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# The Effects of Musical Aptitude and Musical Training on Phonological Production in Foreign Languages

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**Abstract**

This study investigates 128 Chinese college students to examine the effects of their musical aptitude and musical training on phonological production in four foreign languages. Results show that musically-trained students remarkably possessed stronger musical aptitude than those without musical training and performed better than their counterpart in foreign language suprasegmental production. Students of high musical aptitude performed significantly better in suprasegmental production and Russian production as compared with those of low musical aptitude. Musical aptitude could exert some effects on foreign language phonological production. With the music-phonology link confirmed in this study, pedagogical implications for teaching and learning of foreign language phonology are discussed.

**Keywords:** phonological production, foreign languages, musical aptitude, musical training

## 1. Introduction

The origin of human language is a hotly debated issue; for its explanation a range of theories have been posed, e.g., the pooh-pooh theory, bow-wow theory and yo-he-ho theory. Aitchison (2000) illustrated the musical origin of language, which posits that language could have begun with whole melodies rather than with single words. The connection between music and language could trace back to the 18th-century French philosopher Rousseau, who suggested that languages originate from music and the first languages were singable and passionate before they became simple and methodical. The 19th-century German philosopher and linguist Humboldt argued that there may well have been no wandering horde in any desert that did not already have its own songs, for man, as a species, is a singing creature (ibid., pp. 101-102). More recently, Vaneechoutte and Skoyles (1998) put forward a "musical origin of language" hypothesis and elaborated it with two arguments. On the one hand, human beings are musical or singing primates. The ability to sing provides the physical apparatus and neural respirational control that is now used by speech. On the other, speech acquisition depends more upon the Music-Acquiring Device than upon the Language Acquisition Device. Infants identify word beginnings by listening to the melody of stresses and tones and to the rhythmic and intonational cues in speech. In conclusion, musicality and singing capacity underlie both the evolutionary origin of human language and its development during early childhood.

To attest the music-language link, researchers in the fields of language acquisition, psychology and neuroscience have undertaken empirical studies (e.g., Callender, 2007; Dankovičová et al., 2007; Lee & Hung, 2008; Pastuszek-Lipińska, 2004; 2008; Slevc & Miyake, 2006) examining the relations among musical aptitude, musical training and phonology. Their work, however, is still inadequate in three aspects and thus leaves room for improvement.

1) The number of participants in most studies was relatively small, and moreover, few studies took native speakers of Chinese as an independent population. For example, Knickerbocker (2007) investigated a small sample of 22 participants; among them just about ten were recruited from Taiwan and mainland China.

2) The operational definition of musical aptitude was incomplete. Musical aptitude is a measure of one's potential for music learning and the foundation of music achievement (Gordon, 1997, p. 25). In most music-phonology studies, it was limited to receptive musical aptitude. For one thing, ready-made standardized tests only measure receptive musical aptitude. Researchers in hope of assessing productive musical aptitude need to design a special test, which would be demanding. For another, administration of a productive musical aptitude

test is time-consuming. A productive test has to be given to an individual in each session whereas the receptive test can be administered to large populations all at once. Given an asymmetry between perception and production in measuring musical aptitude, investigation of musical aptitude without the inclusion of productive domain is insufficient for presenting a panorama of musical aptitude of the participant.

3) Though musical aptitude and musical training have figured in literature, studies seldom took both of them into account to investigate their mutual relationship and their separate contributions to phonology acquisition.

In order to rise above the aforesaid limitations, this study aimed to reveal the interrelationship between musical aptitude and musical training as well as their effects on phonological production in foreign languages with a sample of Chinese college students. The operational definition of musical aptitude was broadened to subsume both participants' perceptual capacity of discriminating tonal and rhythm patterns and their productive capacity of imitating tonal and rhythm patterns from immediate memory. Phonological production was operationally delimited as how well participants could imitate short sentences in four foreign languages other than English at segmental and suprasegmental levels.

## 2. Method

### *2.1 Research questions*

1) Are there any significant differences between musically-trained and non-musically-trained college students of China in terms of their musical aptitude?

2) Do students with and without musical training significantly differ in their phonological production of four foreign languages (French, German, Russian, and Japanese)?

3) Do students on varying levels of musical aptitude significantly differ in phonologically producing the four foreign languages?

4) To what extent can musical aptitude and musical training affect students' phonological production of the foreign languages?

### *2.2 Participants*

Our original sample comprised 171 1st-year college students from Nanjing Agricultural University (NAU) and Southeast University (SEU), two universities in Nanjing, China. Nevertheless, 43 of them were later excluded from data analysis because of failing to complete the whole set of music and phonology tests, which is to be mentioned in the next part, or having learned at least one of the four foreign languages under study. Therefore, 128 participants constituted the valid sample for this study. They were all Chinese native speakers of normal hearing and right-handedness, aged from 18 to 21 years ($M$ = 19.20). Among them, 39 were males (30.5%) and 89 females (69.5%); 44 were English majors and 84 were non-English majors specializing in music and performance ($N$ = 23) or other areas such as finance and urban planning ($N$ = 61).

