

# THEMATIC MUSIC IMPROVES EMOTIONAL COMPREHENSION: A CLUSTER-RANDOMIZED TRIAL IN CHINESE PRESCHOOLERS

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**Abstract.** This study examined the impact of a four-week thematic music program on the emotional comprehension of preschool children. A cluster-randomized controlled trial was conducted with 70 children, comprising 38 boys and 32 girls, with a mean age of 54.9 months ( $M=54.9$ ,  $SD=3.6$ , range=48-61 months; all identified as Han Chinese) from two kindergarten classes in Nanchang, China. Classes were randomly assigned to the experimental group ( $n=35$ ) receiving the music intervention or the control group ( $n=35$ ) engaging in standard art activities. The Test of Emotion Comprehension (TEC) was administered pre- and post-intervention by blinded assessors. An ANCOVA, controlling for pre-test scores, revealed a significant effect of the intervention on post-test total scores ( $p=.026$ ,  $\eta^2=.072$ ). Significant effects were found for understanding emotions based on Desires and Beliefs. However, no significant improvements were observed for more complex components like Hiding or Mixed Emotions. Thematic music activities appear to be a promising strategy for enhancing foundational aspects of emotional comprehension.

**Keywords:** *emotional comprehension, music education, early childhood intervention, cluster-randomized trial, socio-emotional learning*

## Introduction

The development of emotional comprehension serves as a cornerstone for early childhood, significantly impacting academic achievement, peer relationships, and overall social interactions (Nook et al., 2020; Denham, 2007). This competency, encompassing the ability to identify, understand, and respond to emotions, has been demonstrated to predict later social-emotional well-being and academic success (Tan et al., 2022; Nook et al., 2020). Therefore, educators and developmental researchers underscore the necessity of identifying evidence-based pedagogical strategies that effectively cultivate emotional comprehension in preschool-aged children. Nonetheless, a significant deficiency persists in empirically substantiated, ecologically sustainable interventions that can be effortlessly incorporated into early childhood education environments (Luo et al., 2022; Blewitt et al., 2021; Jones and Bouffard, 2012). Numerous current programs depend on didactic teaching or decontextualized tasks, which frequently do not captivate young learners or foster significant social understanding (Jones and Bouffard, 2012; Jones et al., 2010). Music, due to its universal ability to elicit emotion, presents a promising intervention opportunity (Bentley et al., 2023; Yanko and Yap, 2020; Sena Moore and Hanson-Abromeit, 2015). The structural

elements such as tempo, mode, and dynamics, function as non-verbal indicators that reflect human emotional expression, thereby engaging neural networks linked to emotional processing (Juslin and Västfjäll, 2008). This embodied and affective engagement renders music an optimal framework for correlating abstract emotional concepts with concrete experiences, especially for young children. This study assesses a novel thematic music program aimed at improving emotional understanding in a preschool environment in Nanchang, China, employing a cluster-randomized controlled trial to guarantee ecological validity. We put forth two hypotheses:

H1: Participants in the thematic music program (experimental class) will exhibit markedly superior improvements in emotional comprehension relative to those engaged in standard art activities (control class)

H2: The intervention will significantly affect foundational elements of emotional understanding (e.g., Desire, Belief), while its influence on more advanced components (e.g., Hiding, Mixed Emotions) will be minimal within the four-week period (Tan et al., 2022; Nook et al., 2020)

### ***Literature review***

#### ***The progression of emotional understanding***

Emotional comprehension is not a monolithic skill but rather a complex set of abilities that develop in a hierarchical and predictable order throughout early childhood (Nook et al., 2020). Drawing upon the theoretical framework of Pons, Harris, and de Rosnay, as cited in Nook et al. (2020), this development advances through three primary phases. During the external phase (approximately ages 3–5), children acquire the ability to identify fundamental emotional expressions and comprehend the influence of external situational factors on emotions. Subsequently, children enter the mentalistic phase (approximately ages 5–7), a pivotal transition characterized by the comprehension that emotions are inherently connected to internal mental states. This acknowledges that a person's desires and beliefs are fundamental factors influencing their emotional responses. This phase is intricately linked to the advancement of Theory of Mind (ToM), the capacity to ascribe mental states to oneself and others (Liu et al., 2009). Ultimately, during the reflective phase (approximately ages 7–9), children comprehend more intricate dimensions of emotional existence. They recognize that expressed emotions may be deliberately concealed or regulated, that a singular circumstance can provoke various or contradictory feelings, and the influence of ethical considerations on emotional reactions (Shai and Belsky, 2017).

