Does Instrumental Music Training Improve Chinese Word Reading?

A Quasi-experimental Study

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Abstract

This study set out to investigate whether and how music training improved Chinese word reading in typically developing children. Adopting a quasi-experimental research design, we recruited 86 musically trained children and musically untrained children with similar family income. They were tested on Chinese word reading, phonological awareness, tone awareness, and music perception. Musically trained children outperformed musically untrained children on Chinese word reading, phonological awareness, and tone awareness. According to path analysis, phonological awareness mediated the relation between music perception and word reading in musically trained children, whereas tone awareness did not. This study provides initial evidence supporting the potential of music training to improve Chinese word reading. Moreover, the findings reflect a possible intervention mechanism in which music training improves Chinese word reading by enhancing phonological awareness. From a theoretical perspective, the findings support the phonological awareness account but not the tone awareness account. Moreover, the findings may extend the Precise Auditory Timing Hypothesis to tone languages and the logographic writing system.

Keywords: Music, reading, Chinese, phonological awareness, tone awareness, Precise Auditory Timing Hypothesis

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Playing music and reading words may seem cognitively distant, but research suggests that music training enhances children's word reading abilities (Bhide et al., 2013; Rautenberg, 2015; Moreno et al., 2009). That said, previous research has mainly focused on alphabetical writing systems, creating a knowledge gap in understanding the effect of music training on children learning to read logographic scripts such as Chinese. To enhance the comprehensiveness and diversity of existing literature, we aimed to understand whether and how music training improves Chinese word reading. This study presents an initial investigation with a quasi-experimental design. First, we compared musically trained and untrained children in Chinese word reading. Second, we examined the relative mediating roles of phonological and tone awareness in the

relation between music perception and Chinese word reading in musically trained children.

Effect of Music Training on Word Reading

In recent decades, there has been causal evidence suggesting that music training enhances word reading in alphabetical languages (Bhide et al., 2013; Moreno et al., 2009; Rautenberg, 2015). In a randomized controlled trial (RCT), German children were randomly assigned to a music training group, a visual arts training group, or a business-as-usual control group for nine months. While the three groups exhibited similar accuracies and speeds in German word reading at the pre-test, the music training group demonstrated higher word reading accuracy than the other two groups at the post-test. This result indicated that music training improved German word reading accuracy. In another RCT, Portuguese children were allocated to either music training or painting training (Moreno et al., 2009). Following music training but not painting training, children showed increased accuracy in reading phonologically inconsistent words. Additionally, an English RCT compared the efficacies of music training and phonological training on dyslexic children's word reading (Bhide et al., 2013). Both groups showed comparable improvements in word reading compared to their performance at the pre-test. Therefore, music training and phonological training appeared equally effective in enhancing English word reading (Bhide et al., 2013).

The first research gap is whether music training can improve word reading in the logographic writing system, specifically Chinese. Previous

research has predominantly focused on alphabetical languages like English and Portuguese (Bhide et al., 2013; Moreno et al., 2009; Vidal et al., 2020). In contrast to alphabetical languages, Chinese characters represent morphemes rather than phonemes. For example, the Chinese character □ represents “man” without explicitly indicating the phonemes (/j/ /ʌ/ /n/ and the low falling tone) as English letters do (e.g., the letter “m” for /m/, “a” for /æ/, “n” for /n/). Due to these differences in writing systems, the findings from studies on alphabetical languages may not directly apply to Chinese (Bhide et al., 2013; Moreno et al., 2009; Vidal et al., 2020). To date, only one RCT has been conducted on Mandarin-speaking children, focusing solely on speech discrimination outcomes without evaluating word reading and phonological awareness (Nan et al., 2018). The research gap persists, and addressing it could provide valuable insights to clinicians regarding the potential benefits of music training in enhancing Chinese word reading.