### *2.3 Instruments*

#### 2.3.1 Questionnaire

The questionnaire elicited demographic information from the participants including name, chronological age, gender, university, major, hearing status, and handedness. More importantly, it asked participants to self-report:1) their experiences with foreign languages: what foreign languages other than English they had picked up or learned, 2) their amount of musical training: how many hours (entire courses or portions of class time) they had spent in overt musical training or typically dedicated to musical improvement; and 3) their musical experiences covering ways of musical training (i.e., attending music lessons at school, joining in school choir or band, taking training lessons at school or at professional music institutions), content of musical training (i.e., vocal or instrumental), and whether they had taken music grading tests or entered for music contests.

#### 2.3.2 Receptive Musical Aptitude Test

The test for use was the Advanced Measures of Music Audiation (AMMA), a standardized test that chiefly measures the stabilized musical aptitude of high school and university students with or without a musical background (Gordon, 1989). Although it is intended for testees from western cultures, studies (e.g., Chuang, 1997) have proven its high reliability and concurrent validity for Taiwanese and Korean students and, therefore, its applicability to oriental students.

Among the 20-odd dimensions of musical aptitude, the two dimensions having the greatest bearing on music learning are tonality and rhythm (Gordon, 1987). The AMMA comprised 30 items, measuring the perception of tonality and rhythm. Each item was made up of two short musical phrases, similar or dissimilar to each other. If

the two phrases were dissimilar, they may differ either by one or more tones or by one or more rhythms.

2.3.3 Productive Musical Aptitude Test

This test was from Pei and Ting (2013), consisting of two subtests to measure the production of tonality and rhythm respectively. On the tonality subtest were 3 tonal patterns with rhythm controlled. The tonal patterns contained three, five and seven notes representing three difficulty levels. On the rhythm subtest were 3 rhythm patterns, where tonality remained constant. The rhythm patterns each matched a particular simple time signature, viz., 2/4, 3/4, and 4/4. *Praat 4.4.20* was employed to limit the duration of each musical pattern to 5 seconds, an upper limit of the short-term memory span suggested by Fraisse (1984), without distorting its tonal and rhythm features. The staves for two instances are attached in Figure 1.

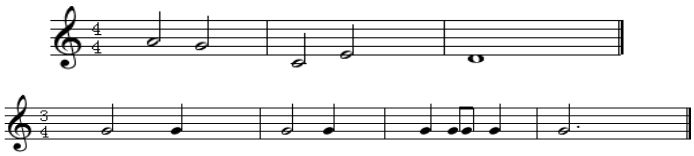

Figure 1. Staves for a tonal pattern (5-tone) and a rhythm pattern (3/4)

2.3.4 Foreign Language Imitation Test

The test was meant to assess participants' ability to imitate short sentences in three European languages (French, German, and Russian) and one Asian language (Japanese). According to the literature of classical rhythm typology (Ramus, 2000; Rouas et al., 2005), the four languages belong to three rhythmic groups. Japanese is known as a mora-timed language; French is syllable-timed while German and Russian are stress-timed.

For each language we selected five sentences from college textbooks, assisted by four experienced lecturers who obtained a Master's degree in linguistics and literature and had taught each of these foreign languages at NAU for a decade or so. The 20 sentences in total covered varied intonations and sentence types (i.e., declarative, exclamation, imperative, yes-no question, and wh-question). They were rather short, lasting 2.6 seconds at most and within the span limit of short-term memory. See the examples in Table 1. Their corresponding audio files were extracted and synthesized with *Adobe Audition 3.0* such that a short pause was inserted between two repetitions of each sentence and a longer pause was left after each sentence for participants to imitate.

Table 1. Example sentences for participants to imitate in the study

| Foreign language | Sentence | English version |
|---|---|---|
| French | Je ne chante pas. | I don't sing. |
| German | Das schmeckt gaz gut! | How delicious! |
| Russian | Где станция метро? | Where is the subway station? |
| Japanese | これはわたしのです。 | This is mine. |

*2.4 Data Collection*

Our data were collected in two sessions from March through December in 2015. The first session, which lasted approximately half an hour, was organized during regular class hours. Participants took the receptive musical aptitude test and the survey. Before the music test, they were introduced to the concepts of tonality and rhythm and given practice. While listening to each music item, which was played once only, they marked answers on the response sheet. Prior to the survey, participants were instructed about how to estimate the amount of their musical training. They could raise doubts about the items when filling out the questionnaire.

