Approaches of Music Therapy in Children with Autism Spectrum Disorders

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Abstract: Autism is a prevalent developmental disorder that poses significant challenges for affected children. Music therapy has emerged as a viable strategy with regard to improving speech and communication abilities in autistic children. This article aims to investigate and analyse the effectiveness of three widely used music therapy approaches: Auditory Motor Mapping Training (AMMT), Family-Centred Music Therapy (FCMT), and Melodic Based Communication Therapy (MBCT). Through a comprehensive review of existing studies, the article demonstrates that all three approaches are effective and offer unique benefits in different aspects for children with ASD. These findings suggest the possibility of integrating the three approaches to maximise therapeutic outcomes.

Keywords: Autism spectrum disorder, music therapy, Auditory Motor Mapping Training, Family-Centred Music Therapy, Melodic Based Communication Therapy

1.   Introduction

Autism Spectrum Disorder (ASD) is a serious neurodevelopmental condition characterised by difficulties with social communication, repetitive behaviours, constrained interests, as well as deficits in expressive or receptive language skills [1]. Music therapy, among other evidence-based therapies, is beneficial in helping autistic people with their interpersonal difficulties and language skills [2]. The use of music therapy in treating autistic populations is anchored in numerous conceptualisations (e.g., sensory-perceptual, developmental, creative, behavioural) and is achieved through a variety of strategies (e.g., songwriting, instrument play, movement) [3]. Three approaches of music therapy developed in recent years attract attention.

Auditory Motor Mapping Training (AMMT) is an intonation-based intervention that aims to enhance speech production by helping autistic children establish relations between particular sounds and articulatory motions [4]. Target words and phrases are presented by simultaneously intoning and tapping the drums to facilitate auditory-motor mapping, and meanwhile, prosodic elements are emphasised in the treatment to enhance right hemisphere functions [5].

Another widely applied model of intervention practice featuring musical elements is Family-Centred Music Therapy (FCMT). It was first put forward by Grace Thompson [6] based on previous studies on music therapy with families and her own experience of thirteen years of practice. This model prioritises collaboration between parent and therapist and encourages active participation of the parent as integration of broad principles combined into music therapy including family-centred practice, relationship-oriented techniques, and natural settings [6].

The third approach, Melodic Based Communication Therapy (MBCT), is a speech therapy first established by Givona Sandiford with the goal of improving verbal output in autistic children by utilizing their presumptive musical talents [7]. It is characterized by (a) pre-established pairing of fixed melody with target words, (b) standardised procedure and tailored reinforcement schedule, and (c) involvement of clapping and rhythm [7].

While there is increasing evidence that these three approaches can improve communication abilities, speech production, and social abilities in young autistic population [8], no studies have yet systematically analysed the efficacy of these three approaches. The current study aims to: (a) conduct a comprehensive review of all existing studies assessing the effectiveness of these three approaches, and (b) systematically analyse them in terms of their respective outcomes and overall effectiveness.

2. Materials and Methods

2.1. Search Strategy

This review was carried out in accordance with the PRISMA recommendations [9]. Major electronic databases including Web of Science, Cochrane, PubMed, and EBSCO databases were searched to identify relevant articles. The search terms were: (a) "autism OR autism spectrum disorder OR ASD OR autistic children OR autistic disorder" AND (b) "auditory-motor mapping training OR AMMT OR melodic based communication training OR MBCT OR family centred music therapy OR FCMT" AND (c) "music OR music therapy." The search was restricted to research that appeared in peer-reviewed publications between January 1980 and May 2023.

2.2. Inclusion Criteria

The pre-specified inclusion criteria were based on the PICOS framework (see Table 1), with others.

Table 1: Eligibility criteria.

Domain	Inclusion Criteria
Patients	Children (below 14 years old) diagnosed with ASD
Interventions	Music therapy using AMMT or FCMT or MBCT
Comparators	Treatment as usual control group or none
Outcomes	Reported
Study designs	Randomized controlled trials or single-subject design (pre-post evaluation)
Others	Published in English with full text available

