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Pitch processing and learning ability of the tone language Chinese

A correlational study of music and language

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ABSTRACT

As evidence of intimate music-language relations grow, a certain connection between the use of tone language and the ability of absolute pitch has been found. Genesis of absolute pitch has long been a controversial topic among scientists. While interest of learning the tone language Chinese increases, it is, from a pedagogical perspective, relevant and engaging to specifically study this connection.

The purpose of this essay is to study a small group of young beginners in Chinese at close quarters. By implementing a pitch-based hearing test, their pronunciation skills in Chinese were compared with sense of pitch shown in the test. The findings point to complex interactions between several factors, and show for instance a significant importance of musical training and learning motivation.

KEYWORDS: absolute pitch, 绝对音高, relative pitch, music, language, pitch processing, tone language, 声调语言, mother tongue, 母语, linguistics, 语言学.

SAMMANFATTNING

Samtidigt som vetenskapliga bevis för en intim relation mellan musik och språk växer, har ett visst samband mellan användning av tonspråk och absolut gehör också upptäckts. Uppkomsten av absolut gehör har länge varit ett kontroversiellt forskningsämne. När intresset att lära sig tonspråket kinesiska ökar globalt, är det ur ett pedagogiskt perspektiv motiverat att studera just detta samband.

Syftet med föreliggande uppsats är att på nära håll studera en liten grupp elever i nybörjarkinesiska. Genom ett gehörstest, baserat på förmågan att uppfatta tonhöjder, har dessa testresultat jämförts med de tidigare observerade uttalsförmågor hos eleverna. Studien pekar på komplexa interaktioner mellan många faktorer, och visar till exempel musikträning och studiemotivation som avgörande faktorer.

提要：随着越来越多的研究证明音乐与语言之间的密切关系，也有证据显示声调语言的使用与绝对音高感之间有着一定的互动关系。绝对音高感的成因一直是一个科学上有争议的话题，如今，学习声调语言普通话的兴趣已是国际性，从教学的角度来看，这两者之间的互动关系是个值得研究的话题。

此研究对一小群中文初学者做了近距离的观察，并对她们进行了音高感的听力测试。通过比较测试数据和她们已表现的中文发音能力及敏感性，本文发现了多种因素之间的复杂关系，比如音乐培训以及学习积极性的关键性。

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Firstly, I would like to thank my tutor, Ronny Lindeborg, for his support of this subject and his guidance through the work process. My wonderful pupils who volunteered for the experiment should have special thanks. This project would simply not have been possible without their cooperation. I wish to thank the school management at my workplace as well, for allowing such an experiment. Last but not least, my gratitudes go to my friends and former colleagues, Adrian Roach and Susan Sabin, for their linguistic comments.

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LIST OF ABBREVIATIONS

AP	Absolute pitch
RP	Relative pitch
PBHT	Pitch-based hearing test
LT	Listening tests on Chinese sounds and tones

1. Introduction

> […]. At five he was able to remark, "Only think, Papa blows his nose in G." He would say that it thundered in G or that the wind was whistling in D, or that the clock (with a two-note chime) struck in B minor, and when the assertion was tested it would invariably be found correct.[1]

Absolute pitch (AP), otherwise known as perfect pitch,[2] is characterized by the ability of a person to identify or re-create a note of particular pitch without any reference note (see Chapter 2). The vivid description above of a former professor of music at Oxford, is indeed a representative example of a child with AP. The phenomenon is actually very rare, even among professional musicians. Because of its rarity, and that some of the most distinguished musicians have been known to possess it, AP is often considered as mysterious, and a sign of exceptional musical ability.[3]

Over the years, the question of how AP occurs has captivated and captured many researchers' interest. AP has been studied within various disciplines. The rarity of AP in the US and Europe is still quite unexplained (see Chapter 2). However, findings from a research published 2006 caught my interest, it has shown that AP evolves as a feature of speech, thus its prevalence among tone language speakers (e.g. Chinese and Vietnamese) is higher than speakers of non-tone languages such as English.[4] The difference between tone and non-tone language[5] can be defined as below:

> Chinese […], being a tonal language, utilizes pitch to express emotional and other paralinguistic information as well as lexical information. English, being a nontonal language, utilizes pitch to express emotional and other paralinguistic information but not lexical information. [6]

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1 Oliver Sacks, "Papa blows his nose in G: Absolute pitch", in Oliver Sacks (ed.), *Musicophilia, Tales of music and the brain,* London: Picador, 2008, 130;
original source: *The Oxford Companion to Music.* 1955. 9th edition, ed. Percy A. Scholes. Oxford: Oxford University Press.