The second session took place outside class in a quiet location. Before that, we had tailored appointment times so that participants need not skip any class for testing. Every participant took the productive musical aptitude test and the foreign language imitation test for about 10 minutes. Music patterns were played twice. The participant reproduced a tonal pattern by singing *la la la* and beat time of a rhythm pattern by singing *da da da*. Each sentence on the phonology test was also played twice. For the purpose of playing the productive stimuli and recording the student performance, we used a laptop with *Adobe Audition 3.0* installed to it.

*2.5 Data Analysis*

2.5.1 Scoring of Tests

1) Scoring of the receptive musical aptitude test

Response sheets to the test were manually scored with two sets of scoring masks enclosed in the AMMA testing kit: one for deriving the tonal score (labeled T1 and T2) and the other for the rhythm score (labeled R1 and R2). The first of each set of scoring masks (T1 and R1) was to identify the number of correct responses, while the second of each set (T2 and R2) highlighted the incorrect ones. To adjust the raw scores, a constant of 20 was added to the correct number of responses and then the number of incorrect responses was subtracted from that total. For instance, the score for tonality is obtained with the formula: (T1 score + 20) – T2 score. Scoring over, the test yielded separate scores for tonality and rhythm perception.

2) Scoring of the productive musical aptitude test

A music professor working at NAU evaluated productive music samples. There were 15 tones on the tonality subtest and 12 bars on the rhythm subtest. Each tone and bar, if accurately reproduced, was awarded three points. In scoring tonal production, the rater disregarded inaccurate production of rhythm, and vice versa. Scoring over, the test yielded separate scores for tonality and rhythm production.

3) Scoring of the foreign language imitation test

The four lecturers who helped us design the test materials rated phonology samples from segmental and suprasegmental perspectives, namely, to what extent the participant articulated speech sounds (vowels and consonants) and resembled native speakers in overall prosodic features (e.g., intonation, rhythm, and stress), both on a 5-point scale. As participants were required to imitate five sentences in each foreign language, they got five ratings on segments and on suprasegments as well. The five ratings on segments were averaged to yield the final score for segmental production in a certain language. The same procedure was repeated for calculating the final score of suprasegmental production in that language.

2.5.2 Statistical Procedures

After the music and phonology tests were evaluated, the scores of each participant were typed into the computer. Separate scores for tonality and rhythm perception as well as production were added up to produce a composite score reflecting his or her musical aptitude. Based on his or her scores of segmental and suprasegmental production for each foreign language, 7 composite scores were obtained including scores on French production, German production, Russian production, Japanese production, foreign language segmental production, foreign language suprasegmental production, and foreign language phonological production reflecting his or her overall phonological competence in production. Afterwards, the participant's amount of musical training surveyed on the questionnaire, coupled with his or her information pertinent to musical experiences, was keyed into the computer. Finally, the statistical package of *SPSS 16.0* was run to perform descriptive analysis, independent samples t-test, one-way ANOVA, correlation analysis and regression analysis as well.

## 3. Results and Discussion

*3.1 Results*

Q1: Are there any significant differences between musically-trained and non-musically-trained college students of China in terms of their musical aptitude?

Of the 128 participants, 61 had received musical training, whereas 67 had not. Musically-trained students primarily attended music lessons at school (65.6%) and/or training courses provided by music institutions (54.1%); 59.0% of them received vocal training and 80.3% got instrumental training; nearly half of them once took part in a music grading test (49.2%) and won prizes in music contests of different levels (44.3%). Descriptive statistics showed that the musically-trained group possessed stronger musical aptitude ($M$ = 124.95) than its counterpart ($M$ = 104.24). Subsequent independent samples t-test spotted a statistically significant difference between the two groups in musical aptitude ($t$ = 6.687, $p$ = .000, 2-tailed).

Q2: Do students with and without musical training significantly differ in their phonological production of four foreign languages (French, German, Russian, and Japanese)?

Independent samples t-test was run again to check out whether receiving musical training or not could result in between-group variations. Results in Table 2 demonstrated that on average the musically-trained group was scored higher than the non-musically-trained group in seven aspects of production. For example, the mean of foreign language phonological production for the former group was roughly 1.04 higher than that for the latter

group, as indicated in the column of "mean difference". However, the statistically significant between-group difference only emerged in foreign language suprasegmental production. In other words, musically-trained students performed significantly better than those not trained in music in suprasegmental production of the four foreign languages.