Phonological Awareness Account

In recent decades, there has been significant theoretical interest in understanding the mechanism by which music training enhances word reading (Tierney & Kraus, 2014; Loui et al., 2011; Patel, 2011). The general concept is that music-related perceptual training improves musical rhythm and pitch perception, which in turn has cross-domain cascading effects on word reading (cf. Schellenberg, 2011; Swaminathan et al., 2018). The Precise Auditory Timing Hypothesis (PATH) embodies this perspective (Tierney & Kraus, 2014). From an acoustic standpoint,

musical rhythmic activities demand more precise timing perception than speech. According to PATH, engaging in musical rhythmic activities can enhance timing perception, thereby assisting in the recognition of durational cues in speech (such as voice onset time and formant transition duration) for accurate phoneme identification and speech segmentation. Importantly, accurate phoneme identification and speech segmentation contribute to the development of phonological awareness, which is the ability to analyze and manipulate phonological units within a word, such as syllables, onset-rhyme, and phonemes (Ziegler & Goswami, 2005). Importantly, phonological awareness is a robust predictor of word reading (Anthony & Francis, 2005; McBride-Chang, 1995; Mohajer & Hu, 2003). In essence, PATH suggests that phonological awareness serves as the mediator between musical rhythm perception and word reading.

In addition to musical rhythm, researchers have suggested that enhancing musical pitch perception could also enhance phonological awareness, thereby benefiting word reading (Loui et al., 2011; Patscheke et al., 2019; Ziegler et al., 2012). Musical pitch perception requires more precise spectral processing compared to phoneme perception (Intartaglia et al., 2017; Shahin, 2011). By improving musical pitch perception, one can also improve phoneme perception, subsequently enhancing phonological awareness (Loui et al., 2011). Furthermore, as pitch can delineate speech boundaries, enhancing pitch perception can assist in speech segmentation, which contributes to phonological awareness (Ziegler et al., 2012). Studies have shown that musical pitch perception

predicted English phonological awareness (e.g., Sun et al., 2017), and a German RCT demonstrated that musical pitch training improved phonological awareness (Patscheke et al., 2019).

In summary, the **phonological awareness account** outlined above suggests that phonological awareness acts as a mediator in the relation between music perception and word reading in musically trained individuals (Loui et al., 2011; Tierney & Kraus, 2014). Here, music perception refers to the ability to perceive musical pitch and rhythm. Despite the non-alphabetical nature of the Chinese language, phonology still plays a crucial role in word reading (Chow et al., 2005; McBride-Chang et al., 2004; Tseng et al., 2023). In Chinese, children must establish and access phonological representations of words to effectively read them aloud (Perfetti et al., 2005). While direct evidence in musically trained children is limited, previous studies have shown that pitch and rhythm perception predicted Cantonese phonological awareness in musically untrained children (Zhang & McBride-Chang, 2014; Zhang et al., 2017).

Furthermore, prior research has shown that two types of phonological awareness, syllable awareness, and onset-rhyme awareness, concurrently and longitudinally predicted Chinese word reading (Chow et al., 2005; McBride-Chang et al., 2004; Tseng et al., 2023). Therefore, both syllable awareness and onset-rhyme awareness were included in the phonological awareness measure used in this study. Building on the phonological awareness account, we hypothesized that phonological

awareness mediated the relation between music perception and Chinese word reading in musically trained children (see Figure 1).

Tone Awareness Account

In addition to phonological awareness, we hypothesized that tone awareness mediates the relation between music perception and Chinese word reading. Tone awareness refers to the ability to extract and differentiate the tonal information of syllables (Burnham et al., 2011; Tong et al., 2015). In Chinese, lexical tone (*tone* hereafter) involves variations in fundamental frequency (F0) within a syllable (Yip, 2002). For instance, the syllable /sə/ can have at least six different meanings based on tone, such as /sə1/ □ for “bad,” /sə2/ □ for “water,” /sə3/ □ for “tax,” /sə4/ □ for "who,” /sə5/ □ for “marrow,” and /sə6/ □ for “sleep.” Acoustically, musical pitch requires more precise F0 perception compared to tone. Even a small deviation of 1 semitone in music can result in a noticeably off-key note, whereas Chinese tones typically differ by an average of 2 to 7 semitones (Patel, 2011; Yiu, 2013). According to the OPERA hypothesis, music training that places a high demand on processing musical pitch would enhance the neural F0 sensitivity of musically trained individuals, subsequently improving their tone perception (Patel, 2011, 2014). Indeed, an RCT demonstrated that six months of piano training increased the neural sensitivity of Mandarin children to tones (Nan et al., 2018). Furthermore, musically trained children surpassed musically untrained children in Chinese tone

awareness (Choi et al., 2025). This finding implied that music training may improve tone awareness.