2 "Perfect pitch" refers to the same ability as AP, and is often used in popular parlance, whereas "absolute pitch" is defined and generally accepted in academic writings, thus the abbreviation AP. Source: Charlotte Gardner, "The ears have it", *BBC Music Magazine* (July 2009), 37.

3 Diana Deutsch et al. "Absolute pitch among American and Chinese conservatory students: Prevalence differences, and evidence for a speech-related critical period". *J. Acoust. Soc. Am.* 119:2 (February 2006), 719.

4 Ibid., 719.

5 Also known in some literature as "tonal language" resp. "nontonal language".

6 Lily Chen-Hafteck & Esther Mang, "Music and language in early childhood development and learning", in McPherson, Gary E. & Graham F. Welch (ed.), *The Oxford handbook of music*

The lexical tones enunciated in a tone language are defined both by their pitch heights (or registers) as well as by their pitch contours.[7]

This seems curious to me and raises questions such as: Is early exposure to a tone language really the key to AP? Is it eventually a question of heredity or environment, or both? Since these findings were based on music conservatory students in the US and in China, the early musical training, as many of these subjects tend to experience, surely must have had some effect on the results? Could for instance a non-musician possess AP as well, and would it be possible to test subjects without any musical expertise?

Whatever answers these questions provide, this interaction between music and language in general seems to be difficult to ignore. In recent years I have gained some pedagogical experiences by teaching Chinese. With that I noticed some obvious differences between my pupils' abilities of perceiving the four tones conveying the meaning of words in Chinese. As a professional musician and a future teacher in music and Chinese, I began to wonder if these differences might be related to the pupil's sense of pitch, which led me to the idea to put through a pitch-based hearing test on my own pupils. Although the number of involved respondents was extremely few in this case, it was an interesting group to study, in the sense that the respondents had quite varied backgrounds and no musical expertise.

1.1 Purpose and research questions

The purpose of this essay is to examine whether the sense of pitch affects receptivity of Chinese pronunciation, particularly the four tones. The underlying research questions are:

If there appears a certain connection between the sense of pitch and the pronunciation skills, how does it show?

In which ways are factors such as cultural, linguistic, musical and ethnic backgrounds reflected in the pitch-based hearing test?

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education, vol.1, New York: Oxford University Press, 2012, 272.

7 Diana Deutsch, "The enigma of absolute pitch", *Acoustics Today* (2006:2), 13.

1.2 Method, material and delimitation

Due to the limited time and resources, this small study focused solely on five respondents from a Swedish primary school, more specifically junior high. They were all female between age thirteen and fourteen. These teenagers started as beginners in Chinese in the autumn of 2013, their different perceptivity of Chinese tones were noticed and documented before implementation of the pitch-based hearing test (PBHT). The idea of this experiment was presented for this group earlier this year (2014), and they all agreed to be part of it. Thus, there was no self-selection of subjects within the group.

One important fact for this experiment was that none of my pupils possessed professional knowledge of music, which enabled a slightly different approach compared to many of the previous AP studies, leading to some difficulties in the implementation of the test. A quick review of pitch names in a Western C major scale was necessary, to make it possible for the respondents to understand design and performance of the test. No musical instruments were used for this review.