Table 2. Differences in foreign language phonological production between musically- and non-musically-trained groups

| | Levene's Test for Equality of Variances | | t-test for Equality of Means | | |
|---|---|---|---|---|---|
| | F | Sig. | t | Sig. | Mean Difference |
| Foreign language phonological production | 2.953 | .088 | 1.931 | .056 | 1.03651 |
| Foreign language segmental production | 3.695 | .057 | 1.444 | .151 | .41380 |
| Foreign language suprasegmental production | 1.981 | .162 | 2.287 | .024* | .62271 |
| French production | 2.115 | .148 | .915 | .362 | .18483 |
| German production | .206 | .651 | 1.562 | .121 | .31838 |
| Russian production | 1.373 | .244 | 1.713 | .089 | .37915 |
| Japanese production | 2.974 | .087 | 1.528 | .129 | .15415 |

Q3: Do students on varying levels of musical aptitude significantly differ in phonologically producing the four foreign languages?

Judging from descriptive statistics, participants varied considerably in their profile of musical aptitude, with scores ranging from 47 to 151 ($M$ = 114.11). In order to examine the relation between the total score of musical aptitude and that of foreign language phonological production, Pearson correlations were preformed, finding that the two were positively correlated and the correlation was significant at the 0.01 level ($r$ = . 281, $p$ = .001).

With the scoring results of musical aptitude, we divided participants into three groups, i.e., low-, medium- and high-musical-aptitude groups, and then performed one-way ANOVA to test possible discrepancies among them. The results of F test in this ANOVA were found to be significant: suprasegmental production ($F_{(2, 125)} = 3.405$, $p$ = .036) and Russian production ($F_{(2, 125)} = 3.558$, $p$ = .031) differed significantly based on group. To ascertain between which specific groups there was a significant difference in either suprasegmental or Russian production, we looked at the results of Scheffe post hoc test recapitulated in Table 3. In matters of suprasegmental production, low-musical-aptitude students were observed, on average, to have 0.351 fewer scores than medium-musical-aptitude students and 0.963 fewer scores than high-musical-aptitude students. Nevertheless, the significant difference was only found between low and high groups ($p$ = .039). Similarly, high-musical-aptitude students also performed better than medium- and low-musical-aptitude students in regard to Russian production, but the significant difference only emerged between low and high groups ($p$ = .043). To summarize, two results significant at the .05 level were found. Students of high musical aptitude had significantly higher levels of suprasegmental production and Russian production as compared with those of low musical aptitude.

Table 3. Differences in foreign language phonological production across low-, medium-, and high-musical-aptitude groups

| Dependent Variable | (I) Group | (J) Group | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Suprasegmental production | Low | Medium | -.35111 | .32367 | .557 | -1.1530 | .4507 |
| | | High | -.96319 | .37301 | .039* | -1.8873 | -.0391 |
| | Medium | Low | .35111 | .32367 | .557 | -.4507 | 1.1530 |
| | | High | -.61208 | .33607 | .195 | -1.4447 | .2205 |
| | High | Low | .96319 | .37301 | .039* | .0391 | 1.8873 |
| | | Medium | .61208 | .33607 | .195 | -.2205 | 1.4447 |
| Russian production | Low | Medium | -.17889 | .26044 | .790 | -.8241 | .4663 |
| | | High | -.76181 | .30015 | .043* | -1.5054 | -.0182 |
| | Medium | Low | .17889 | .26044 | .790 | -.4663 | .8241 |
| | | High | -.58292 | .27043 | .102 | -1.2529 | .0870 |
| | High | Low | .76181 | .30015 | .043* | .0182 | 1.5054 |
| | | Medium | .58292 | .27043 | .102 | -.0870 | 1.2529 |

Q4: To what extent can musical aptitude and musical training affect students' phonological production of the foreign languages?

To discover whether musical aptitude and musical training could affect foreign language phonological production, stepwise multiple linear regressions were performed. For the sake of comparison, participants' gender and age were also submitted to analysis. Gender as a categorical variable was transformed into a dummy variable beforehand. As a result, two variables entered the regression model (Table 4).

Table 4. Regression model on foreign language phonological production and its predictors

| Step | Independent variable | R | R square | R square change | F value | Final Beta |
|---|---|---|---|---|---|---|
| 1 | Musical aptitude | .281 | .079 | .079 | 10.793** | .272** |
| 2 | Gender | .338 | .114 | .035 | 8.063** | .188* |

Note: $^{*}p < .05$, $^{**}p < .01$.

The model accounted for about 11% of the variance in foreign language phonological production. Musical aptitude entered first into the model, significantly accounting for 8% of its variance. Gender entered in Step 2, accounting for additional 3.5% of the variance. Obviously, musical aptitude accounted for more variance than did gender and was most predictive of foreign language phonological production. Comparison of the final (post-Step 2) standardized beta weights further highlighted the relative importance of musical aptitude, which had a larger beta weight ($\beta = .272$, $p = .002$). Musical aptitude could make a unique contribution to explaining foreign language phonological production. However, no significant effect for musical training on phonology production was found.