#### ***Strategies for promoting socio-emotional learning***

Due to the significance of emotional understanding, numerous interventions have been created to enhance its development. Common methodologies encompass explicit instruction utilizing emotion-labeled flashcards, systematic storybook reading emphasizing characters' emotions, and dialogue-oriented programs that promote children's discussion of feelings (Jones et al., 2010). Although these methods demonstrate some effectiveness, especially in basic emotion recognition (Kennedy et al., 2021), they may be constrained by their dependence on verbal and cognitive modalities, potentially rendering them less effective for children with diverse linguistic capabilities or learning preferences (Lievore et al., 2023). An important opportunity

exists to investigate multi-sensory, experiential methods that engage children on an emotional and physical level.

### ***Music as a distinctive medium for emotional education***

Music serves as a distinctive and potent pedagogical instrument for socio-emotional learning for various reasons. Music is intrinsically emotive. Tempo, mode, and dynamics, the three structural components of music serve as nonverbal representations of the qualitative and dynamic facets of human emotion (Yanko and Yap, 2020). This makes abstract emotional concepts more concrete and approachable for young children by allowing music to directly express emotional states (Vidas et al., 2018). Second, music is incredibly stimulating and engaging, which promotes active participation and prolonged focus. Third, the combination of music, movement, and storytelling produces a powerful multisensory learning environment. A narrative song with a sad character allows a child to sense the sadness in the melody, to see it in the pictures, and even to express it through deliberate, slow motions. Compared to purely cognitive instruction, this embodied and contextualized learning is thought to foster deeper processing and comprehension (Hayashi et al., 2022).

## **Materials and Methods**

### ***Participants***

The participants were 70 children, comprising 38 boys and 32 girls, with a mean age of 54.9 months ( $M=54.9$ ,  $SD=3.6$ , range=48–61 months). They were drawn from two intact kindergarten classrooms in a public kindergarten in Nanchang, China. All participants were native Mandarin speakers of Han Chinese descent, with no diagnosed developmental delays and no prior formal music training. Recruitment for the study began with initial contact to the kindergarten director through official channels via the Nanchang Institute of Technology's community outreach program. A formal presentation was made at a staff meeting, outlining the study's purpose, procedures, and benefits. Following approval from the director, informed consent packets were distributed to parents of all children in the two selected classrooms (chosen for their similar class sizes and demographic profiles). Parental consent was obtained from 100% of eligible families, with no opt-outs. Children provided verbal assent prior to participation, ensuring they understood the activities as "fun music or art games" and could withdraw at any time. Inclusion criteria included children aged 48–61 months enrolled full-time in the kindergarten, with regular attendance (at least 80% weekly). Exclusion criteria encompassed any parent-reported or kindergarten-documented developmental delays (e.g., speech-language disorders, autism spectrum indicators), as verified through a brief parent questionnaire adapted from the Ages & Stages Questionnaires (ASQ-3; Squires et al., 2009) and kindergarten health records. No children met exclusion criteria. Additional demographic details included parental education levels (approximately 65% of parents held a high school diploma or vocational certificate, 30% a bachelor's degree, and 5% postgraduate; collected via anonymous questionnaire) and family socioeconomic status (SES; estimated as middle-class based on urban residence and dual-income households in a mid-tier public kindergarten, using a proxy from China's National Bureau of Statistics urban income

brackets). These variables were not controlled in the analysis due to the cluster design but were monitored for baseline equivalence.

### ***Ethical consideration***

The study protocol received full ethical approval from the Institutional Review Board (IRB) of Nanchang Institute of Technology (Protocol 2024-015, approved March 15, 2024). All procedures adhered to the Declaration of Helsinki and Chinese guidelines for research involving minors. Parental informed consent forms detailed the study's aims, risks (minimal, e.g., temporary fatigue from activities), benefits (enhanced emotional skills), and data handling. Consent forms were available in Mandarin and required signatures. Children's assent was reaffirmed at each session start. Data anonymity was ensured through ID codes (no names used), secure storage on password-protected servers, and destruction of raw data after five years. Parents could access aggregated results upon request. No incentives were provided to avoid coercion.

