Training with embodied musical activities has positive effects on unfamiliar language imitation skills.

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Abstract

Research shows that musical expertise benefits second language (L2) phonological learning [1], however little is known on the potential effects of training musical melodic and rhythmic skills on language production skills. This study investigated the role of training musical features such as melody, rhythm, and accent with embodied activities [2] (e.g., without any speech input) on imitation skills. We hypothesized that embodied musical learning would activate participants' melodic and rhythmic musical skills, which will transfer to their ability to imitate speech.

Fifty Chinese adolescents participated in three 45-minute classroom training sessions. They were randomly assigned to one of two conditions: the Embodied Music group followed rhythmic and melodic activities involving body movements; the Non-Embodied Music group followed traditional music classes.

Before and after training, participants took part in a sentence-imitation task involving six unfamiliar languages. For each language, imitation skills were evaluated in terms of accentedness by three native speakers. Results showed a significantly higher improvement in the Embodied Music group. These findings demonstrate for the first time the beneficial effects of training students with embodied musical activities on speech imitation skills and add evidence of the bootstrapping effect of training musical rhythmic and melodic features on speech production.

Index Terms: music and language, speech imitation skills, musicality and language acquisition, embodied music cognition.

1. Introduction

There has been a growing interest in investigating the interactions between music and language in the last decades. Unlike other domains of human expertise, both music and language are organized temporally and reach our perceptual system with the same frequency spectra. In addition, the suprasegmental features of rhythm, stress, intonation, or phrasing in language find their counterpart in rhythm, accent, melodic, and phrasing in music [3]. Research in cognitive sciences has shown that music expertise may enhance cognitive functions that are not directly related to music, such as verbal intelligence [4, 5], auditory working memory [6], creativity [7], processing speed for both visual and audiovisual information [8], etc. These findings have provided supportive evidence of a tight relationship between music and language in the brain [9, 10, 11]. The positive transfer from music to language skills has been investigated in terms of musical expertise, musical aptitude, and musical training. From the perspective of musical expertise, Besson and colleagues found that musicians are more sensitive to speech perception [12, 13, 14]. As for musical aptitude, higher musical perceptive abilities may trigger better language skills for both young and adult populations. For instance, [15] tested the L1 (English) reading skills of 42 children and found that regardless of music experience, those children who obtained higher scores in a musical aptitude test performed better in silent reading, auditory memory, and attention tasks. Regardless of musicianship or musical aptitude, musical training sessions may also enhance language processing. For example, presenting new vocabulary with a melody helped children better remember the target words [16]. Interestingly, results of a two-year training study with 24 eight-year-old children showed enhanced segmentation skills in children who followed musical training compared to painting training [17].

Pedagogically, music serves well as a powerful teaching tool for both young and adult learners in the foreign language classroom [18]. Teachers use musical activities in the classroom for a variety of reasons. For example, music helps build an enjoyable atmosphere, favors vocabulary memorization, and promotes the learners' attention and learning processes [19]. Although a handful of experimental studies have empirically explored the positive interactions between music and language, there is still little evidence from classroom-based studies looking at the potential effects of training with musical activities on foreign language pronunciation skills.

Previous studies have found that singing helped adult participants remember and pronounce sentences in an unfamiliar language [20] but also favored learners' speaking skills in general. In an exploratory classroom study [21] with Scottish learners of French, it was found that singing activities facilitated more grammar, listening comprehension, intonation, and flow of speech than visual art and drama activities. However, in terms of a test reproducing a set of French words of food items, no improvement was found in the pronunciation scores for the singing group. In contrast, a study investigating the comparisons between singing and listening to a French song about body parts in a lab setting has indicated that singing could be more effective for Chinese college students improving their pronunciation in those target noun words that appeared in the lyrics [22].

Rhythmic training has been used as a music-based method to improve memorization skills [23] and speech production in non-typical [24] and typical populations [25]. The association of visual/tactile (gestures) and auditory rhythmic cues has also facilitated speech production [26, 27, 28]. For instance, while [26] found that the observation of rhythmic hand gestures
helped reduce accentedness in Catalan learners of English, hand-clapping to the rhythmic structures of French noun words helped improve the production of French final lengthening both in Chinese adolescents [27] and Catalan children [28]. The above-mentioned studies reporting beneficial effects of musical activities on foreign language pronunciation have mainly used activities with both linguistic and musical components. However, it is still unknown if the benefits of musical training involving embodied melodic and rhythmic activities (with no speech involved) may transfer to language production skills such as speech imitation.