### *3.2 Discussion*

#### 3.2.1 Relationship between Musical Aptitude and Foreign Language Phonological Production

Our study indicated that musical aptitude could predict and affect foreign language phonological production by explaining its variance to a certain degree. Several previous studies also investigated via regression analysis if musical aptitude could explain any variance in English as a second or foreign language phonology. For instance, Slevc and Miyake (2006) discovered that musical aptitude assessed in receptive and productive domains was

able to explain 12% of the variance in English receptive phonology and 8% of the variance in English productive phonology. Sheppard et al. (2007) reported that the subjects' self-estimated singing ability, roughly equivalent to productive musical aptitude, accounted for 17% of the variance in English pronunciation ability.

Unlike the abovementioned studies, ours subsumed the suprasegmental level for scrutiny and revealed students of high and low musical aptitude to be significantly different in their suprasegmental production. This finding echoes with what prior literature has documented. For example, in Zybert and Stępień's (2009) study, the Polish secondary school students with greater musical aptitude performed much better in discriminating and imitating English intonation patterns than did their counterpart. In China, Pei and Ting (2013) surveyed 214 university non-English majors for the first time and found significant differences in English phonology between students of high and low musical aptitude. The global effects of musical aptitude on English phonological skills primarily manifested themselves on suprasegmental level and in productive domain. Once again, our study verified the role musical aptitude plays in suprasegmental production. For this, we bring up two explanations.

One explanation is that suprasegmental features and music are objectively similar, both drawing upon the same acoustic parameters such as fundamental frequency, amplitude, and duration. The former is usually compared to melodies of a language. Students with high receptive musical aptitude have auditory acuity which may be transferred to assist them in perceiving and discriminating the prosodic cues embedded in a language. Peynircioğlu et al. (2002) asserted that having a sensitive ear for music indicates sophisticated auditory pattern analysis skills, which seem to enhance sound manipulation in general, including the ability to manipulate linguistic sounds. Those who can recognize and analyze musical patterns are also likely to be better at analyzing verbal materials in detail. Patel (2008) further brought forth the notion of shared mechanisms for learning the sound categories of speech and music. That is, an individual's ability to form sound categories in one domain has some predictive power with regard to sound category learning in the other domain.

The other explanation is that suprasegmental features are predominantly processed by the right hemisphere where music is processed (e.g., Nathoo et al., 2005; Patel et al., 1998). With the application of electrophysiological neuroimaging techniques like PET and fMRI, accumulated evidence has disclosed that the dichotomy in lateralization of brain function is overly simplistic. While mainstream language functions (e.g., vocabulary and grammar) are often lateralized to the left hemisphere, prosodic language functions, such as intonation and accentuation, are predominantly processed by the right hemisphere. For most people, the left temporal lobe interprets the sound patterns that make up words, associating these patterns with meaning, while the right temporal lobe interprets musical patterns and also sound patterns that become music, or the changes in vocal quality that help to express emotions and intentions (Blackburn, 2003). To cite some studies, Nathoo et al. (2005) observed an epileptic patient in their fMRI study. During a word generation task, there was activation of the patient's left superior temporal gyrus situated in the left temporal lobe, and also the right superior temporal gyrus in the right temporal lobe. At operation during corticography of the right temporal lobe, no speech arrest or aphasic-semantic deficits were encountered despite the fMRI activations. However, the patient had dramatic loss of intonation and singing abilities. Besides, Patel et al. (1998) discovered that subjects who had impairments in musical discrimination and perception very often encountered similar impairments in discrimination and perception of linguistic prosody.

Our study also found that students of high and low musical aptitude were significantly different in Russian production. To probe into the reasons behind it, we conversed with the Russian lecturer and 8 students from NAU (5 females, 3 males; 3 English majors, 5 non-English majors). The lecturer told us that stress is a crucial aspect of Russian pronunciation. Participants who articulated stress improperly in reproducing the Russian sentences were apt to get low scores. From those students we knew that while they unanimously chose Japanese as the easiest foreign language to mimic, half of them regarded Russian and French as the most difficult to imitate. In daily life, students could be exposed to Japanese through Japanese anime or other channels, but had little contact with Russian or French. Besides, speech sounds of Russian and French were drastically dissimilar to those in Chinese; it was challenging for them to roll up the tongue so as to articulate retroflexes. Given that French and Chinese are syllable-timed languages, Russian, a language typologically different from Chinese, may cause greater difficulty to participants.