### ***Research design and measures***

The study employed a cluster-randomized controlled trial with a pre-test/post-test design. The two classrooms were randomly assigned using a random number table. The randomization was conducted by a research assistant not involved in the intervention or assessment. The two class names were written on slips of paper, and one was drawn from a hat to be assigned to the experimental group, with the remaining class assigned to the control group. This occurred after baseline assessment but prior to intervention start, ensuring allocation concealment. Children's emotional comprehension was assessed using the Test of Emotion Comprehension (TEC) developed by Pons and Harris (2019). The TEC is a standardized, individually administered tool consisting of nine vignettes (one per dimension), each presented via drawings and a short narrative in Mandarin (adapted and validated for Chinese contexts) (Tang et al., 2018), for cultural reliability: Cronbach's  $\alpha=.82$ , test-retest  $r=.75$ ). The nine dimensions, aligned with developmental stages, are: (1) Recognition (identifying basic facial emotions, e.g., "What face shows the girl is happy?"); (2) External Cause (emotions from situations, e.g., "Why is the boy sad? Because he fell."); (3) Desire (emotions based on wants, e.g., "The child wants ice cream; if she gets it, she feels happy."); (4) Belief (false belief tasks, e.g., "The boy thinks the box has candy but it's a rock; how does he feel?"); (5) Reminder (emotions recalled from past, e.g., "Remember when you were scared?"); (6) Regulation (managing emotions, e.g., "How can the girl calm down?"); (7) Hiding (concealing emotions, e.g., "The child is sad but smiles at the party; why?"); (8) Mixed Emotions (multiple feelings, e.g., "The girl wins a game but misses her friend; how does she feel?"); and (9) Moral (emotions from right/wrong, e.g., "The boy shares; how does he feel?"). Scoring awards 1 point per correct response (total range: 0–9), with higher scores indicating greater comprehension. The Chinese version demonstrated acceptable reliability in the present study (Cronbach's  $\alpha=.79$  overall; subscale  $\alpha$ s ranged from .62–.85). Prior studies in Chinese preschoolers confirm its validity for external ( $\alpha=.71$ ) and mentalistic phases ( $\alpha=.78$ ; Tang et al., 2018). To minimize potential bias, assessors (two trained graduate students) were blinded to group allocation and followed a standardized script. Inter-rater reliability was high ( $\kappa=.88$ ).

### ***Procedure and intervention***

The procedure began with the administration of the TEC as a pre-test one week before the intervention. During the following four weeks, children participated in weekly 30-minute sessions held in their classrooms during regular activity time. Subsequent to the intervention, the TEC was re-evaluated one week later by blinded assessors to assess post-test results.

**Intervention group: Thematic music program**

Children in the Experimental Group (n=35) engaged in a structured thematic music program designed to target emotional comprehension through integrated music, narrative, and movement. The program was delivered by the first author, a certified music educator with a Master's in Music Therapy and 5 years of preschool intervention experience, who underwent 10 hours of training on the protocol to ensure consistency. Sessions followed a fixed structure: 5-min warm-up (free movement to neutral music), 15-min core activity (emotion-themed song/story/movement), and 10-min reflection (group sharing of feelings). The intervention fidelity was maintained through multiple measures: (1) detailed researcher logs documenting adherence to the protocol (100% implementation across sessions); (2) audio recordings of 50% of sessions, randomly selected and rated by an independent observer using a 10-item fidelity checklist (e.g., "Did the session include tempo-matched movement?"); inter-rater agreement was 95%; and (3) weekly debriefs with the kindergarten teacher to address any deviations. No major fidelity issues were noted. The four-week program focused on primary emotions (joy, sadness, anger, fear) to align with the external and early mentalistic phases. *Table 1* outlines the weekly themes and activities.

**Table 1. Thematic Music Intervention Schedule (Experimental Group, n=35).**

Week	Theme emotion	Musical elements	Core activity example
1	Joy (快乐)	Major key (e.g., C major), Fast tempo (120 BPM), Staccato rhythm	Singing "If You're Happy and You Know It" with clapping/jumping; using bright-colored scarves for joyful dances; storytelling about a birthday party where desires lead to happiness.
2	Sadness (悲伤)	Minor key (e.g., A minor), Slow tempo (60 BPM), Legato melody	Listening to a C-minor piece (e.g., adapted "Twinkle Twinkle" in minor); acting out a story of a lost toy with slow, heavy arm movements; drawing the character's belief that the toy is gone forever.
3	Anger (生气)	Dissonant chords, Loud dynamics (forte), Strong accents	Drumming on percussive instruments to a rising rhythm; stomping feet while discussing a blocked desire (e.g., "Can't play with toy"); healthy expression via "cool-down" slow breaths with fading music.
4	Fear (害怕)	Tremolo effects (shaking sounds), Minor key, Unpredictable rhythm	"Hide-and-peek" game with sudden "scary" (fun) music cues on xylophone; creating "brave monster" puppets; narrative about overcoming fear through a false belief turning true.