The hearing test was rather simple, "Perfect Pitch (Absolute Pitch) Test – C Scale" from www.audiocheck.net was chosen for this purpose.[8] It included 10 columns with one piano note each, in the form of an audio file. The respondent chose a range between C3 and B4, to label every file. The notes were piano tones that were played randomly. No time constraints were put on the respondent during the test, and the notes were played whenever she felt ready. Besides the actual test, the link also contained a section with help files that presented all the individual piano notes used in the blind test. This could primarily help respondents with good relative pitch (RP), "[t]he ability to identify musical intervals by name (e.g., major second [M2], perfect fourth [P4], and perfect fifth [P5].)"[9]

Two chances were given to every respondent. The first attempt, without any preparation, reference note or feedback, was to determine whether the respondent actually had absolute pitch. Provided that the respondent did not possess AP, the files that presented all the individual piano notes were then played for the respondent, followed by the simple request to hear her sing single notes based on

8 http://www.audiocheck.net/blindtests_abspitch.php

9 Michael J. Hove, Mary Elizabeth Sutherland & Carol L. Krumhansl, "Ethnicity effects in relative pitch", *Psychonomic Bulletin & Review* 17:3 (2010), 310.

what she heard. The actual second attempt, allowing for access to the help files, was thus intended to maximize the use of RP as a cue.

Results of the PBHT are presented in Chapter 3. Once these results were compiled, individual interviews were followed. These questions concerned their cultural, linguistic, musical and ethnic backgrounds (see Appendix 1). The test results were later analyzed in light of these factors, as well as the pupil's previously exhibited pronunciation skills, partially by compilation from three specifically chosen listening exercises.

During the collection of materials for this paper, the large amount of Western research on the topic took me by surprise. Consequently this paper came to be a close reading and understanding of existing research, alongside its main purpose as described above in section 1.1. Since Chinese, being a tone language, has become a research subject, some kind of Chinese academic interest in this area was presumed. As a multi-national state, China (People's Republic of China) has numerous local dialects and minority languages, why it is necessary to point out that the term “Chinese” as used in this paper, refers only to the promoted national language Putonghua in China, also commonly known as Mandarin.

However, these studies turned out to be on the contrary very few. Translations from the Chinese material are my own, and it was ultimately only one academic article that became relevant for discussion in the paper. At any rate, the qualitative textual analysis of previous research findings constitute a substantial part of background description and final discussion.

1.3 Speech-related critical period

The concept of critical period was first introduced into the field of language acquisition by Penfield and Roberts in 1959. Eight years later, it was refined by Lenneberg in *Biological Foundations of Language.*[10] The critical period hypothesis (CPH) holds that:

> primary language acquisition must occur during a critical period which ends at about the age of puberty with the establishment of cerebral lateralization of function. A strong

10 Jan Vanhove, “The critical period hypothesis in second language acquisition: A statistical critique and a reanalysis,” *PLOS ONE* 8:4 (July 2013), 1.

> implication of this hypothesis is that the processes involved in any language acquisition which takes place after the age of puberty will be qualitatively different from those involved in first language acquisition. A commonly drawn, though not absolutely necessary, corollary of the CPH is that any language learning which occurs after the age of puberty will be slower and less successful than normal first language learning.[11]

Research in second language acquisition "adopted the critical period hypothesis (CPH) and applied it to second and foreign language learning, resulting in a host of studies."[12] The same is true for research in AP. It is, for instance, linked to Deutsch's suggestion that "AP was originally packaged in with other features of speech", thus "it might be expected to be heavily influenced by the speech-related critical period."[13] The time frames for acquiring speech are further described in Chapter 4.

11 Catherine E. Snow & Marian Hoefnagel-Höhle, "The critical period for language acquisition: Evidence from second language learning," *Child Development* 49:4 (1978), 1114; original sources: Krashen, S. "The critical period for language acquisition and its possible bases." In D. Aaronson & R. W. Rieber (eds), *Developmental psycholinguistics and communication disorders.* New York Academy of Sciences, 1975; E. Lenneberg, *Biological foundations of language.* New York: Wiley, 1967; E. Lenneberg, "On explaining language." *Science* (1969:165), 635-643; T. Scovel, "Foreign accents, language acquisition and cerebral dominance," *Language learning* (1969:19), 245-253.

12 Vanhove (2013), 1.

13 Diana Deutsch et al. "Absolute pitch among students in an American music conservatory: Association with tone language fluency", *J. Acoust. Soc. Am.* 125:4 (April 2009), 2399.