In light of the feedback obtained, we attempted to explain why musical aptitude functioned in Russian production in three ways. First, in Russian there are 7 intonational contours for use on various occasions and virtually no rules to dictate which syllable has to be stressed, so the same word pronounced with different stress positions can take multiple meanings (Li, 2011). Russian may have more in tune with music than the other three languages, and stronger musical aptitude may help students capture and produce rich musicality and suprasegmental features in Russian.

Second, both music production and foreign language pronunciation require motor skill on the part of the participants. Whether it be the productive musical aptitude test or the foreign language imitation test, participants should give full play to their motor skill. Motor skill refers to the muscular movements of the vocal organs, whereby the sounds of speech are made and through which thought, desire and attitudes are expressed (Cummings, 2005). In contrast with their counterpart, participants of strong productive musical aptitude had a flexible manipulation of vocal organs, which may aid them to correctly position their articulators involved in Russian production and facilitate their performance.

Third, considerable imitative ability underlies successful music production and Russian production. Purcell and Suter (1980) surveyed twenty variables for predicting which of them could determine success in mastering foreign language pronunciation. Aptitude for oral mimicry was a proven determinant. In this study strong productive musical aptitude implied a strong imitative ability, as participants did their utmost to orally imitate music patterns on the productive musical aptitude test. Therefore, participants with strong productive musical aptitude also had strong imitative ability, which may more or less help them cope with difficult Russian sentences. Actually, the association among productive musical aptitude, imitative ability and foreign language pronunciation has drawn attention from some researchers. Zybert and Stępień (2009) observed that some individuals were able to produce foreign languages thanks to their tremendous mimicry capability. Incidentally, these individuals were concurrently also musically gifted.

#### 3.2.2 Relationship between Musical Training and Foreign Language Phonological Production

In our study, although musical training failed to predict foreign language phonological production, musically-trained students had an advantage in suprasegmental production. Previously, a few studies explored the relationship between musical training and success in foreign language pronunciation. Pastuszek-Lipińska (2004, 2008), for example, initiated a research project where 106 native speakers of Polish were required to repeat the English sentence "May I help you?" and imitate phrases in six foreign languages: English, Belgian Dutch, French, Italian, Spanish, and Japanese. Results of t-test evidenced that musicians significantly outperformed non-musicians. Musically-trained people were perceived as more fluent and able to repeat more phrases and with fewer errors. However, Callender's (2007) presentation of two experiments, one involving 13 native speakers of English learning German, and the other involving 26 native speakers of Russian learning English, provided contrary results. Music education had no significant positive effect on foreign language pronunciation. Callender suggested that musical aptitude and learner level may be relevant confounding factors. Both studies mentioned above have potential problems with their choice of participants. Callender (2007) just investigated a small sample of participants, and those in Experiment 2 were excellent English teachers in their home countries, which may cause a ceiling effect. As to the participants in Pastuszek-Lipińska (2004), they had a wide age bracket (15-69) and varying levels of language competence. Our study guaranteed the homogeneous nature of participants, who were all college students in their freshman year, and revealed that the more musical training students get, the better they could perform in foreign language pronunciation, especially in suprasegmental production due to the similarity and shared processing mechanisms between music and suprasegmental features.

Musical training could facilitate phonology acquisition in that it improves adaptive plasticity of the brain, phonological awareness, and memory, among others (see Christiner & Reiterer, 2013; 2015; Lee & Hung, 2008; Marques et al., 2007). Human brain is functionally and structurally adaptable to environmental stimuli from musical training. There is generally a higher degree of plasticity in the brain of trained musicians. Modification of hemispheric lateralization may generate changes in both the auditory and motor areas of the brain. The sensitivity to discrepancies in pitch and rhythm resulting from musical training could translate into increased phonological awareness. With it, students are better able to perceive the unfamiliar speech of a foreign language, and are thus better able to produce it. Additionally, Ho et al. (2003) reported that children who received music instruction have greater verbal memory. Verbal memory is primarily controlled by the left temporal lobe which tends to be larger in musicians than in non-musicians.

#### 3.2.3 Relationship between Musical Training and Musical Aptitude

Our study pointed to a statistically significant difference between groups with and without musical training in terms of their musical aptitude. Earlier studies have attested to the training effects on musical aptitude. In Martin (1964), 130 American students from the 4$^{th}$ through the 12$^{th}$ grades were given musical training for 27 months. They were administered the Drake Musical Aptitude Tests before and after the training period. Results showed significant aptitude test score changes following musical training, thus indicative of some training effect. Schneider et al. (2002) afforded a scientific explanation of the training effects on the development of musical aptitude. The researchers played music tones of varying frequencies to three groups, i.e., professional musicians,

amateur musicians, and non-musicians, and then recorded and compared the processing responses in participant's primary auditory cortex. They found that a region of the primary auditory cortex called Heschl's gyrus was more active in professional musicians compared to amateur musicians and considerably more active than that of non-musicians. Professional musicians, who were of the greatest musical aptitude, had more grey matter and a larger size of Heschl's gyrus than other participants. Grey matter volume was the key parameter influencing the activation of the primary auditory cortex and Heschl's gyrus had an essential impact on musical aptitude.