2.3. Study Selection and Data Extraction

This section must be in one column. During the database search process, 56 possibly eligible publications were found in total. After removing duplicates, 32 articles were left. Following a check of each article's title and abstract using the aforementioned inclusion and exclusion criteria, 13 articles were selected for full-text reviews. All 13 articles were read through and 11 of them were screened as eligible ones (see Figure 1).
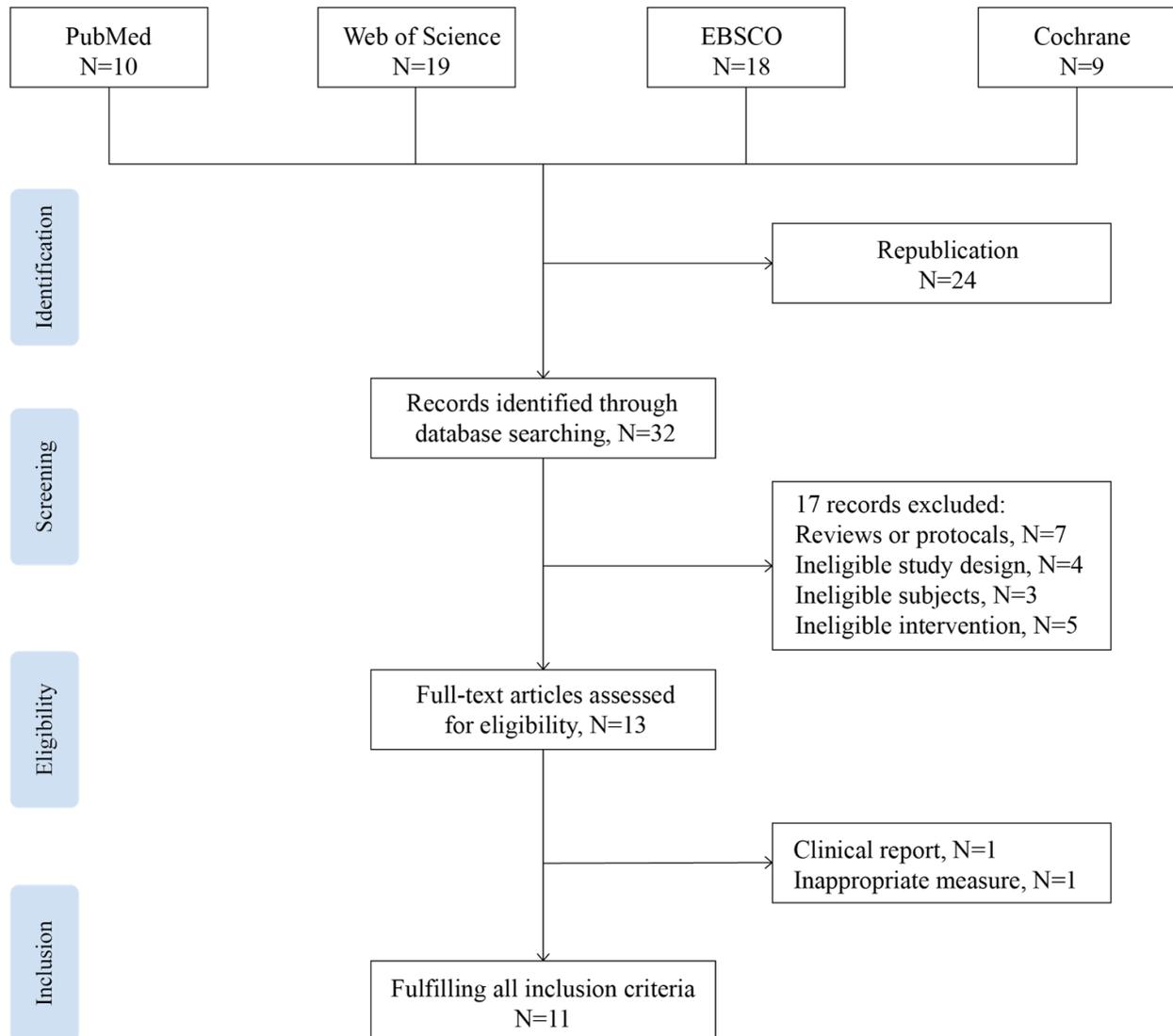
Figure 1: Literature search flow chart according to PRISMA.

2.4. Data Analysis

After the study specifics were extracted, the articles were organised thematically depending on the methodology used (see Table 2, 3, and 4).

Table 2: Studies assessing AMMT in autistic children.

