability across contexts and populations. A similar pattern emerged for alphabetisation and reading-related outcomes. Again, statistically robust evidence was limited as only Walton (2014) reported a clearly significant effect, while the remaining studies showed smaller and non-significant effects. These results suggest that music-based interventions may support emergent alphabetisation skills, but the evidence remains tentative, particularly given that the participants were not yet formally schooled.

Evidence for the macro-category of language content was limited. Only two studies addressed lexical and semantic outcomes, and effect size data could be extracted only from Reeves Montgomery (1997). This study indicates that the intervention had no measurable impact on lexicon or semantic skills. Consequently, no reliable conclusions can be drawn regarding the effects of musical training on lexical and semantic development. Similarly, text comprehension was investigated only by Newland (2013), but data extraction was not possible. Although the author reported improvements in comprehension within the intervention group, the absence of extractable quantitative data precludes any estimation of effect size and limits its interpretability.

No evidence was found regarding the use of language, highlighting a substantial gap in the literature.

Overall, the studies examined in this systematic review only partially met their objectives, as they address an area that is still largely unexplored: the use of musical interventions to support language development in educational and childcare settings. The results obtained reveal some points of contact, as well as divergences from previous literature. As in other studies discussed, no one has examined children aged between 0 and 3 years, and most have focused predominantly on the form of language (at the expense of content and use).

With regard to form, the results confirm, albeit partially, previous evidence on the significant relationship between musical activities and phonological awareness (Anvari et al., 2002), as well as

between musical skills and the development of reading abilities (Anvari et al., 2002; Corrigan & Trainor, 2011). On the contrary, with regard to content, the absence of significant effects does not allow us to confirm with certainty the conclusions of Forgeard et al. (2008) on the relationship between musical training and vocabulary development.

Finally, in line with the literature describing language use as a complex skill that develops later and is closely linked to the maturation of interpersonal relationships, this component is poorly represented. However, unlike previous studies that highlight a link between music and language use through processes of interpersonal synchrony, cooperation, and emotional regulation (Cirelli et al., 2014; Dissanayake, 2000), these aspects are completely absent in the studies included in this review.

Overall, although the presence of moderate effects in some linguistic domains suggests that musical activities may be promising support tools in educational contexts, the evidence remains fragmentary.

LIMITATIONS OF EVIDENCE AND REVIEW PROCESS

The present systematic review faced some limitations inherent to the evidence identified and the review process itself.

Firstly, although the initial search aimed to explore the relationship between music and language in the 0-6 age range, this objective was only partially met by the retrieved data: a complete absence of musical interventions focused on the 0-3-year-old population was found. This gap can be explained by the fact that the review methodology prioritised evidence-based articles with robust quantitative data analysis. Interventions involving music and the toddler population typically employ qualitative methods and often lack a focus on specific variables, given the inherent challenges in assessing abilities and conducting musical training in this age group. The exclusive focus on “evidence-based interventions” may therefore constitute a limitation of the review process itself, as it may have precluded the inclusion of relevant research on the 0-3 population, which remains an important avenue for future investigations.

Secondly, a significant limitation concerns the total absence of data relating to the use of language dimension (pragmatics). In particular, the available studies did not include measures targeting social-pragmatic abilities, such as turn-taking, conversational responsiveness, or situational appropriateness. Consequently, it was not possible to assess whether musical interventions could support social interaction and functional communication skills. Nevertheless, this represents a theoretically relevant outcome, as early music-based activities typically involve shared emotional engagement, joint attention, listening skills, and coordinated social interaction, all of which are closely related to the development of social use of language (Cirelli et al., 2014; Dissanayake, 2000). It was therefore expected that musical training might be associated with improvements in children’s ability to adapt communicative behaviour to the interactional context and to manage conversational exchanges more effectively (Trevathan, 1999). The lack of evidence in this domain is presumably due to the substantial methodological challenges involved in standardising and quantifying pragmatic abilities, alongside the predominant research focus on the form and content domains. Despite these limitations, we hope that our systematic review has helped to pinpoint crucial unaddressed research gaps in the literature, thereby encouraging future investigations on this topic.