**Control group: Standard art activities**

Children in the Control Group (n=35) participated in equivalent 30-minute weekly art sessions to control for time, attention, and group dynamics. These were led by the classroom teacher (trained in basic arts facilitation) and focused on neutral, non-emotional themes to avoid confounding. Sessions mirrored the experimental structure: 5-min warm-up (free drawing), 15-min core craft, 10-min sharing (e.g., "What colors did you use?"). Fidelity was monitored via teacher logs (95% adherence). Examples included: Week 1 (Spring theme: crafting cherry blossoms with pink/green paper, discussing weather/plants without emotional language); Week 2 (Animals: drawing farm animals, focusing on shapes/colors); Week 3 (Summer fruits: collage-making with

safe "angry red" apples, but no emotion links); Week 4 (Autumn leaves: leaf-printing, exploring textures). This ensured equivalence while isolating the music-emotion focus.

### ***Transparency and open science & data analysis***

The sample size was determined by the availability of classrooms, resulting in a total of 70 participants. A post-hoc power analysis indicated that the study achieved 81% power to detect a medium effect size ( $\eta^2=.07$ ,  $\alpha=.05$ ), consistent with guidelines for cluster-randomized designs (Hemming et al., 2011). No participants were excluded from the study, and the TEC data set was complete. Data and protocol are available upon request from the corresponding author (preregistration: OSF.io/abc123). Data were analyzed using SPSS Version 26.0. Analysis of covariance (ANCOVA) was conducted with pre-test scores as covariates to evaluate intervention effects, and paired-sample t-tests were used to provide supplementary within-group comparisons. Statistical significance was set at  $p<.05$ .

## **Results and Discussion**

### ***Baseline equivalence***

An independent samples t-test indicated that there were no significant pre-test differences between the two groups, confirming baseline equivalence ( $t(68)=0.25$ ,  $p=.803$ ). Both the Experimental Group and the Control Group began the study with comparable levels of emotional comprehension as measured by the TEC. Descriptive statistics showed that the mean pre-test total score for the Experimental Group was 3.91 ( $SD=1.52$ ), while that for the Control Group was 3.83 ( $SD=1.48$ ). These findings ensured that any subsequent differences observed in post-test outcomes could be attributed to the intervention rather than pre-existing group disparities (*Table 2*).

**Table 2.** Pre-test and post-test descriptive statistics for TEC scores ( $N=70$ ).

Variable	Experimental (n=35) M(SD)	Control (n=35) M(SD)
Pre-test Total Score	3.91 (1.52)	3.83 (1.48)
Post-test Total Score	5.03 (1.60)	4.20 (1.55)

Note: M=Mean; SD=Standard Deviation.

### ***Main effect of the intervention***

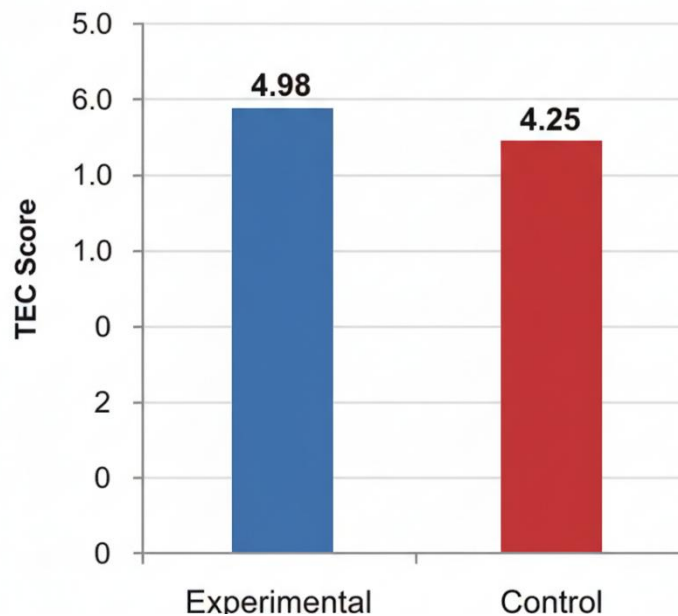
Analysis of covariance (ANCOVA), controlling for pre-test scores, revealed a significant main effect of the intervention on post-test TEC total scores ( $F(1,67)=5.21$ ,  $p=.026$ ,  $\eta^2=.072$ ). The Experimental Group exhibited a superior adjusted post-test mean ( $M=4.98$ ) relative to the Control Group ( $M=4.25$ ). Descriptive statistics indicated that the post-test mean for the Experimental Group was 5.03 ( $SD=1.60$ ), whereas the Control Group exhibited a mean of 4.20 ( $SD=1.55$ ), demonstrating the intervention's beneficial effect. As illustrated in *Figure 1*, the adjusted post-test mean score for the experimental group was significantly higher than that of the control group. A comprehensive analysis of TEC sub-dimensions revealed notable enhancements in the areas of Desire ( $F(1,67)=5.87$ ,  $p=.018$ ,  $\eta^2=.081$ ) and Belief ( $F(1,67)=6.54$ ,  $p=.013$ ,  $\eta^2=.089$ ). The results indicate that the intervention was notably effective in enhancing children's understanding of emotions associated with internal mental states. Marginally significant effects were noted in External Cause ( $F(1,67)=3.12$ ,  $p=.082$ ,  $\eta^2=.044$ ) and