Study	Study design	Population	Language	Diagnostic	Interventions	Main findings	Outcome (brief)
1 Wan et al. (2011) [4]	Single-subject design	$N = 6$ Age: 5-9 y.o. Gender: 5 M, 1 F	English	ASD Severity: Non-verbal	AMMT: Two tuned drums, target words intoned on two pitches; Boardmaker pictures as visual cues. Settings: forty 45-min individual sessions 5 times a week for 8 weeks (30h in all)	Statistically significant positive effect on child's ability to approximate consonant-vowel approximations. ($p = .001$)	+
2 Kim (2014) [10]	Single-subject design	$N = 2$ Age: 7;2 and 9;4 Gender: NA	Korean	Participant 1: ASD Participant 2: ASD, ADD	AMMT: Tuned drums, target words intoned on two to three pitches; Boardmaker pictures as visual cues. Settings: nine 30-min individual sessions over 4 weeks (4.5h in all)	20% and 26% more speech produced overall ($\chi^2(9, N=2) = 11.909, p = 0.219$)	+ (not significant)
3 Massey (2016) [11]	Single-subject design	$N = 7$ Age: 5-8 y.o. Gender: 5 M, 2 F	English	ASD Severity: Non-verbal	AMMT: Target words intoned on two to three pitches; Boardmaker pictures as visual cues. Settings: twelve 20-min bi-weekly individual sessions (4h in all)	Overall word production increase ($p = .424$) and pre-linguistic gesture development ($p = .063$)	+ (not significant)
4 Chenau-sky et al. (2016) [12]	Randomized control design	$N = 23$ (AMMT), 7 (SRT). Age: AMMT: 3;5–9;8 SRT: 3;9–8;5 Gender: AMMT: 20 M, 3 F, SRT: 5 M, 2 F	English	ASD Severity: Minimal verbal	AMMT: Electronic drums, target words intoned on two pitches; Boardmaker pictures as visual cues. SRT: Imitating and repeating utterances (not intoned). Settings: 10 participants had 20 sessions of AMMT; the other 13 had 25 sessions of AMMT (7 of them were matched to SRT-treated children); 7 participants had 25 sessions of SRT.	1) Improvement in %SA ($p < .05$), %CC ($p < .05$), and %VC ($p = .008$) after 25 therapy sessions of AMMT. 2) More increase in %SA and %CC after AMMT compared to SRT ($p = .008$). 3) Higher responsiveness in AMMT than SRT group.	+
5 Chenau-sky et al. (2017) [13]	Randomized control design	$N = 4$ Age: 4;1-6;7 Gender: all M	English	ASD Severity: Minimal verbal (MCDI: 1 and 3); More verbal (MCDI: 90 and 131)	AMMT: Electronic drums, target words intoned on two pitches; Boardmaker pictures as visual cues. SRT: Imitating and repeating utterances (not intoned). Settings: Twenty-five 45-min individual sessions 5 times a week for 5 weeks (18.75h in all)	1) Greater improvement after AMMT in the majority of the outcome measures compared to SRT. 2) Larger effect sizes (Cohen's $d > 1.3$) of adjusted gains in AMMT over SRT in more-verbal than minimal verbal participants.	+
6 Yan et al. (2021) [14]	Randomized control design	$N = 15$ (AMMT), 15 (SRT) Age: 3-6 y.o. Gender: AMMT: 13 M, 2 F; SRT: 13 M, 2 F.	Chinese	ASD Severity: Nonverbal ($N=6$); Low-verbal ($N=24$)	AMMT: Target words intoned on two pitches, treatment via the APP "Music Mediated and Lexicon-Integrated (MMLI)." SRT: Imitating and repeating utterances (not intoned). Settings: 12 individual sessions 6 times a week for 2 weeks	1) Both AMMT and SRT produced gains in low-verbal individuals, with AMMT better speeding the pace of development. 2) One nonverbal individual exhibited improvement in the learned items after AMMT, while all the others remained nonverbal.	+ (for low-verbal participants) o (for nonverbal participants)
7 Chenau-sky et al. (2022) [15]	Randomized control design	$N = 8$ (AMMT), 6 (SRT) Age: AMMT: 7.0 ± 1.11, SRT: 6.5 ± 1.0. Gender: AMMT: 6 M, 2 F; SRT: 5 M, 1 F.	English	ASD Severity: Minimal verbal (ADOS-2 score: 22.9±2.5; KSPT raw score: 12.9±13.0);	AMMT: Two tuned drums, target words intoned on two pitches; laminated pictures as visual cues. SRT: Imitating and repeating utterances (not intoned). Settings: 25 45-min individual sessions 5 times a week for 5 weeks (18.75h in all)	1) Greater improvement in percent syllables approximately correct ($p = .002$) and percent vowels correct ($p = .01$) after AMMT than SRT. 2) For percent consonants correct, AMMT outscored SRT on trained stimuli but failed behind on untrained stimuli.	+ (for syllables and vowels)

ASD, autism spectrum disorder; AMMT, Auditory Motor Mapping Training; ADD, attention deficit disorder; SRT, speech repetition therapy; %SA, Percent Syllables Approximated; %CC, Percent Consonants Correct; %VC, Percentage Vowels Correct; MCDI, MacArthur-Bates Communication Development Inventory; ADOS-2, Autism Diagnostic Observation Schedule-2; KSPT, Kaufman Speech Praxis Test.