## 4. Conclusion

As we are stepping into the era of global village, communications among nations become increasingly frequent. A number of college students in China are learning English and other foreign languages to be bilingual and even multilingual. In our study, 19 students were learning Korean as an optional course on university campus, and 3 had learned Italian. Considering that phonology is the cornerstone of oral communication, this study has following pedagogical implications for teaching and learning of foreign language phonology.

First, with the music-phonology link confirmed in this study, the value of music education should be fully appreciated. Musical aptitude is an interactive product of innate capacities and musical experiences. Parents and educators can expect to influence children's musical aptitude from their birth to their early age while it is still forming through immersing them in music. Music education started at the youngest possible age may facilitate foreign language phonology learning in due course. In daily practice, it is imperative for parents to immerse their children in rich musical environment and engage them in musical training programs and activities. Schools should integrate music into curricula and provide qualified music teachers, as teachers with no training in music are not equipped to provide the high-quality musical experiences necessary for pupils. Second, this study offers a new way to facilitate foreign language phonological instruction. Teachers may consider incorporating music elements in their classrooms. For example, Morgan (2003) recommended that teachers administer musical aptitude tests to assess their students prior to instruction, then group them and create an appropriate phonology learning program, i.e., music-oriented program for musically-endowed students and traditional phonetic transcription and corrective program for musically-challenged students. A melodic approach of this sort is at least a plausible educational alternative that enhances foreign language learners' awareness of sounds, rhythms, and intonations, etc.

Although the study extends the scope of previous research in several aspects, it is not without its limitations. In addition to musical aptitude, musical training as well as gender and age, which were submitted to regression analysis in our study, previous literature has identified other factors possibly contributing to phonology acquisition such as aptitude for oral mimicry. Those factors can also be included for analysis in future research. Besides, two raters had better be invited to evaluate participants' music and phonology samples for inter-rater reliability. There is thus a need for more refined studies along these lines to advance our understanding of the intricate relationships among musical aptitude, musical training and foreign language phonology.

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## References

Aitchison, J. (2000). *The seeds of speech: Language origin and evolution*. Cambridge: Cambridge University Press.

Blackburn, L. B. (2003). *Growing up with epilepsy: A practical guide for parents*. New York: Demos Medical Publishing.

Callender, C. (2007). Music and foreign language pronunciation. *Saarland Working papers in Linguistics*, *1*, 38-55.

Christiner, M., & Reiterer, S. M. (2015). A Mozart is not a Pavarotti: Singers outperform instrumentalists on foreign accent imitation. *Frontiers in Human Neuroscience*, *9*, 1-8. http://dx.doi.10.3389/fnhum.2015.00482

Christiner, M., & Reiterer, S. M. (2013). Song and speech: Examining the link between singing talent and speech imitation ability. *Frontiers in Psychology*, *4*, 1-11. http://dx.doi.10.3389/fpsyg.2013.00874

Chuang, W. C. (1997). *An investigation of the use of music aptitude profile with Taiwanese students in grades*

*four to twelve*. Unpublished doctoral dissertation, Michigan State University.

Cummings, T. F. (2005). The best language method. In R. C. Smith (Ed.), *Teaching English as a foreign language, 1936-1961: Foundations of ELT* (pp. 57-60). Routledge: Taylor & Francis Group.

Dankovičová, J., House, J., Crook, A., & Jone, K. (2007). The relationship between musical skills, music training and intonation analysis skills. *Language and Speech*, *50*(2), 177-225. http://dx.doi.10.1177/00238309070500020201

Fraisse, P. (1984). Perception and estimation of time. *Annual Review of Psychology*, *35*(1), 1-36. http://dx.doi.org/10.1146/annurev.ps.35.020184.000245

Gordon, E. E. (1997). *Music education: The forgotten past, troubled present, and unknown future*. PA: GIML.

Gordon, E. E. (1987). *The nature, description, measurement, and evaluation of music aptitude*. Chicago: G. I. A. publications.

Gordon, E. E. (1989). *Manual for the advanced measures of music audiation*. Chicago: G. I. A. publications.

Ho, Y.-C., Cheung, M.-C., & Chan, A. S. (2003). Music training improves verbal but not visual memory: Cross-sectional and longitudinal explorations in children. *Neuropsychology*, *17*(3), 439-450. http://dx.doi.10.1037/0894-4105.17.3.439

Knickerbocker, K. G. (2007). *Revisiting the language-music relationship: Exploring pitch recognition and discourse intonation in adult ESL students*. Unpublished doctoral dissertation, University of San Francisco, CA.