Critical to the **tone awareness account** is the role of tone awareness in Chinese word reading. In a previous study, tone awareness was found to predict Chinese word reading concurrently, even after controlling for chronological age, non-verbal intelligence, speeded naming, and phonological awareness (McBride-Chang et al., 2008). This finding was corroborated in a later study that additionally controlled for receptive vocabulary (Yeung & Ganotice, 2014). Furthermore, in another study, tone awareness was shown to correlate with Chinese word reading and could even differentiate children with dyslexia from those without (Wang et al., 2017). Given its associations with musical pitch and Chinese word reading, we hypothesized that Cantonese tone awareness serves as a mediator in the relation between music perception and Chinese word reading (see Figure 1).

The Current Study

Collectively, the two theoretical accounts propose two different mediators (phonological awareness and tone awareness) that connect music perception with Chinese word reading in musically trained children. For each account to hold, the musically trained children should outperform the untrained children on both Chinese word reading and the mediator. Moreover, the mediator should significantly mediate the relation between music perception and Chinese word reading in the musically trained children.

In our view, the two theoretical accounts need not be mutually exclusive. Specifically, phonological and tone awareness could both mediate the relation between music perception and Chinese word reading. To holistically ascertain these potential mediators, we employed path analysis. If both accounts were supported, we would further evaluate their relative weights to identify the mediator which plays a heavier role. By examining the phonological awareness account, we can yield potential evidence for extending PATH and related hypotheses to the Chinese writing system. Similarly, exploring the tone awareness account would allow for the development of a model tailored to tone languages. A holistic evaluation would provide insights into which accounts are more influential in elucidating the relations between music perception and Chinese word reading in musically trained children.

In short, the current study was motivated by the two research questions below:

1. Would musically trained children outperform musically untrained children in Chinese phonological awareness, tone awareness, and word reading?

2. What are the relative mediating roles of phonological and tone awareness in the relation between music perception and Chinese word reading in musically trained children?

Methods

Participants

We recruited 86 Chinese children (mean age = 4.95 years old, *SD* = .73 year) from local kindergartens in Hong Kong. There were 48 boys and 38 girls. In Hong Kong, formal reading instruction typically begins at kindergarten when children are around 4 to 5 years old. We targeted this age group because they are at the early stage of reading instruction, and phonological and tone awareness are more important for Chinese word reading in early readers than in advanced readers (Choi et al., 2018; McBride-Chang et al., 2008).

Based on the effect size reported in a previous study (Bhide et al., 2013), we conducted a priori power analysis with G*Power to estimate the sample size. With the significance level set as .05, a sample size of 86 was required to detect the between-group difference in word reading with 80% power. The inclusion criteria were (1) learnt Cantonese Chinese as a mother tongue, (2) living in Hong Kong, and (3) had never lived abroad. The exclusion criteria were having an on-going diagnosis or history of (1) speech, language, and hearing difficulties, (2) dyslexia, and (3) neurodevelopmental disorders.

The study was approved by the Human Research Ethics Committee of The University of Hong Kong. Prior to data collection, parents gave written consent and filled out a music background questionnaire for their children.

Based on their prior music learning experience, we classified the children as musically trained children (n = 43) and musically untrained children (n = 43). Based on established criteria, we defined musically

trained children as children who had been receiving at least six months of continuous instrumental music training outside school (Choi et al., 2025). In our musically trained group, 42 children received more than 12 months of music training (M = 22.32 months, SD = 15.12 months) and one child received nine months of music training. On average, they started receiving music training at 3.62 years old (SD = .91 year). The musically untrained children had never received any form of music training other than regular music lessons at their kindergartens.

While we surveyed all children's family income, due to ethical reasons, parents were given an option not to disclose. Among the 70% of children whose parents who had chosen to disclose, the musically trained children (n = 28) and musically untrained children (n = 32) did not differ significantly in their family income, p = .402.