Table 3: Studies assessing FCMT in autistic children.

Study	Study design	Population	Language	Diagnostic	Interventions	Main findings	Outcome (brief)
8 Thompson et al. (2014) [16]	Randomized control design	N = 23 Age: 3-5 y.o. Gender: NA	English	ASD Severity: Nonverbal or minimal verbal	**FCMT:** Parent-child music interactions with assistance and advice from music therapists. **ECI:** 1.55 h of weekly contact with ECI service with 0.64 h additional therapies per week **Settings:** sixteen 30-40 min individual sessions in participant's own home once a week for 16 weeks **(9.33h in all)**	Improvement in family and community social interactions (VSEEC; $p < .001$; MTDA; $p = .001$) and the parent–child connection; No significant gain in language abilities ($p = 0.824$) or social responsiveness ($p = .946$).	+ (for family and community social interactions, and parent-child connection) o (for language skills or social responsiveness)
9 Vaiouli and Andreu (2022) [17]	Single-group, pre-post convergent mixed method design	N = 8 Age: 3-6 y.o. Gender: 7 M, 1 F **Caretaker:** 7 mother, 1 father	Greek	ASD Severity: Nonverbal or minimal verbal	**FCMT:** Parent-child music interactions with assistance and advice from music therapists. **Settings:** 16 individual sessions of 40 minutes each, held once a week for 16 weeks **(10.67h in all)**	Improvement in preverbal communicative actions (PPECS, $p < .01$; CSBSDP, $p < .02$).	+

ASD, autism spectrum disorder; FCMT, Family-Centred Music Therapy; VSEEC, Vineland Social-Emotional Early Childhood Scales; MTDA, Music Therapy Diagnostic Assessment; ECI, early childhood intervention; PPECS, Pragmatics Profile of Everyday Communication Skills; CSBSDP, Communication and Symbolic Behaviour Scales Developmental Profile.

Table 4: Studies assessing MBCT in autistic children.

Study	Study design	Population	Language	Diagnostic	Interventions	Main findings	Outcome (brief)
10 Sandiford (2012) [7]	Randomized control design	N = 12 Age: 5-7 y.o. Gender: 11 M, 1 F	English	ASD Severity: Nonverbal	**MBCT:** Using hand claps to mimic the rhythm while listening to 25 target words arranged to 25 distinct tunes recorded on CD. **Traditional therapy:** Typical therapeutic techniques in a private practise environment. **Settings:** Twenty 45-minute individual sessions, four times a week for five weeks. **(15h in all)**	MBCT is more efficient than conventional therapy and more effective at helping patients apply newly acquired abilities to real-world situations compared to traditional therapy.	+
11 Sandiford et al. (2013) [18]	Randomized control design	N = 12 Age: 5-7 y.o. Gender: 11 M, 1 F	English	ASD Severity: Nonverbal	**MBCT:** Using hand claps to mimic the rhythm while listening to 25 target words arranged to 25 distinct tunes recorded on CD. **Traditional therapy:** Typical therapeutic techniques in a private practise environment. **Settings:** Twenty 45-minute individual sessions, four times a week for five weeks. **(15h in all)**	Significant increase in PLSI score after MBCT (72.3 ± 10.1 vs 65.4 ± 7.0, $p=.04$) but not traditional therapy (67.7 ± 1.2 vs $66.8 \pm.5$, $p=.32$).	+

ASD, autism spectrum disorder; MBCT, Melodic Based Communication Therapy; PLSI, Pragmatic Language Skills Inventory.