IMPLICATIONS

Further research is needed to deepen the understanding of the relationship between music and language development in children aged 0-6 in educational settings, including research involving children with non-typical developmental pathways. Working on this relationship could have practical implications for nursery and kindergarten services, as well as for children’s development. In many educational institutions, there is a lack of funding and insufficient preparation to implement music interventions, resulting in a relatively low number of children engaging in music activities before the age of six. Increasing research on music training and raising awareness of the importance of this type of intervention among educators and teachers could promote its adoption as a recommended practice

across different educational settings, thereby improving both service integration and quality, and children's developmental outcomes (United Nations, 2015).

CONCLUSIONS

This systematic review demonstrated substantial, although incomplete, knowledge regarding the relationships between music-based interventions conducted in educational services and language abilities in children aged 0-6. No study comprehensively examined this age group. The relationship between music and language remains under debate and necessitates further exploration. Other investigations in this area would also be crucial for informing the development of educational programs.

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No potential conflict of interest was reported by the authors.

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AVAILABILITY OF DATA

This systematic review is regularly registered on OSF and available at <https://osf.io/nw8ez/overview>. The data extraction and data synthesis are available upon contacting the corresponding author.

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APPENDIX A: SYNTHESIS OF THE MAIN CHARACTERISTICS OF STUDIES

Study	Country	Design	NT	NC	Age in months	Duration in weeks	Frequency	Session length in min	Type of music intervention	Type of control	Assessment task	Results
Baek (2009)	South Korea	Quasi-experimental pre-posttest design	20	19	70.4	8 (14 sessions)	2/week	30	Music instruction using picture books with related creative music activities	General music class in which the picture books were read, but children did not engage with creative music activities.	Sulzby's Emergent Reading Scale	Experimental condition scores significantly higher than the control group in reading competence.
Carson-Swift (2022)	USA	Experimental pre-posttest design	27	29	60-72	12	2-3/week	30	Both the training and control groups received music training, but the experimental group received an additional 60-90 minutes per week of music and movement instruction.	Both the training and control groups received music training, but the control group did not receive an additional 60-90 minutes per week of music and movement instruction.	PAST Test for phonemic awareness. RAN/RAS for Rapid Naming and Alternating Stimulus Test.	The experimental and control group did not show significant growth, showing no different effect between groups on any measure.
Converse Richards (2011)	USA	Pre-posttest design	11	27	Not reported	8	2/week	40	Rhythm group subjects investigated the duration of sound.	Pitch group subjects explored the highness, and the control group engaged in 20-minute weekly read-aloud sessions.	Test of Phonological Awareness	Specific components of music potentially enhance the phonological awareness of the most challenged of kindergarten readers in both rhythm and pitch groups, even if the pitch group results are higher.
Hunt (2012)	Wales	Mixed method design (quasi-experimental+semistructured interviews+mosaic approach)	18	20	36-48	6 session	Not reported	20	Key aspects of the intervention involved rhyme and exaggerated and varied use of language.	Passive control group.	Phonological discrimination task	Significant gain in phonological discrimination for children in intervention group, compared to control group, where there was no gain.

Study	Country	Design	NT	NC	Age in months	Duration in weeks	Frequency	Session length in min	Type of music intervention	Type of control	Assessment task	Results
Lehman (2019)	USA	Quasi-experimental design	46	30	65	1 year	Daily	20	Movement, play, and music are utilized in Song-Experience-Games, which form the foundation for instruction.	Regular preschool program and did not receive any special training.	Phonological Awareness Test 2	Students participating in Education Through Music classrooms demonstrated significantly higher performance in the areas of segmentation (i.e., using sentences, syllables, and phonemes) as well as rhyming production.
Linnavalli et al. (2018)	Finland	Longitudinal design	Not reported	Not reported	61	Not reported	Not reported	Not reported	Music playschool.	Dance lessons and passive control group.	Phoneme processing and Vocabulary subtests.	Music playschool significantly improved the development of children's phoneme processing and vocabulary skills.
Moritz (2007)	USA	Longitudinal design	14	13	66	1 year	Daily	45	Kodály method.	The Silver-Burdett Making Music curriculum uses a variety of musical instruction techniques and both popular and culturally-diverse music.	A battery of phonological awareness tests.	Musical training is related to improvements in children's phonological awareness subskills in rhyming and phoneme segmentation. Research has shown that phonological awareness enhances reading acquisition.
Nelson (2016)	USA	Experimental pre-posttest design	25	18	57	8	2/week	15	The IRL intervention consisted of numerous developmentally appropriate tasks designed to target the development of both rhythm and literacy skills.	Participated in regular classroom activities.	PALS-PreK literacy assessments for phonemic awareness.	Results indicate that the IRL intervention significantly improved the rhythm and rhyme awareness of the intervention group over the comparison group.