Procedure

Each child was tested individually by a research assistant in a quiet room at a local kindergarten or our university. The research assistant had a Bachelor degree in Linguistics, with experience working with children. The order of task presentation was counterbalanced across children. All audio stimuli were presented at a comfortable volume via children size headphones. Recesses were given between the tasks. After study completion, the children received a certificate and 50 HKD book coupon. All study materials are available online at https://osf.io/dpum9/?view_only=f29c0540df804c6885d47cc0c40c762a

Tasks

Word Reading

We adopted a modified version of the Chinese word reading task (McBride-Chang et al., 2004). The task contained 30 monosyllabic words and 25 di-syllabic words that were chosen from Hong Kong kindergarten books (see Table 1). The words were arranged with increasing difficulty. Children were asked to read aloud each word. The experimenter judged whether each word was accurately pronounced, without providing feedback to the child. A trial was considered incorrect if children provided null response, or pronounced it with any wrong or missing phoneme and/or tone. One point was given for each correct trial and no point was given for incorrect trials. The percentage accuracy was calculated by dividing the number of correct test trials by 55. Testing discontinued if children failed to read aloud 10 consecutive items. The internal consistency of this task was high with a Cronbach's alpha of .98.

Phonological Awareness

We adopted a modified version of the Chinese phonological awareness task (Choi et al., 2016). There were two subtasks: syllable deletion and onset phoneme deletion. The syllable deletion subtest consisted of 20 trials where children were asked to reproduce a trisyllabic word or pseudoword by omitting the first, second, or third syllable (e.g., say /pa1 si2 tsam6/ without /si2/). The onset phoneme deletion subtest had 10 trials where children were asked to reproduce a monosyllabic word or pseudoword without the onset phoneme (e.g., say /k^hai1/ without /k^h/). Tone matching was not required in these

subtasks as they focused on segmental information. Each subtask had two practice trials with feedback, and each correct test trial carried one point. The percentage accuracy was calculated by dividing the number of correct test trials by 30. The internal consistency of this task was high with a Cronbach's alpha of .96.

Tone Awareness

We used the odd-one-out task from a previous study (Cheng, 2018). On each trial, children were first presented with three monosyllabic words (e.g., /ma5/ /fa1/ /tsʰa1/). Then, they were asked to identify the word that had a different tone than the others (e.g., /ma5/). The task consisted of two blocks. In one block, the rhyme was the same within each trial (e.g., /ma5/ /fa1/ /tsʰa1/). In the other block, the rhyme was different within each trial (e.g., /ŋan5/ /pɔ1/ /jy5/). The task began with four practice trials that provided feedback, followed by 36 test trials with no feedback. Each correct test trial was awarded one point. The percentage accuracy was calculated by dividing the number of correct test trials by 36. The internal consistency of this task was satisfactory, with a Cronbach's alpha of .72.

Music Perception

We adopted the abbreviated version of the Montreal Battery of Evaluation of Musical Abilities, with the melody and the rhythm subtests (Peretz et al., 2013). In the melody subtest, each trial contained two melodic phrases with a 1500ms interstimulus interval (ISI). After listening to the two melodic phrases, children judged whether the two

phrases were identical or different. On each “different” trial, the second melodic phrase preserved the original key of the first phrase, except with an out-of-key note, a changed note that changed the pitch direction of the surrounding intervals, or a changed note that altered intervals.

The rhythm subtest had a similar procedure as the melody test. On each different trial, the rhythm of the second rhythmic phrase was altered by changing the durations of two adjacent notes, but with the number of notes and original meter preserved. The stimuli of the melody and rhythm subtests can be heard on OSF (https://osf.io/dpum9/?view_only=f29c0540df804c6885d47cc0c40c762a). In each subtest, there were three practice trials with feedback provided and 20 test trials without feedback. Each correct test trial was given one point. The percentage accuracy of each subtest was calculated by dividing the number of correct test trials by 20. The internal consistency of this task was fairly satisfactory, with a Cronbach’s alpha of .60.

Results

Our first research question was whether musically trained children would outperform musically untrained children on Chinese phonological awareness, tone awareness, and word reading. We conducted a one-way MANOVA with Chinese phonological awareness, tone awareness, and word reading as the dependent variables and group (musically trained and musically untrained) as the between-subjects factor. The overall main effect of group was significant, $\Lambda_{Wilks'} = .81$, $F(3, 82) = 6.35$, $p = .001$, $\eta_p^2 = .19$. Specifically, musically trained children outperformed

musically untrained children on phonological awareness, $F(1, 84) = 13.77$, $p < .001$, $\eta_p^2 = .14$, tone awareness, $F(1, 84) = 4.36$, $p = .040$, $\eta_p^2 = .05$, and word reading, $F(1, 84) = 15.53$, $p < .001$, $\eta_p^2 = .16$ (see Table 2).