2. Theoretical background

AP is "the [...] ability to identify or produce by name (e.g., C, C#, D) a musical pitch without a reference tone."[14] [It] is extremely rare in the U.S. and Europe, with an estimated prevalence in the general population of less than one in 10 000.[15] Nevertheless, it is not always easy to define AP, as

> [t]he precision of absolute pitch varies, but it is estimated that most people with it can identify upwards of seventy tones in the middle region of the auditory range, and each of these seventy tones has, for them, a unique and characteristic quality that distinguishes it absolutely from any other note.[16]

While scientists agree on the interaction between language and music, they seem to argue about the genesis of AP. In pursuit of comprehension of absolute pitch, it has been compared with absolute color recognition:

> […] to those with absolute pitch, every tone, every key seems qualitatively different, each possessing its own "flavor" or "feel", its own character. Those who have absolute pitch often compare it to color – they "hear" G-sharpness as instantly and automatically as we "see" blue.[17]

Compared to AP, 98 per cent of the general population is believed to posses absolute color recognition.[18] So, considering it only involves 12 notes within the octave, and the countless hours professional musicians spend on musical scores by reading, playing and hearing the notes, "the real mystery of absolute pitch is not why some people possess this ability, but instead why it is so rare".[19] As consolation for this unsolved mystery, it is worth mentioning that this ability does not necessarily bring benefits to all auditory or musical tasks.[20]

Deutsch has in recent years administrated several comprehensive on-site tests in US and in China. These studies covered many essential issues regarding AP. The results from her study in 2006, as mentioned in the introduction, showed:

> First, […]. The earlier the age of onset [of musical training], the higher the probability of

14 Michael J. Hove, Mary Elizabeth Sutherland & Carol L. Krumhansl, "Ethnicity effects in relative pitch", *Psychonomic Bulletin & Review* 17:3 (2010), 310.
15 Deutsch et al. (2006), 719.
16 Sacks (2008), 129.
17 Ibid., 130.
18 Gardner (2009), 37.
19 Deutsch (2006), 11.
20 Deutsch et al. (2009), 2398; Deutsch (2006), 11.

> meeting the criteria for absolute pitch. Second, the prevalence of absolute pitch was far higher for the CCOM [Central Conservatory of Music in China] than for the ESM group [Eastman School of Music in U.S.]. […]. Comparisons were also made between the male and female subjects within each subgroup […]. No effects of gender were found […].[21]

This study is just one of many research projects to demonstrate the effect of early musical training on sense of pitch. Several other intervening factors have been argued as well. The survey by Baharloo et al. (1998) focused on genetic components and "suggested that both early musical training and genetic predisposition are needed for the development of AP".[22] Hove et al. (2010) examined ethnicity effects in RP, relative pitch, for non-musicians in US respectively Asia. The Asian advantage that was shown here indicates that the "perceptual-cognitive advantage in labeling pitch-based sensory events is more general and is not limited to highly trained musicians". More intriguing is the fact that no evidence supporting tone-language effects was observed in these studies.[23] In addition, the cultural och environmental factors are mentioned.[24]

However, the theory about early musical training's effects on sense of pitch seems to stand unquestioned. "Parentese" or "infant-directed speech" is practically the earliest musical contact for an infant. "[I]t is measured, repetitive, and finely regulated in pitch, timbre, and loudness. [… it] paves the way for learning language."[25] "Dramatic stories" in infant-directed speech "become carriers of the conventional features and rituals of the mother's culture. They are the biological foundations of her language".[26] Thus, the links between music, language development, and the cultural environment are obvious. Furthermore, the effects of early musical training on language development in young children has been proven by neuroscientific research, since musical training enhances "language areas in the brain to process pitch and timing changes".[27] All these evidence seem to support the conjecture of tone language's effect on sense of pitch.

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21 Deutsch et al. (2006), 720-721.
22 Siamak Baharloo et al. "Absolute pitch: An approach for identification of genetic and nongenetic components", *Am. J. Hum. Genet.* (1998:62), 224.
23 Hove, Sutherland & Krumhansl (2010), 314.
24 Ibid., 315.
25 Colwyn Trevarthen & Stephen Malloch, "Musicality and musical culture: Sharing narratives of sound from early childhood", in McPherson, Gary E. & Graham F. Welch (ed.), *The Oxford handbook of music education, vol.1,* New York: Oxford University Press, 2012, 249-250.
26 Trevarthen & Mallock (2012), 250.
27 Chen-Hafteck & Mang (2012), 270-271.