Lee, C. Y., & Hung, T. H. (2008). Identification of Mandarin tones by English-speaking musicians and nonmusicians. *Journal of the Acoustical Society of America*, *124*(5), 3235-3248. http://dx.doi.10.1121/1.2990713

Li, G. C. (2011). On self-practice of Russian pronunciation and intonation. *Russian Learning*, *2*, 50-53.

Marques, C., Moreno, S., Catro, S. L., & Besson, M. (2007). Musicians detect pitch violation in a foreign language better than nonmusicians: Behavioral and electrophysiological evidence. *Journal of Cognitive Neuroscience*, *19*(9), 1453-1463. http://dx.doi.10.1162/jocn.2007.19.9.1453

Martin, J. G. (1964). Aptitude test score changes following musical training. *Journal of Educational Research*, *57*(8), 440-442. http://dx.doi.org/10.1080/00220671.1964.10883116

Morgan, C. (2003). *Musical aptitude and second-language phonetics learning: Implications for teaching methodology*. Unpublished doctoral dissertation, Simon Fraser University. Canada.

Nathoo, N., Dileep, N., Michael, P., & Michael A. V. (2005). Mapping prosody: Correlation of functional magnetic resonance imaging with intraoperative electrocorticography recordings in a patient with a right-sided temporooccipital glioma. Case illustration. *Journal of Neurosurgery*, *103*(5), 930. http://dx.doi.10.3171/jns.2005.103.5.0930

Pastuszek-Lipińska, B. (2008). Musicians outperform nonmusicians in speech imitation. *Lecture Notes in Computer Sciences, 4969*, 56-73. http://dx.doi.org/10.1080/00220671.1964.10883116

Pastuszek-Lipińska, B. (2004). An overview of a research project and preliminary results of two experiments on perception and production of foreign language sounds by musicians and non-musicians. *TMH-QPSR*, *46*(1), 61-74.

Patel, A. D. (2008). *Music, language, and the brain*. Oxford: Oxford University Press.

Patel, A. D., Peretz, I., Tramo, M., & Labreque, R. (1998). Processing prosodic and musical patterns: A neuropsychological investigation. *Brain and Language*, *61*(1), 123-144. http://dx.doi.10.1006/brln.1997.1862

Pei, Z. W., & Ting, Y. R. (2013). An empirical study on the effects of musical aptitude on English phonological skills of Chinese university students. *Foreign Language World*, *1*, 36-44.

Peynircioğlu, Z. F., Durgunogˇlu, A. Y., & Úney-Küsefogˇlu, B. (2002). Phonological awareness and musical aptitude. *Journal of Research in Reading*, *25*(1), 68-80. http://dx.doi.10.1111/1467-9817.00159

Purcell, E. T., & Suter, R. W. (1980). Predictors of pronunciation accuracy: A reexamination. *Language Learning*, *30*(2), 271-287. http://dx.doi.10.1111/j.1467-1770.1980.tb00319.x

Ramus, F. (2000). Perception of linguistic rhythm by newborn infants. *Cognitive Psychology*, Retrieved from

http://cogprints.org/872/3/newborns01.pdf

Rouas, J., Farinas, J., Pellegrino, F., & Andre-Obrecht, R. (2005). Rhythmic unit extraction and modelling for automatic language identification. *Speech Communication*, *47*(4), 436-456. http://dx.doi.10.1016/j.specom.2005.04.012

Schneider, P., Scherg, M., Dosch, H. G., Specht, H. J., Gutschalk, A., & Rupp, A. (2002). Morphology of Heschl's gyrus reflects enhanced activation in the auditory cortex of musicians. *Nature Neuroscience*, *5*(7), 688-694. http://dx.doi.10.1038/nn871

Sheppard, C., Hayashi，C., & Ohmori, A. (2007). Factors accounting for attainment in foreign language phonological competence. *Proceedings of 16th International Congress of Phonetic Sciences*, Saarbrücken, 1597-1600.

Slevc, R., & Miyake, A. (2006). Individual differences in second-language proficiency: Does musical ability matter? *Psychological Science*, *17*(8), 675-681. http://dx.doi.10.1111/j.1467-9280.2006.01765.x

Vaneechoutte, M., & Skoyles, J. R. (1998). The memetic origin of language: Modern humans as musical primates. *Journal of Memetics*, Retrieved from http://users.ugent.be/~mvaneech/ORILA.FIN.html

Zybert, J., & Stępień, S. (2009). Musical intelligence and foreign language learning. *Research in Language*, *7*(1), 99-111. http://dx.doi.10.2478/v10015-009-0007-4

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