2.5. Risk of Bias Assessment

The technique developed by the Cochrane Collaboration was used for risk of bias assessment [19]. Each item for the studies included was examined and then classified as "low," "high," or "unclear" (see Figure 2).
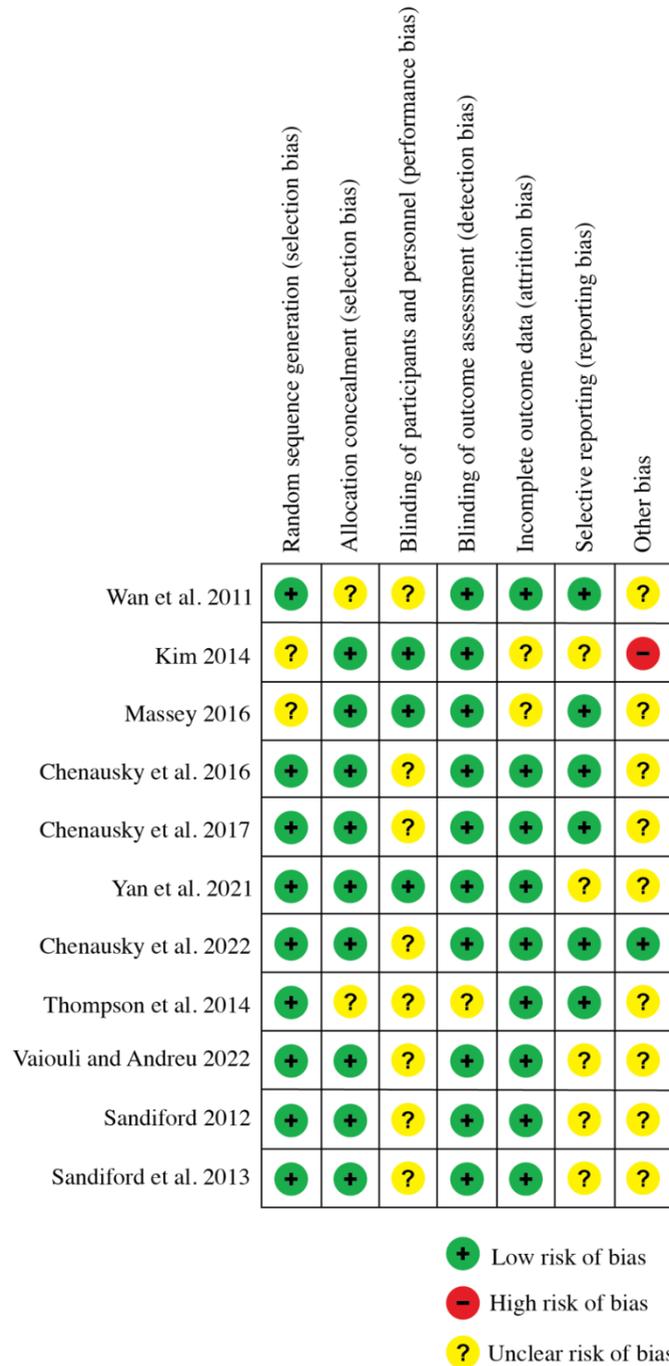
Figure 2: Risk of bias assessment of included studies.

3.   Results

3.1.   Characteristics of the Included Studies

In all studies included, the sample sizes were small to medium, with 2 to 30 participants, predominantly nonverbal or minimally verbal autistic children aged between 3 and 9 years. One study [13] diverged from this demographic, comparing the efficacy of treatment on a more-verbal child with a minimally verbal child. The treatment duration varied between 2 to 24 weeks (M=9±7.16), with participants receiving 4-30 hours (M=14±8.11) of treatment and treatment frequencies ranging from 5 times a week to once every two weeks. Most studies were conducted in English (N=8), while three studies were conducted in Korean [10], Chinese [14], and Greek [17] respectively.

3.2.   Effect of AMMT on Autistic Children

Studies have demonstrated that AMMT can enhance autistic children's overall speech production and responsiveness [4,10-13,15]. Typically, significant improvements in the production of syllables, vowels, and consonants can be achieved after 18 to 19 hours of treatment.

According to Wan et al. [4], after AMMT, all children had noticeably improved in word and phrase understanding, with generalisation to things that were not practised in therapy. Chenausky et al. [12] found that the AMMT group considerably outperformed the Speech Repetition Therapy (SRT) control group in terms of Percentage Syllables Approximated and Percentage Consonants Correct. Additionally, in a further study [13], they compared the efficacy of AMMT in minimal verbal children and a more-verbal child, revealing that the more-verbal participant with ASD exhibited significantly larger effect sizes in terms of improvements. Massey [11] conducted a study that was similar to Wan et al. [4], and found an increase (yet not significant) in overall speech production ($p = .424$) and the development of pre-linguistic gestures ($p = .063$) after twelve 20-min bi-weekly AMMT sessions.