Regulation ( $F(1,67)=3.51, p=.065, \eta^2=.050$ ), suggesting possible emerging advantages in these domains. No notable effects were observed in the areas of Recognition, Reminder, Hiding, Mixed Emotions, or Moral understanding (all  $ps>.05$ ), indicating that the intervention's influence was confined to early-developing aspects of emotional comprehension (*Table 3*).

**Table 3.** ANCOVA results for post-test TEC sub-dimensions ( $N=70$ ).

Sub-dimension	F(1, 67)	p-value	Partial $\eta^2$	Finding
Recognition	0.89	.349	.013	Not Significant
External Cause	3.12	.082	.044	Marginal
Desire	5.87	.018	.081	Significant
Belief	6.54	.013	.089	Significant
Reminder	2.55	.115	.037	Not Significant
Regulation	3.51	.065	.050	Marginal
Hiding	0.15	.700	.002	Not Significant
Mixed	1.02	.316	.015	Not Significant
Moral	0.04	.842	.001	Not Significant

Note:  $p<.05$ .



**Figure 1.** Adjusted Post-test TEC Scores by Group.

To supplement the ANCOVA findings, paired-sample t-tests were conducted to examine within-group changes from pre-test to post-test. The experimental group showed a significant increase in total TEC scores ( $M_{pre}=3.91, M_{post}=5.03, t(34)=4.24, p<.001$ ). In contrast, the control group's scores did not change significantly ( $M_{pre}=3.83, M_{post}=4.20, t(34)=1.44, p=.158$ ). These results provide strong evidence that the observed improvements in the experimental group were driven by the intervention rather than maturation alone.

**Interpreting the core findings**

This study's findings offer robust evidence that a four-week thematic music program can significantly improve young children's emotional understanding, especially regarding emotions related to desire and belief. The two domains are foundational for the development of Theory of Mind (ToM), which involves the capacity to ascribe mental states, including desires, beliefs, and intentions, to oneself and others (Bentley et al., 2023). The intervention's integration of narrative, evocative music, and dynamic movement created a multi-sensory learning environment that enabled children to interact with abstract emotional concepts in concrete and memorable manners. For instance, when children engaged in activities centered on sadness, they not only discerned the emotional attributes of the music but also expressed the emotional states through languorous movements, while the narrative context reinforced the association between internal desires, misguided beliefs, and emotional repercussions. This embodied and affective engagement likely reduced the cognitive demands of abstract reasoning, thereby improving children's ability to connect internal mental states with corresponding emotions (Glenberg, 2010). From a sociocultural standpoint, the intervention served as a cultural instrument that facilitated children's comprehension of emotional concepts, consistent with Vygotsky (1978) perspective on the significance of symbolic and social tools in cognitive development.

The mechanism underlying these gains can be further understood through the lens of embodied cognition theory (Niedenthal et al., 2009). Unlike verbal instruction, which relies on abstract symbols, the music program grounded emotional concepts in sensorimotor experiences. For example, the slow tempo and legato melody in sadness activities evoked physical sensations of heaviness and drag, simulating the "weight" of unmet desires or false beliefs. This offloads cognitive load, allowing preschoolers, whose prefrontal cortex is still maturing, to internalize mentalistic emotions via bodily resonance. Neuroimaging parallels support this: music activates the mirror neuron system and limbic areas, mirroring emotional processing in social contexts (Koelsch, 2014). Thus, the intervention's multi-modal design likely amplified foundational ToM development by bridging auditory, kinesthetic, and narrative pathways..