Upon the question of ethnicity, Deutsch also mentioned infants' ability "to perform a perceptual learning task that required referring to the absolute pitches of tones" in her survey from 2009, and that the speech-related critical period "might extend down to infancy".[28] Reasoning of this critical period led accordingly to amplify the connection between fluency of a tone language and sense of pitch. Findings in this survey have shown that "the differences in performance levels [on a test of AP] […] were determined by language rather than ethnicity".[29]

Briefly, research in this field could be summarized as follows: "Growing evidence points to a link between musical abilities and certain phonetic and prosodic skills in language. However, the mechanisms that underlie these relations are not well understood."[30]

28 Deutsch et al. (2009), 2398.
29 Ibid., 2400.
30 Aniruddh D. Patel & John R. Iversen, "The linguistic benefits of musical abilities", *Trends in Cognitive Sciences* 11:9 (2007), 369.

3. Results

During the PBHT, the obtained scores were listed, as well as frequency of utilization of the help files during the second attempt. Aside from this quantitative data, the overall impressions of the performances were also noted in detail. These are considered and form part of the qualitative analysis.

Given that many of Deutsch's studies showed "none effect of gender",[31] it could further be conjectured that consistency of entirely female respondents in this study should not have a significant impact on the results. As specified in the background, primarily with reference to the studies of Hove et al.,[32] the output for this experiment was that teenagers without any musical expertise could possess the ability of RP.[33] Nor was the ability of AP entirely excluded.

The main results of the experiment are shown below in Figure 1.

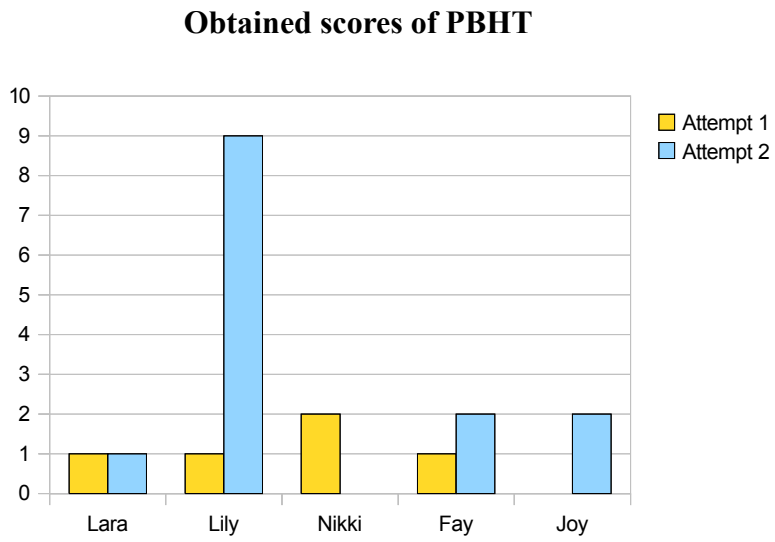

Figure 1: Number of correct answers. The maximum score was 10 for each attempt. Fictitious names are used for all respondents.

The respondents had on average delivered low scores, and none in this group seemed to possess AP. Nevertheless, *Lily* stood out with a significantly improved score at the second attempt, with 9 of 10, and was most likely to possess RP. For

31 Deutsch et al. (2006), 720;
Deutsch et al. (2009), 2400; and
D. Deutsch, Xiaonuo Li & Jing Shen, "Absolute pitch among students at the Shanghai Conservatory of Music: A large-scale direct-test study", *J. Acoust. Soc. Am.*134:5 (November 2013), 3855.

32 Hove, Sutherland & Krumhansl (2010), 314.

33 Ibid., 310-316.

the majority of this group, the results between the two attempts were just slightly varied. *Lara* did not improve at all, by that means the possession of RP could be excluded. The same applies to *Nikki*, due to a failed second try. As for the rest, the improvements were marginal.

One disadvantage with this hearing test was that the participants could not attend all at once, for assurance of an equal leveled test for all respondents. As described in section 1.2, the notes were played randomly. This means the same notes in succession could occur in some of the tests. However, it has shown that this never occurred more than once during a continuous test. With the observed overall impression as a supplement, this deficiency is therefore assumed to be negligible.