Next, we ascertained the relative mediating roles of phonological and tone awareness in the relation between music perception and Chinese word reading in musically trained children. Specifically, path analysis was conducted to examine the relations among music perception (musical rhythm and pitch perception), phonological awareness, tone awareness, and Chinese word reading using maximum likelihood estimation. The hypothesized model included direct effects from music perception to phonological and tone awareness and from these mediators to Chinese word reading. Model fit was assessed using Chi-square (χ^2), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA).

The path model demonstrated a good fit to the data: $\chi^2(3) = 3.55$, $p = .315$, CFI = .99, RMSEA = .07 (see Figure 2). Music perception significantly predicted phonological awareness (standardized $\beta = .75$, $p = .045$) and tone awareness ($\beta = .59$, $p = .037$). Phonological awareness, in turn, significantly predicted Chinese word reading ($\beta = .69$, $p < .001$). However, tone awareness did not significantly predict Chinese word reading ($\beta = -.10$, $p = .454$). Additionally, musical rhythm perception ($\beta = .46$) and musical pitch perception ($\beta = .51$) significantly predicted phonological awareness, $ps < .05$. Analysis of indirect effects indicated

significant mediation through phonological awareness. Specifically, both musical rhythm and pitch perception indirectly influenced Chinese word reading through phonological awareness (standardized total indirect effect $\beta = .46$, $p < .05$). In contrast, the indirect effect through tone awareness was not significant.

Discussion

Our goal was to investigate whether and how music training improved Chinese word reading. Consistent with our hypothesis, the musically trained children outperformed the untrained children on Chinese word reading. As the musically trained and untrained children had similar family income, the musical advantage was unlikely due to increased educational resources. Extending previous studies which focused on alphabetical languages, our quasi-experimental evidence suggests that music training may improve word reading in the logographic writing system specifically Chinese (Bhide et al., 2013; Moreno et al., 2009). When learning written Chinese words, children need to establish phonological and orthographic representations and form interconnections between them (Perfetti et al., 2005). To accurately read aloud a written word, children need to have an accurate and stable phonological representation of the word (Perfetti & Hart, 2002). As reasoned below, we believe that musically trained children excel in this aspect compared with musically untrained children.

Supporting the phonological awareness account, our results yielded a mediation model in which phonological awareness mediates the

relation between music perception and Chinese word reading in musically trained children. The findings suggested that musical training enhances Chinese word reading primarily through its positive impact on phonological awareness, rather than through tone awareness (Loui et al., 2011; Patscheke et al., 2019; Tierney & Kraus, 2014). Among the musically trained children, musical rhythm perception predicted phonological awareness, in turn predicting Chinese word reading. This finding is fully consistent with PATH, which attributes phonological awareness improvement to musical rhythmic activities which demand more precise timing perception than speech (Tierney & Kraus, 2014). With better phonological awareness, musically trained children are able to form more accurate phonological representations, facilitating word reading (Perfetti & Hart, 2002; Perfetti et al., 2005). Importantly, we found that besides rhythm, musical pitch perception also predicted phonological awareness in the musically trained children. As described in the Introduction, the two possible reasons are enhanced phoneme perception and speech segmentation (Loui et al., 2011; Ziegler et al., 2012). Our findings extend PATH by suggesting that both musical rhythmic and pitch activities may improve phonological awareness and lead to gains in Chinese word reading.