In the present study, we follow the embodied music cognition paradigm. The involvement of the voice, hand, and body movement is crucial to perceive, experience, and learn music [29]. One well-known music teaching approach implementing embodied music cognition is the so-called Dalcroze Eurhythms pedagogy, developed in the early 20th century by the Swiss composer, musician, and music educator, Émile Jaques-Dalcroze [2]. This approach aims at developing musical abilities such as sense of rhythm, the finesse of hearing, and spontaneous expression by practicing the coordination between music and body movements, and it is considered a very effective method to acquire rhythmic and melodic skills [30, 31].

Following previous evidence showing the positive role of melodic (e.g., singing) and rhythmic (e.g., hand clapping) training on pronunciation when presented together with speech, the goal of the present study was to further explore the role of music on speech production skills by exclusively training musical skills with embodied activities inspired by Dalcroze Eurhythms.

In this classroom intervention with Chinese adolescents, we empirically assessed the effect of music training with a series of non-linguistic embodied melodic and rhythmic activities on speech imitation skills in six unfamiliar languages. We hypothesized that music training would enhance participants’ perception of melodic and rhythmic features in music, which in turn would improve their language skills in an imitation task with different types of language [32].

2. Methods

2.1. Participants

A total of fifty adolescent students in 8th grade from Zhangjiu Experimental Middle School (Shandong, China) participated in our study on a voluntary basis. Participants were asked to fill in the musical and linguistic background questionnaire [27]. All were Mandarin native speakers with low proficiency in English as L2. None reported speaking a third language or being a musician.

Previous to the experiment, detailed instructions about the activities during the sessions as well as the complete training materials prepared by the first author were sent to the school administrators and the music teachers. Five meetings were organized to solve any doubt.

Participants were trained in two classrooms with two different teachers under one of the following conditions: a) three 45-min sessions with embodied rhythmic and melodic activities (Embodied Music group); b) three 45-min sessions with regular music sessions at their school (Non-Embodied Music group). A total of 48 students were included in the analysis due to the absence of 2 students in one of the training sessions (Embodied Music group: N = 25, 15 females, M_age = 13.8 years, SD = .577; Non-Embodied Music group: N = 23, 10 females, M_age = 13.7 years, SD = .559).

2.2. Materials

All the materials for this study are available at https://osf.io/9udny/.

2.2.1. Pre- and posttest

To measure the participant’s ability to spontaneously imitate non-native speech, a modified version of the speech imitation task used in [27] was created, featuring a total of six foreign languages from different typologies (Catalan, Hebrew, Japanese, Russian, Turkish, and Vietnamese). For each language, two short sentences (between 5 to 12 syllables long, M = 8.83, SD = 2.33) were recorded by a native speaker. The sentences were embedded in an online presentation platform Alchemer (www.alchemer.com), and randomized automatically.

2.2.2. Embodied rhythmic and melodic activities

Following the Dalcroze music approach, we incorporated and adapted a variety of embodied activities tapping on musical rhythm and melody. Prior to each activity, the music teacher introduced the target music concept, showed example videos of the activity (when necessary), and gave precise instructions. For the Embodied Music group, ten activities were prepared for the three sessions. Table 1 shows the distribution of activities across sessions.

Activity 1. Move to the beats. This activity involved three pieces of classic piano songs with varying tempo, such as the piano piece Peer Gynt Suite No.1 Op.46 by Edward Grieg, with accelerating BMP (beat per minute) from 85 to 200. Participants were asked to walk out the beats with and without hand clapping.

Activity 2. Move to rhythm patterns. A total of 6 short and simple pieces of rhythm were selected. First, the music teacher produced one piece of rhythm twice on a tambourine, then the students stood still and reproduced it with hand-clapping. Second, the teacher produced the same rhythm again, and the students needed to adjust their steps to walk naturally to the rhythm.