The PBHT was in the whole successful. Figure 2 shows the frequency of utilization of the help files during the second test:

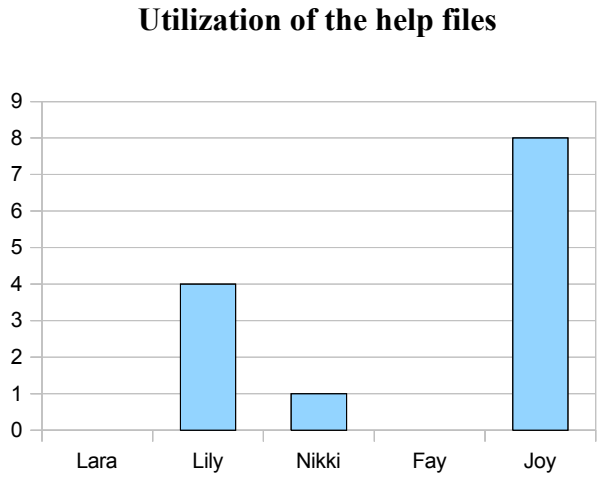

Figure 2: Number of attempts to use the help files.

Every respondent was free to choose whether or how often she wanted to listen to one of the audio files as a cue. Different strategies were used within the group. Interestingly, these were consistent with the overall impressions of the respondents' performances in general.

Lara did not possess RP. Logically it would not be profitable for her to use any help files. Although *Fay* made small progress at her second try, she did show obvious shortcomings in her sense of pitch. It was, in fact, impossible for her to distinguish whether a tone was sharper or flatter than the previous. This might explain why she never used any of the audio files that were available. The marginal improvement she made in the second test was therefore assumed to be

by chance. Where *Nikki* was concerned, she gave the impression of actually wanting to succeed. This performance anxiety could, in this case, have negative effects on the result. However, she had difficulties singing a simple C major scale, confirming the earlier conjecture that she lacked the ability of RP. This anxiety was also shown in the case of *Joy*. She used the files regularly, hoping to receive a good result. Despite her efforts, many of the help files she used seemed to create rather distractions. Another observation was that she, on several occasions, listed correctly but with octave errors. The test took no account of this fact. Considering it was natural for her to sing whatever tones she was asked, it was conjectured that she had a good sense of pitch. *Lily* was proven to possess RP. It can be seen in figure 2 that she used the files moderately. The overall impression was that she could sing with ease and the utilization of the files was very strategical.

3.1 Exhibited pronunciation skills

The findings above are compared with respondents' different receptivities of Chinese in this section. These documented pronunciation skills were compiled just until recently. They were partly based on results from some listening tests on Chinese sounds and tones (LT) included in the teaching, partly on my own assessments of the pupils' oral pronunciation skills. Figure 3 shows the same result from the PBHT as in figure 1, but in tabular form, to facilitate comparing with the results from the listening tests shown below in figure 4.

Obtained scores of PBHT (tabular form)

Respondent / Attempt	Lara	Lily	Nikki	Fay	Joy
1	1	1	2	1	0
2	1	9	0	2	2

Figure 3: Number of correct answers. The maximum score was 10 for each attempt.

Obtained scores of LT

Respondent / Type of exercise	Lara	Lily	Nikki	Fay	Joy
1. sounds[34]	8	7	8	7	8
2. tones[35]	5	5	6	2	7

Figure 4: Performance on average from three listening tests. The maximum score was 10 for each test. These tests were originally exercises in the teaching material, but have been conducted as tests under certain time pressure.

The performance level for the exercises with Chinese sounds was generally higher than for the exercises with Chinese tones. It indicates an increased severity with the pronunciation of the Chinese tones in particular. It was also clear that the RP possessor, *Lily*, was not more receptive to the Chinese sounds or tones than the others. *Fay* had apparent difficulties with the Chinese tones, while *Joy* delivered consistently high scores for all exercises.

My own observations and estimates of the group's pronunciation skills were quite in accordance with the results shown above.