Two studies investigated AMMT in languages other than English [10,14], yet one of them yielded statistically insignificant outcome [10], probably due to limited invention time (4.5h in total). Despite of statistical insignificance, the author did find overall growth in word production in children with ASD after AMMT performed in Korean. The other study investigated the effect of AMMT compared to SRT in nonverbal and minimal verbal native Chinese autistic children and found that for minimal verbal individuals, AMMT better accelerates the rate of progress in speech production; however, for nonverbal individuals, the responsive rate is extremely low (one out of six), and all participants showed no progress under both treatments [14]. This outcome is inconsistent with the other studies. Since no other studies have investigated AMMT in Chinese, further research and more data are necessary to draw valid conclusions.

3.3.   Effect of FCMT on Autistic Children

The effectiveness of FCMT in autistic children was investigated in two studies. Results showed that in contrast to conventional early childhood intervention, the parent-child bond and social interactions in home and community were improved by FCMT, but linguistic abilities and general social responsiveness were not [16].

Vaiouli and Andreu [17] expanded the use of FCMT to Greek and examined its effects on preverbal and verbal communication abilities of young autistic children. They found that FCMT improved preverbal communicative actions, such as eye-gaze, gestures, and sounds, and facilitated interaction and meaningful engagement in social activities between parents and their children.

3.4. Effect of MBCT on Autistic Children

Two studies by Sandiford [6,18] showed notable effectiveness of MBCT on speech production and pragmatics in nonverbal autistic children. The therapy was found to be more efficient than conventional speech and language therapy at eliciting speech in participants and helping them transfer newly acquired abilities to real-world situations. Additionally, the study showed that MBCT was also successful in enhancing pragmatics, exhibiting its promise as a strategy for enhancing social language abilities in autistic children.

4. Discussion

The goal of this study was to systematically review and analyse the existing literature on the effects of three music therapy techniques in autistic children, namely AMMT, FCMT, and MBCT. This review summarized and analysed studies examining the efficacy of the three approaches, providing general and detailed information on the current research status for future studies. This review shows that (a) all three approaches have positive impact on children with ASD, and that (b) enhancement brought by the three approaches lie in different aspects, with AMMT mainly improving speech production, FCMT encouraging communication and strengthening family relationship, and MBCT refining social language skills. This diversity in improvements indicates the possibility of combining the three approaches to yield better outcomes in autistic children.

Check that in line drawings, lines are not interrupted and have a constant width. Grids and details within the figures must be clearly readable and may not be written one on top of the other. The studies included have the common limitations of small sample size, broad age range, and wide discrepancy in total treatment time received. The limited relevant studies and data require future efforts in examining the approaches in more specific age groups, broader populations (e.g., more-verbal autistic children), and across different cultural contexts. The realization of further studies relies largely on standardized and detailed protocols of each treatment approach including the specification of materials used and regulations of procedures.

Moreover, efforts are called for the popularization of the approaches of music therapy. This necessitates a thorough analysis of the financial effects and procedural difficulties, as well as a careful evaluation of the requisite expertise in relevant domains. Specifically, for FCMT, it is necessary to consider if a set program of training and coursework could enable parents of autistic children to conduct this kind of therapy skillfully without the supervision of a licensed therapist. If such home-based treatments of low cost and high practicability is feasible, it would potentially benefit numerous children with ASD, as well as their families, especially in countries or regions with limited access to ASD professionals and relevant medical resources. Additionally, for AMMT and MBCT, the development of AI therapist programs should be prioritized to mitigate human resource costs and expedite the dissemination of these therapies.

5. Conclusions

The current review demonstrates that AMMT, FCMT and MBCT, as approaches to music therapy, are effective and beneficial to children with ASD in different aspects. Furthermore, it suggests the possibility of integration of the three approaches. AMMT has been demonstrated to enhance autistic children's speech and response. FCMT has exhibited positive impacts on social interactions, parent-child relationships, and preverbal communicative actions, while MBCT has been found to be effective in eliciting speech and enhancing social language skills in nonverbal autistic children. The effectiveness of these therapies in various settings and languages needs to be further studied, and future efforts should focus on promoting the widespread adoption of these approaches, including

assessing costs, addressing practical challenges, and developing AI therapist programs to facilitate their dissemination.

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