Activity 3. Move to the accents in the melody. Participants stood in pairs and acted as playing tennis while listening to a piece of a piano with very salient accents. When hearing accents in the music, the participants had to act as swinging a racket in alternation with their partners.

Activity 4. Move to the final accent. The piece of music consisted of four notes with different melodies and rhythms. Participants were asked to listen to the three first notes and make predictions of when the fourth note appeared and quickly jumped/landed to the fourth note.

Activity 5. Move to the change of musical scale. The material consisted of an instrumental piece with a series of different musical scales. When hearing an ascending scale, participants needed to make some steps forward and raise their arms above the head; when hearing descending scales, participants needed to move backward and put down their arms; when hearing non-changing scales, they spun around while lifting their arms.
Activity 6: Rhythmic body percussion part 1. The instrumental version of the famous song *We will rock you* was used. Participants were divided into three groups based on the "stomp-stomp-clap" structure of this song, and each group was in charge of one action, in this sense, the first group stomped to every first beat; the second group tapped their body twice every first and second beat; the third group hand-clapped to every third beat.

Activity 7: Rhythmic body percussion part 2. The instrumental piece *Take Five* by Dave Brubeck was used in this activity. Students sat in a circle and performed body percussion with sandbags, following the rhythm of the music. The activity involves a set of body movements such as picking up the sandbag in front of oneself, touching one's right knee, then touching the left knee, passing the sandbag to the student who sat on one's left side, clapping their hands, and doing freestyle body movements during the prelude and the interlude.

Activity 8: Balloons game: touching the beat. The two pieces of music used in this activity were *Le quattro stagioni: La Primavera* by Antonio Vivaldi and *Hungarian Dance No.5 in G Minor* performed by Martynas. Each participant was given one air balloon. They threw the balloon into the air while the music was played and then started to touch/point the balloon following the beat of the songs with their two forefingers alternatively to prevent the balloon from falling down.

Activity 9: Move to the beats: quick reaction. Participants started walking to the beats when a piece of piano music started to play. Several breaks (silence) would occur during the music, and as soon as the students heard the silence, they had to stop and clap out the tempo by themselves.

Activity 10: Musical group event. During this group activity, students learned and performed a full set of movements to the folk opera *Viennese Musical Clock*. The "dance" movements were rhythmical and easy to learn and follow. The full set of movements were split into ten sections and the teacher guided the students with the help of the audiovisual materials.

### 2.2.3. Traditional music classes

The three extra-curricular 45-minute sessions for the Non-Embodied Music group were designed and planned by a music teacher from the same middle school. The sessions involved activities that typically fitted their teaching curriculum such as music appreciation, explanations about instruments, as well as musicians and background knowledge, watching audiovisual music stories, and so on. The music pieces used in the three sessions were *Liangzhu: The Butterfly Lovers, Colorful clouds chasing the moon*, and *Blossoms on a Moonlit River in Spring*, all of them selected from the music textbook for 8th graders.

### 2.3. Experimental procedure

The music training sessions for both the groups took place on the school premises in two multimedia classrooms, carried out with the support from two music teachers. While the students were seated in the non-embodied music group, in the embodied music group, the classroom was free of chairs and tables, and the students were able to move around comfortably. The three training sessions took place during the same week for three consecutive days. All the sessions were recorded (see Figure 1). The pretest took place the same day as the first session, and the posttest took place the same day as the last session.

### 2.4. Data assessment

Participants' ability to imitate speech in the six languages was evaluated by three native speakers of each language. The raters were asked to evaluate the target imitation produced by participants in terms of accentuatedness on a Likert scale from 1 to 9, where 1 corresponded to "extremely accented" and 9 indicated "not accented at all". The ratings were performed online through the platform Alchemer.

For each item, the raters first listened to the sentence produced by a native speaker, and then to two oral productions, which corresponded to the pretest and posttest renditions by a single participant, presented in random order. The application allowed the raters to play any audio file as many times as they wished.

Inter-rater reliability was assessed with the Intraclass correlation coefficient (ICC) for each pre- and posttest item. This procedure was realized with the program SPSS 26. The scores were .757 (Catalan), .789 (Hebrew), .907 (Japanese), .919 (Russian), .897 (Turkish), and .831 (Vietnamese), which are interpreted as good or excellent reliability [33].