The only exception was that *Lily* was expected to deliver better scores for LT. This respondent had always impressed me with her easiness of oral pronunciation, even for the four Chinese tones. She had a particular fondness of imitating voices or

34 Liu et al. 刘珣主编, *New Practical Chinese Reader 1, Workbook and CD* 新实用汉语课本 1, 综合练习册加配套录音 CD, Beijing Language and Culture University Press 北京语言大学出版社 (2012). Exercise 1 “Circle the right sound according to what you hear on the tape.” in chapters 1-5.

35 Ibid. Exercise 2 “Circle the right tone according to what you hear on the tape.” & Exercise 3 “Mark the correct tone on the following syllabled according to what you hear on the tape.” in chapters 1-5.

other kind of surrounding sounds. In that sense, her performance in the PBHT was not a surprise. Nonetheless, it was noted that her motivation of learning was lacking in balance, especially in comparison with *Nikki* and *Joy*. Results from the LT seem to verify this observation. At any rate, it implies a falsification of a direct link between sense of pitch and susceptibility of Chinese pronunciation. This indicates that interactions of more factors, such as learning motivation, may influence the outcome.

On the other hand, *Fay's* results clearly show, that she was lacking in both sense of pitch and pronunciation skills of Chinese tones. These shortcomings were familiar in the teaching, and the link between these two abilities are obvious in this case. Since her score for the task of sounds was substantially higher, it suggests that the learning of Chinese sounds does not require a good sense of pitch.

3.2 Cultural and musical background

Ethnic and cultural background of the respondents are briefly listed below. These include interview questions 1–3 and 10–14 (see Appendix 1):

Cultural background

Category / Respondent	Ethnic origin	Cultural background	Native language(s)
Lara	Swede	Swedish	Swedish
Lily	Swede/Finnish	Swedish	Swedish
Nikki	Chinese	Swedish (adopted)	Swedish
Fay	Arabian (Middle East)	Arabic & Swedish	Arabic
Joy	Swede/Finnish	Swedish	Swedish (& Finnish)

Figure 5: Cultural background of the group. Lily has Finnish descent but neither understood nor spoke the language. None in the group had been in China except Nikki, who was adopted by Swedish parents in infancy (3-4 months old). Together with her Swedish parents, she returned to China at the age of 5 and lived there for 2 years. Since starting school back in Sweden, she and her adoptive parents have made regular short visits to China. Despite these frequent visits, she claimed she had never spoken Chinese before this course. Fay moved to Sweden at the age of 8 with her Arabic parents. She identified herself as both Arabian and Swedish. Joy is half Finnish. She understood the language through her father and paternal grandmother, but did not speak

Finnish herself.

The group, generally, had a Swedish cultural background. *Nikki* and *Fay* represented ethnic backgrounds that were non Scandinavian. Given that *Nikki* had lived in China for two years in her childhood, her performance was not proportionate to her advantages. Thus, the Chinese origin did not necessarily provide advantage in pitch processing, neither in susceptibility of Chinese sounds and tones. By that means the environmental factors, primarily cultural environment, could have more of an impact on *Nikki* than the genetic factors. This will be illustrated from different perspectives in the final discussion.

Joy was the only one who had two native languages, although Swedish was normally used in the family. As mentioned in the above section, this respondent delivered high scores for all exercises in LT. Furthermore, she was conjectured to possess a good sense of pitch. Thus, it can be assumed that bilingualism, susceptibility to second language and musical hearing ability are related to each other in this case. *Fay* should also be considered as bilingual, although, she came into contact with Swedish late in childhood. This concerns issues such as the critical period, and exposure to language and music in early childhood. These will be further discussed in Chapter 4.

So far, the language environment and cultural background have shown to affect the performance levels more than inheritance and genes. Answers to the remaining interview questions, emphasizing musical environment and background (see Appendix 1, questions 4–9), are summarized as below:

Musical background

Category / Respondent	Age of onset of musical training(s)	Instrument(s)	Duration of music lessons (year)	Practice habit	Parents' musical background/interest
Lara	11	vocal	ongoing (currently 4)	one hour/instrument /weekday	both generally interested in music
		clarinet, flute (recorder)	1		
Lily	6	clarinet	1	one hour/week	mother listens to all kinds of music
Nikki	7	flute (recorder)	2	irregular	father plays with a band in his leisure time
	10	piano	2		
Fay	/	/	/	/	not interested at all
Joy	6	vocal	ongoing (currently 9)	often	father listens to music a lot; grandmother played with a band in her leisure time before
	13	piano	ongoing (currently 2)	irregular	

Figure 6: Musical background of the group. None of the respondents had a professional music background at home. (Note that the respondents' views on their parents' "interest of music" could vary, as well as their assessments in this matter were not objective.)