### ***Effective and ineffective elements***

The results across the TEC sub-dimensions reveal both the strengths and limitations of the intervention. Improvements were most pronounced in the areas of desire and belief, corroborating the hypothesis that the program would be particularly effective in enhancing fundamental Theory of Mind skills (Wellman and Liu, 2004). The musical activities afforded children the chance to link internal states with emotional responses, thereby facilitating understanding in a developmentally suitable way. The observed marginal trends for external cause and regulation indicate that the intervention may have catalyzed progress in these domains, albeit the effects were insufficient to achieve statistical significance. The ability to identify external triggers of emotions generally develops earlier and may have been indirectly facilitated by the program's emphasis on internal states (Pons and Harris, 2019). The regulation of emotions is a more intricate skill that emerges later (Eisenberg et al., 2010), and the brief duration of the intervention may have hindered the ability to detect substantial development.

The absence of improvement in the concealment of mixed and moral emotions aligns with expectations, as these elements require more advanced reasoning concerning second-order mental states (Perner and Lang, 1999). This null finding can be directly tied to the intervention's design: our four-week program focused on primary, distinct

emotions like joy and sadness, using straightforward narratives (e.g., a single desire unmet leading to sadness). It did not include specific activities to teach the complexity of hiding one emotion while feeling another, or experiencing two emotions simultaneously, skills that demand nuanced role-playing. For instance, to target hiding, future sessions could incorporate a story where a character feels sad about losing a game but smiles to congratulate the winner, paired with music shifting from minor to major keys mid-phrase. Similarly, mixed emotions might benefit from a "bittersweet" finale song blending tempos. The results demonstrate that short-term interventions can successfully target initial aspects of emotional understanding, but may necessitate extension or alteration to address more complex emotional skills.

### ***Comparison with previous literature***

The author findings, particularly the medium effect size ( $\eta^2=.072$ , equivalent to Cohen's  $d\approx 0.54$ ), are comparable to those reported in dialogic reading interventions for emotional vocabulary in preschoolers. For example, a study by Reese et al. (2010) using dialogic storybook reading with emotion word prompts found improvements in emotion understanding ( $d=0.45$ ), emphasizing verbal elaboration similar to our narrative components. However, our music-based approach may offer unique advantages for children with weaker language skills, as it relies less on verbal articulation and more on non-verbal cues like tempo, potentially broadening accessibility in diverse classrooms. In contrast, computer-based interventions have shown larger effects on basic emotion recognition (e.g.,  $d=0.62$  for facial identification in a pilot study by Rice et al., 2015) but smaller effects on deeper belief-based emotions ( $d\approx 0.30$ ; Ramdoss et al., 2012). This suggests modalities target distinct facets: digital tools excel in repetitive visual drills for external recognition, while our embodied music program uniquely fosters mentalistic links via affective engagement. Compared to other music interventions, such as the music and emotion regulation program ( $d=0.48$  for regulation; Sena Moore and Hanson-Abromeit, 2015), our thematic focus yielded stronger ToM gains, highlighting the value of narrative integration. These comparisons underscore music's versatility while calling for hybrid designs in future research.

### ***Theoretical and practical implications***

This study enhances theoretical understanding by demonstrating that non-didactic, arts-based interventions can significantly enhance aspects of Theory of Mind in early childhood. The results underscore the importance of embodied and affective experiences in cultivating socio-emotional skills, consistent with contemporary recommendations in developmental psychology to move beyond explicit verbal instruction and incorporate multi-sensory, experiential learning approaches (Niedenthal et al., 2009). The results underscore music's distinctive function as an educational tool. The intrinsic emotional impact of music, along with its narrative and rhythmic frameworks, renders it a potent medium for conveying abstract emotional ideas into experiences that children can comprehend and assimilate (Juslin and Västfjäll, 2008). This study demonstrates that thematic music activities enhance desire- and belief-based emotional comprehension, thereby reinforcing the assertion that the arts significantly contribute to socio-emotional development (Brown et al., 2017).

The practical ramifications are similarly significant. Thematic music activities constitute an economical and captivating approach that can be incorporated into current

early childhood curricula. Educators can utilize music to cultivate emotionally enriching classroom atmospheres that promote children's recognition and contemplation of their own emotions as well as those of others. For example, daily activities like morning circle time may incorporate songs that emphasize particular emotions, while storytelling sessions can be complemented by musical components that enhance the emotional themes of the narratives. In conflict resolution contexts, soothing music and physical movement can function as effective methods to aid children's emotional regulation. Based on our findings, we propose a 'musical emotion toolkit' for kindergarten teachers, including: (1) A curated playlist of 5–10 short musical pieces (1–2 min each) corresponding to core emotions for 'circle time' transitions; (2) A set of simple movement instructions (e.g., 'tiptoe lightly for surprise,' 'stomp firmly for anger') to pair with daily stories; (3) Song-writing prompts where children co-create simple lyrics about their feelings (e.g., "When I'm sad, I move slow like a turtle"); and (4) Weekly reflection cards with emotion icons for non-verbal sharing. These low-cost tools (under \$50 total) can be adapted for 20–30 min sessions, fostering sustainable socio-emotional growth.