However, our findings do not support the tone awareness account. As expected, the musically trained children outperformed the untrained ones in Chinese tone awareness. This extends OPERA by suggesting that music training not only facilitates perception but also the metalinguistic

ability to extract and differentiate the tonal information of syllables (Burnham et al., 2011; Tong et al., 2015). However, as far as we are concerned, improving their tone awareness seemed to have little bearing on Chinese word reading. This finding contradicts previous studies on musically untrained children (McBride-Chang et al., 2008; Yeung & Ganotice, 2014). Worthy to note, tone awareness did not significantly predict Chinese word reading even in our musically untrained children. Thus, it is unlikely for the result discrepancy to arise from population differences (i.e., musically trained versus untrained). Instead, we believe that task nature differences led to the result discrepancy. The previous studies adopted the tone detection and discrimination tasks to measure tone awareness (McBride-Chang et al., 2008; Yeung & Ganotice, 2014). Strictly-speaking, these tasks assessed the perception of tone rather than the *metalinguistic* awareness of tone (Tong et al., 2015). While tone perception was found to be related to word reading (Zhang & McBride-Chang, 2010), our study has not found any support that tone awareness contributed to Chinese word reading.

In the theoretical context of testing the two accounts, our study suggests that the phonological awareness account suffices for explaining the potential effect of music training on Chinese word reading. In particular, there is little need to propose an additional account involving tone awareness. Supplementing the existing studies in the alphabetical writing system (Loui et al., 2011; Patscheke et al., 2019), our study in the Chinese writing system further suggested the universality of the

phonological awareness account. Moreover, our results supported the applicability of PATH to Chinese children (Tierney & Kraus, 2014). However, our study also reflected the role of musical pitch perception in improving phonological awareness, indicating that the rhythmic-based PATH alone may not fully account for the effect of music training on phonological awareness.

With the phonological awareness account now established, it would be worthwhile to explore other potential accounts. In music theory classes, children need to form symbol-to-sound associations when learning how to read musical symbols. When playing musical instruments, musically trained children continuously utilize symbol-to-sound associations to retrieve the auditory information (e.g., one quarter of the duration of a whole note) from the symbols (e.g., ♩). To read aloud a written word, children needed to utilize word-to-sound association to access its phonological representation (Perfetti & Hart, 2002; Perfetti et al., 2005). It is possible that the ability to form and utilize symbol-to-sound associations is transferrable from the music domain to the language domain. Future studies can investigate whether the symbol-to-sound-association account co-exists with the phonological awareness account, and if so, ascertain their relative contributions to word reading.

There are three other ways to extend the current study. The quasi-experimental research design has restricted causal inference (Schellenberg, 2011). With initial evidence identified, we are launching a full-scale RCT to establish causal links between music training and

Chinese word reading. Second, as previous studies found syllable awareness and onset-rhyme awareness to predict Chinese word reading, we included these measures in our phonological awareness task (Chow et al., 2005; McBride-Chang et al., 2004; Tseng et al., 2023). To avoid fatigue of the young children we tested, we included only 30 trials in the task. Future studies can include more trials such that syllable awareness and onset-rhyme awareness could be analyzed separately (Herrera et al., 2011). This would provide a nuanced understanding of music-to-language transfer in relation to different phonological grain sizes. For example, music training may facilitate syllable awareness only, onset-rhyme awareness only, or both, and these skills may predict word reading differently. Finally, about 30% of the parents refused to disclose their family income. Excluding their children from our sample would have rendered the statistical power inadequate for the data analyses. Future studies can explore the possibility of using a proxy variable that reliably reflects family income.

In conclusion, musically trained children outperformed the untrained children on Chinese word reading. This quasi-experimental finding supports the possibility that music training can improve Chinese word reading in typically developing children. Consistent with PATH and OPERA, musically trained children had better phonological and tone awareness than musically untrained children (Patel, 2011, 2014; Tierney & Kraus, 2014). Importantly, we found phonological but not tone awareness to mediate the relation between music perception and word

reading. These findings provide some initial evidence of the underlying intervention mechanism: music training improves Chinese word reading via enhancing phonological but not tone awareness. From a theoretical perspective, this study offers initial evidence for extending the phonological awareness account and PATH to tone languages and the logographic writing system. With quasi-experimental evidence now identified, it would be worthwhile to test causality with an RCT. Lastly, future studies are needed to explore other potential accounts, such as the symbol-to-sound-association account.

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Author Contributions

WC wrote the main manuscript text and VKWL conducted the main data analysis. SK and AB provided intellectual feedback. All authors reviewed the manuscript.

Data Availability Statement

All study materials, data, and analysis codes are available online at https://osf.io/dpum9/?view_only=f29c0540df804c6885d47cc0c40c762a

Additional Information

The authors declare no competing interests.