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Study	Country	Design	NT	NC	Age in months	Duration in weeks	Frequency	Session length in min	Type of music intervention	Type of control	Assessment task	Results
Newland (2013)	USA	Experimental design	Not clear	Not clear	60-72	18	Not reported	Not reported	Curriculum additions included music and movement, songs and alliterations.	The control group received regular classroom instruction and regular music instruction, but did not receive the additional instruction in music class specific to phonemic awareness.	STAR Early Literacy.	While the study did not provide statistically significant data, students in the experimental group did score higher than those in the control group.
Reeves Montgomery (1997)	USA	Pre-posttest design (not specifically reported)	75	70	Not reported	6	Not reported	Not reported	Classes receiving instruction through movement activities while singing action songs.	Classes not receiving instruction through movement activities while singing action songs.	Smith's Picture-Word Recognition Test (PWRT).	Kindergarten students who received instruction through movement while singing action songs did not score significantly higher on the PWRT than students who did not receive instruction through movement while singing action songs.
Vidal et al. (2020)	Portugal	Pre-posttest design	23	21	42	30	1/week	45	Lessons included live instruments or their own voice, familiarization with different instruments, and instrument discrimination exercises, playing with their own body and objects of their day life.	Visual arts classes comprehended a great variety of arts, including painting (famous artists and everyday life painting), cinema, architecture, and sculpture.	Conf-IRA Phonological Awareness Screening and Assessment Instrument.	Children receiving music classes show greater improvement, indicating that music lessons have influenced phonological awareness.

Study	Country	Design	NT	NC	Age in months	Duration in weeks	Frequency	Session length in min	Type of music intervention	Type of control	Assessment task	Results
Vinales del Egado (2023)	USA	Quasi-experimental pre-posttest design	13	12	69.3	18	5/week	30	Lessons in the rhythm-training program focused on developing students' understanding of the concepts of tempo and duration	Lessons in the pitch training program focused on developing students' discrimination and production of high and low tones.	(a) a Color Naming test, (b) tests to measure phonological awareness skills, and (c) assessment tasks to measure alphabet knowledge and concept of word awareness.	The type of music training program had no significant effect on students' gains in early literacy skills.
Walton (2014)	Canada	Quasi-experimental pre-posttest design	44	49	66	12	2/week	20	The songs group teaching involved choral singing and movements created for the project to teach phonological skills, letter-sounds, and word reading.	Children received their regular language and literacy programs.	Rhyming ability, phoneme identity, letter-sound knowledge, and word reading.	Children in the songs group had increased letter-sounds, medial phoneme identity and word reading compared to children in the control group. Children in both groups made equal gains in rhyming and identifying phonemes.