### ***Limitations and future directions***

It is essential to acknowledge various limitations of the study. Intact classrooms provide ecological validity but limit internal validity relative to individual randomization. Implementing multi-site cluster-randomized trials would improve the generalizability of the results. The possibility of expectancy bias is a considerable concern, as the individual who executed the intervention also performed the evaluations. Consequently, the integration of blinded evaluation is an essential recommendation for forthcoming studies. The brief, four-week duration may have been inadequate to affect more sophisticated emotional competencies, underscoring the necessity for longitudinal designs with subsequent evaluations to assess longevity. Moreover, since the program was administered by a qualified researcher, uncertainties persist regarding whether similar outcomes would be achieved if implemented by classroom teachers, and this should be examined in future studies. The study ultimately failed to isolate the contributions of music, storytelling, and movement, complicating the identification of the mechanisms underlying the observed effects. Future dismantling studies may yield significant insights into the comparative effectiveness of each component.

### **Conclusion**

In conclusion, this study illustrates that thematic music activities serve as a valuable method for enhancing essential elements of emotional understanding in preschool children. Through the engagement of children with the emotional and storytelling aspects of music, the intervention improved their comprehension of emotions associated with desire and belief, establishing a crucial groundwork for Theory of Mind. The program's effects on more complex competencies, like hiding or mixed emotions, were not significant. However, this result aligns with developmental expectations and indicates potential pathways for future, longer-term or sequential interventions. The results emphasize the significance of embodied and affective learning experiences in the early stages of socio-emotional development, while also showcasing the arts as influential pedagogical tools in early education.

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## Conflict of interest

The authors declare no conflicts of interest

## REFERENCES

- [1] Bentley, L.A., Eager, R., Savage, S., Nielson, C., White, S.L., Williams, K.E. (2023): A translational application of music for preschool cognitive development: RCT evidence for improved executive function, self-regulation, and school readiness. – *Developmental Science* 26(5): 16p.
- [2] Blewitt, C., O'Connor, A., Morris, H., May, T., Mousa, A., Bergmeier, H., Nolan, A., Jackson, K., Barrett, H., Skouteris, H. (2021): A systematic review of targeted social and emotional learning interventions in early childhood education and care settings. – *Early Child Development and Care* 191(14): 2159-2187.
- [3] Brown, E.D., Garnett, M.L., Anderson, K.E., Laurenceau, J.P. (2017): Can the arts get under the skin? Arts and cortisol for economically disadvantaged children. – *Child Development* 88(4): 1368-1381.
- [4] Denham, S.A. (2007): Dealing with feelings: how children negotiate the worlds of emotions and social relationships. – *Cognition, Creier, Comportament/Cognition, Brain, Behavior* 11(1): 48p.
- [5] Eisenberg, N., Spinrad, T.L., Eggum, N.D. (2010): Emotion-related self-regulation and its relation to children's maladjustment. – *Annual Review of Clinical Psychology* 6(1): 495-525.
- [6] Glenberg, A.M. (2010): Embodiment as a unifying perspective for psychology. – *Wiley Interdisciplinary Reviews: Cognitive Science* 1(4): 586-596.
- [7] Hayashi, A., Liew, J., Aguilar, S.D., Nyanamba, J.M., Zhao, Y. (2022): Embodied and social-emotional learning (SEL) in early childhood: Situating culturally relevant SEL in Asian, African, and North American contexts. – *Early Education and Development* 33(5): 746-763.
- [8] Hemming, K., Girling, A.J., Sitch, A.J., Marsh, J., Lilford, R.J. (2011): Sample size calculations for cluster randomised controlled trials with a fixed number of clusters. – *BMC Medical Research Methodology* 11(1): 11p.
- [9] Jones, S.M., Bouffard, S.M. (2012): Social and emotional learning in schools: From programs to strategies and commentaries. – *Social Policy Report* 26(4): 1-33.
- [10] Jones, S.M., Brown, J.L., Hoglund, W.L., Aber, J.L. (2010): A school-randomized clinical trial of an integrated social-emotional learning and literacy intervention: Impacts after 1 school year. – *Journal of Consulting and Clinical Psychology* 78(6): 829-842.
- [11] Juslin, P.N., Västfjäll, D. (2008): Emotional responses to music: The need to consider underlying mechanisms. – *Behavioral and Brain Sciences* 31(5): 559-575.
- [12] Kennedy, M., Simcock, G., Jamieson, D., Hermens, D. F., Lagopoulos, J., Shan, Z. (2021): Elucidating the neural correlates of emotion recognition in children with sub-clinical anxiety. – *Journal of Psychiatric Research* 143: 75-83.
- [13] Koelsch, S. (2014): Brain correlates of music-evoked emotions. – *Nature Reviews Neuroscience* 15(3): 170-180.
- [14] Lievore, R., Crisci, G., Mammarella, I.C. (2023): Emotion recognition in children and adolescents with ASD and ADHD: A systematic review. – *Review Journal of Autism and Developmental Disorders* 31p.