Table 1

Chinese Word Reading List

□	□	□	□	□
□	□	□	□	□
□	□	□	□	□
□	□	□	□	□
□	□	□	□	□
□	□	□	□	□
□□	□□	□□	□□	□□
□□	□□	□□	□□	□□
□□	□□	□□	□□	□□
□□	□□	□□	□□	□□
□□	□□	□□	□□	□□

Note. The wordlist started from left to right, and top to bottom.

Variable	**Overall (*SD*)**	**Musically trained (*SD*)**	**Musically untrained (*SD*)**	**Group difference**
Word reading	51.64 (34.28)	65.10 (30.87)	38.18 (32.46)	T > UT***
Phonological awareness	56.70 (30.65)	68.14 (27.97)	45.27 (29.18)	T > UT***
Tone awareness	37.53 (14.05)	40.63 (16.11)	34.43 (10.96)	T > UT*
Chronological age	4.95 (0.73)	5.08 (0.77)	4.83 (0.66)	T = UT

Table 2

Means and Standard Variations of all Variables

Note. The maximum possible task scores were 100. T = musically trained; UT = musically untrained; $^{***}p < .001$; $^{*}p < .05$.

Figure 1

The Conceptualized Model Explaining the Relation between Music Perception and Chinese Word Reading in Musically Trained Children

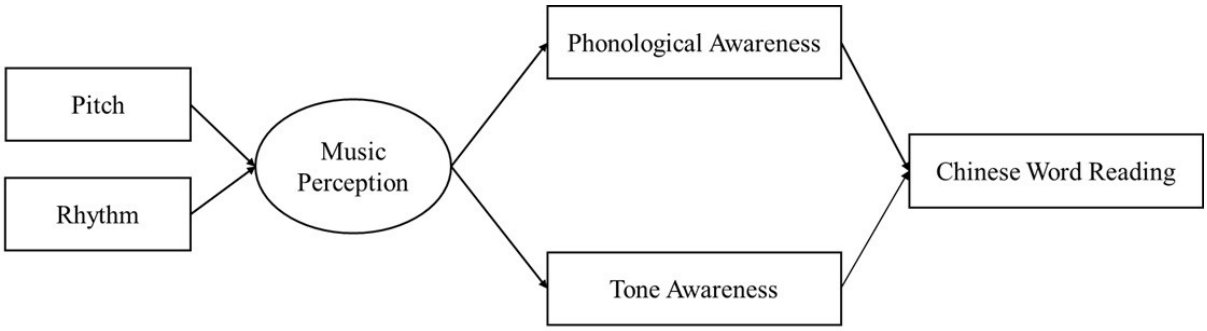
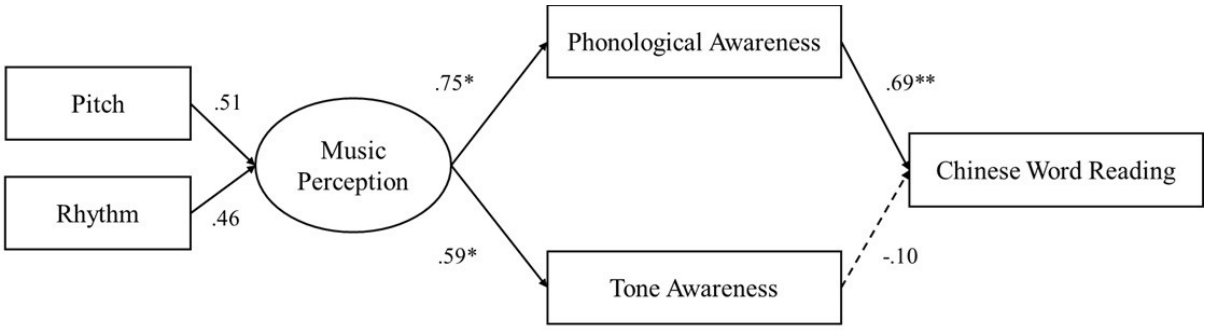


Figure 2

The Path Model Explaining the Relation between Music Perception and Chinese Word Reading in Musically Trained Children



Note. $^{*}p < .05$; $^{**}p < .01$. Residual terms are omitted for clarity. Significant paths are indicated by solid lines; insignificant paths are indicated by dashed lines.