APPENDIX B: THE EFFECT SIZE OF EVERY STUDY IS DIVIDED INTO DIFFERENT OUTCOMES

Study	Outcome	Task	NT	NC	d	g	Var g	SE g	CI95%	Z	Interpretation
Carson-Swift (2022)	Phonology	PAST	27	29	0	0	0.07	0.26	-0.51; 0.51	0	Negligible effect
Converse Richards (2011)	Phonology	Test of phonemic awareness	11	27	0.1	0.1	0.12	0.35	-0.59; 0.76	0.29	Negligible effect
Hunt (2012)	Phonology	Phonological discrimination task	18	20	1.45	1.42	0.13	0.36	0.71; 2.13	3.94	Huge effect
Lehman (2019)	Phonology	Segmentation of phoneme	46	30	0.63	0.62	0.06	0.24	0.15; 1.09	2.58	Medium effect
Moritz (2007)	Phonology	Delation compounds/syllables	14	13	0.14	0.14	0.14	0.37	-0.56; 0.87	0.38	Negligible effect
Nelson (2016)	Phonology	PALS PreK Composite	25	18	0.15	0.15	0.1	0.32	-0.48; 0.78	0.47	Small effect
Vidal et al. (2020)	Phonology	Conf-IRA	23	21	3.95	3.88	0.26	0.51	2.88; 4.88	7.61	Huge effect
Vinuales del Egido (2023)	Phonology	Phonological awareness	13	12	-0.08	-0.08	0.15	0.39	-0.68; 0.68	-0.21	Negligible effect
Walton (2014)	Phonology	Final phoneme	44	49	0.23	0.23	0.04	0.2	-0.16; 0.62	1.15	Small effect
Baek (2009)	Alphabetisation and Reading	Reading scale summed page	20	19	0.19	0.19	0.1	0.32	-0.44; 0.82	0.59	Small effect
Carson-Swift (2022)	Alphabetisation and Reading	RAN/RAS	27	29	0	0	0.07	0.26	-0.51; 0.51	0	Negligible effect
Nelson (2016)	Alphabetisation and Reading	PALS PreK Composite	25	18	0.15	0.15	0.1	0.32	-0.48; 0.78	0.47	Small effect
Walton (2014)	Alphabetisation and Reading	Final phoneme	44	49	1.04	1.03	0.05	0.22	0.64; 1.42	4.68	Large effect
Reeves Montgomery (1997)	Lexicon and Semantics	PWRT	67	65	0	0	0.03	0.17	-0.33; 0.33	0	Negligible effect

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Ambra Natati is a third-year PhD Candidate at the University of Verona, Department of Human Sciences, Psychology curriculum. She graduated in Philosophy (2021) and Philosophical Sciences (2023) at the University of Milan. She is working on a doctoral project in developmental psychology, education, and music pedagogy. In particular, she collaborates with municipal daycares of the city of Verona to promote music training to enhance linguistic, rhythmic, and executive functions in 2- to 4-year-olds. Currently, she is visiting London (University College of London) for a 6-month period abroad to go deeper into the topic of music and developmental competencies under the supervision of Dr Nina Politimou, an expert in the field.



Giada Mignolli is a third-year PhD Candidate at the University of Verona, Department of Human Sciences, Psychology curriculum. She graduated in Psychosocial Studies (2018) from Goldsmiths, University of London, and in Psychology (2023) from the University of Verona. Her research focuses on emotion regulation, attachment, and attitudes toward disability, with a particular interest in the role of individual and relational dynamics in shaping social perceptions and caregiving tendencies. Alongside this line of research, she has developed a growing interest in developmental psychology, both in terms of research and clinical practice with children.



Miriam Urbani is a soprano, singing teacher, choir director, and music educator. She obtained her first-level academic diploma in singing from the E. F. Dall'Abaco Conservatory in Verona (2019) and her second-level academic diploma in music education from the L. Marenzio Conservatory in Brescia (2021). Her training has been further enriched by numerous refresher and advanced courses in music education, with particular reference to vocal training in childhood, choral singing, music for early childhood, and active educational models (Orff-Schulwerk, Gordon Method, sensory music, body percussion), as well as inclusive teaching and musical interventions for children with special educational needs.

She has been involved in action research and teaching in the field of music education for over ten years, working in both school and extracurricular contexts, particularly in nurseries and kindergartens in the province of Verona. In 2024, she founded the *Canta con noi* APS Music School and created the *Lalai Music Lab 0-6* method, an educational-musical intervention model for early childhood that integrates voice, movement, listening, and storytelling in a playful, relational, and inclusive way. Alongside her teaching activities, she is involved in choral conducting, teaching modern singing, and developing educational and artistic projects for educational purposes, with a particular focus on the educational, social, and community value of the musical experience.