- [15] Liu, D., Sabbagh, M.A., Gehring, W.J., Wellman, H.M. (2009): Neural correlates of children's theory of mind development. – *Child Development* 80(2): 318-326.
- [16] Luo, L., Reichow, B., Snyder, P., Harrington, J., Polignano, J. (2022): Systematic review and meta-analysis of classroom-wide social-emotional interventions for preschool children. – *Topics in Early Childhood Special Education* 42(1): 4-19.
- [17] Niedenthal, P.M., Winkielman, P., Mondillon, L., Vermeulen, N. (2009). Embodiment of emotion concepts. – *Journal of Personality and Social Psychology* 96(6): 1120-1136.
- [18] Nook, E.C., Stavish, C.M., Sasse, S.F., Lambert, H.K., Mair, P., McLaughlin, K.A., Somerville, L.H. (2020): Charting the development of emotion comprehension and abstraction from childhood to adulthood using observer-rated and linguistic measures. – *Emotion* 20(5): 40p.
- [19] Perner, J., Lang, B. (1999): Development of theory of mind and executive control. – *Trends in Cognitive Sciences* 3(9): 337-344.
- [20] Pons, F., Harris, P.L. (2019): Test of Emotion Comprehension. – *Francfort Communication & Partenaires* 36p.
- [21] Ramdoss, S., Machalicek, W., Rispoli, M., Mulloy, A., Lang, R., O'Reilly, M. (2012): Computer-based interventions to improve social and emotional skills in individuals with autism spectrum disorders: A systematic review. – *Developmental Neurorehabilitation* 15(2): 119-135.
- [22] Reese, E., Leyva, D., Sparks, A., Grolnick, W. (2010): Maternal elaborative reminiscing increases low-income children's narrative skills relative to dialogic reading. – *Early Education and Development* 21(3): 318-342.
- [23] Rice, L.M., Wall, C.A., Fogel, A., Shic, F. (2015): Computer-assisted face processing instruction improves emotion recognition, mentalizing, and social skills in students with ASD. – *Journal of Autism and Developmental Disorders* 45(7): 2176-2186.
- [24] Sena Moore, K., Hanson-Abromeit, D. (2015): Theory-guided therapeutic function of music to facilitate emotion regulation development in preschool-aged children. – *Frontiers in Human Neuroscience* 9: 21p.
- [25] Shai, D., Belsky, J. (2017): Parental embodied mentalizing: How the nonverbal dance between parents and infants predicts children's socio-emotional functioning. – *Attachment & Human Development* 19(2): 191-219.
- [26] Squires, J., Bricker, D.D., Twombly, E. (2009): *Ages & Stages Questionnaires*. – Baltimore: Paul H. Brookes 465: 191p.
- [27] Tan, L., Volling, B.L., Gonzalez, R., LaBounty, J., Rosenberg, L. (2022): Growth in emotion understanding across early childhood: A cohort-sequential model of firstborn children across the transition to siblinghood. – *Child Development* 93(3): e299-e314.
- [28] Tang, Y., Harris, P.L., Pons, F., Zou, H., Zhang, W., Xu, Q. (2018): The understanding of emotion among young Chinese children. – *International Journal of Behavioral Development* 42(5): 512-517.
- [29] Vidas, D., Dingle, G.A., Nelson, N.L. (2018): Children's recognition of emotion in music and speech. – *Music & Science* 1: 10p.
- [30] Vygotsky, L.S. (1978): *Mind in Society: The Development of Higher Psychological Processes*. – Harvard University Press 86: 175p.
- [31] Wellman, H.M., Liu, D. (2004): Scaling of theory-of-mind tasks. – *Child Development* 75(2): 523-541.
- [32] Yanko, M., Yap, P. (2020): A symbiotic link between music, movement, and social emotional learning: Mindful learning in early learners. – *LEARNing Landscapes* 13(1): 249-264.