A General Linear Mixed Model (henceforth GLMM)
using IBM SPSS Statistics 26 was run with ACCENTEDNESS as the dependent variable. GROUP (two levels: the Embodied Music group vs. the Non-Embodied Music group), SESSION (two levels: pretest and posttest), and GROUP*SESSION were set as fixed factors. One random effects block was specified, with PARTICIPANT and ITEM intercepts.

3. Results

Results showed significant main effects of SESSION ($F(1, 1121) = 49.371, p < .001$) and interaction GROUP*SESSION ($F(1, 1121) = 14.057, p < .001$). Post-hoc pairwise comparisons between the pretest and the posttest revealed that there was a significant difference both in the Embodied music group ($t = 7.88, p < .001$) and the Non-embodied music group ($t = 2.245, p < .05$). The comparisons between groups at pretest and posttest revealed that there was no significance between groups at pretest ($t = .487, p = .626$) and a significant difference between groups at posttest ($t = 2.049, p < .05$), see Figure 2.

![Figure 2: Estimated means of accentedness scores across the two conditions, GROUP (Embodied Music group vs. Non-Embodied Music group) and SESSION (pretest vs. posttest)](image)

4. Discussion and conclusions

The current study aimed at exploring the effects of embodied musical training on speech imitation skills in Chinese adolescents through three intensive 45-minute training sessions compared to three traditional music sessions. The Embodied Music group experienced music rhythm and melody through body movements and the Non-Embodied music group remained seated while taking traditional music classes. Our results indicate that a three-session intervention involving embodied musical melodic and rhythmic activities exclusively (with no speech involved) helped Chinese adolescents to improve their speech imitation skills in six unfamiliar languages significantly more than traditional music classes.

While the small improvement in accentedness in the non-embodied group may be due to the repetition of the imitation task at pre- and posttest, the larger improvement in the embodied music group may well be attributed to the embodied melodic and rhythmic training activities proposed in the present intervention. Our findings added evidence to the embodied music cognition paradigm by showing that both music and body movements at the same time provide an enhancing effect not only on cognitive functions, but also on speech production. In future research, a more fine-grained analysis of participants' oral production at pre- and posttest could help determine whether these improvements in speech imitation skills are related to an improvement in the imitation of prosodic features specifically.

Even though our results support the claims of the music embodied cognition paradigm [29], our control group did not perform exactly the same type of activities. Further studies might want to investigate the gains of embodied musical activities in comparison with a matched non-embodied musical training where participants specifically learn rhythm and melody without body movements. Interestingly, as suggested by [34], the talent for speech sound imitation and pronunciation skills in a foreign language may be highly interdependent. As mentioned before, previous research has shown how activities in the L2 classroom involving singing or listening to songs in the target language might be effective for L2 pronunciation. To our knowledge, no previous study has tested the potential effects of musical training (with no speech involved) for the improvement of foreign language pronunciation.

Adding to the evidence of the positive effect of musical aptitude and expertise in L2 phonological learning [1, 13], the present study further states the role of music embodied activities on oral language skills. Although not everyone can be a musician, the implementation of music activities in the language classroom may benefit everyone [35, 36]. Crucially, they are helpful for L2 speech perception and production [16, 20] and especially combined with embodied activities [27, 28]. However, these kinds of programs were generally designed for children and should be further tested with adults.

It will be interesting to also look at the potential role of embodied musical activities on L2 proficiency. In our case, all the adolescents spoke English as their L2 but with low-level proficiency. The involvement of music activities may also increase positive emotions and willingness to participate [2], which may be one of the reasons for the positive findings. It will also be interesting to divide the adolescents into high and low musicality groups, but unfortunately, the sample size of our participants with high musical expertise and/or aptitude was too small. It might be the case that those with high musical aptitude or expertise would benefit less from the embodied musical activities and rely more on their musical skills [37].

To our knowledge, our study is the first to demonstrate the beneficial effects of musical training featuring embodied rhythmic and melodic activities without speech input on language oral skills. Future research will need to look closer at the potential beneficial effects of embodied musical training on L2 pronunciation.

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6. References