The majority of this group had musical training, although very short-lived for most of them. *Fay* was the only one who had neither interest in music nor musical environment. Hence, it is reasonable to assume that the complete absence of musical background had in this case led to lack of pitch sensitivity and inferior receptivity of Chinese tones. This will be discussed specifically in section 4.2.

All respondents have so far proved to be unique, with their different performance levels and varied backgrounds. *Lara* was assumed to be a non-possessor of RP. As it is shown in figure 6, she practiced diligently on several musical instruments during one year, between the age of 11 and 12, yet she delivered mediocre results in all tests. In contrast, *Lily* and *Joy* started their music lessons at the age of six, earliest in the group. Considering the very short musical training of *Lily*, who yet proved to possess RP, and the consistently high performance levels of *Joy*, it clearly indicates a determining factor of age of onset of musical training.

Nikki and *Joy* were mentioned to have shown strong motivations of learning. It could be seen in figure 6 that their age of onset of musical training were similar,

as well as their practice habit and environmental background. However, the observed differences between their performance levels, especially the one relating to receptivity of Chinese tones, can not be ignored. The reasons that underlie these differences could be *Joy's* greater interest in music, and her still ongoing music training. The latter also differs with bilingualism. Nevertheless, the evidence is not convincing enough to make any assumptions.

3.3 Summary

Results of this experiment have shown that none of the respondents had AP. On the other hand, one of them was shown to be a RP-possessor. It is thus possible to implement a PBHT on respondents with no musical expertise.

This study demonstrated some connections between sense of pitch and pronunciation skills in Chinese. It is clear that pronunciation of Chinese tones has an increased severity than Chinese sounds for these Swedish pupils. Furthermore, the genetic factors are proven to have no effect, it is rather several other environmental factors, such as early exposure to language and music, that are determining factors for the learning ability of Chinese pronunciation.

However, sense of pitch is not necessarily required for learning Chinese sounds. It is also interesting to note, that the motivation of learning could be crucial to the study results. Anyhow, the case of *Lily* defies a direct link between pitch sensibility and pronunciation skills, it is still unclear what underlies this anomaly. Additionally, there are a few ambiguities concerning the impact of bilingualism and ongoing music training that are left to be discussed.

4. Discussion

Exposure to language and music during the critical period has been concluded as a determining factor in present study. Given that the critical period might extend even down to infancy, and that the "infant-directed speech paves the way for language learning" (see Chapter 2),[36] it is reasonable to assume that exposure to two languages in infancy, as in the case of *Joy*, provides a positive effect on her sensitivity to Chinese pronunciation. Equally, it explains why bilingualism was not shown to have any positive effect on *Fay*, who was also considered as bilingual but arrived in Sweden at the age of eight. Some studies of recovery of speech following brain injury have indicated, that the effect of the speech-related critical period is "most positive […] before age 6, less positive between ages 6 and 8, and very poor after puberty."[37]

Deutsch believes there is "similarity between the time frames for acquiring speech, on one hand, and AP, on the other".[38] This is crucial for her argument that AP evolves as a feature of speech, which could eventually explain why the prevalence of AP among tone language speakers has shown to be higher than among speakers of non-tone languages.[39] This cross-domain comparison of music and linguistic abilities in early life is studied by many scientists:

> It is actually quite difficult to distinguish between the intonation contour in speech and melodic contour in singing in early vocalization (Chen-Hafteck, 1997). Meng (2001) calls such a phenomenon "intermediate vocalization". In a study of the early vocalization of English monolingual and Chinese bilingual children she found that even though English monolingual children displayed clearer distinctions between speech and singing than Chinese bilingual children, theses distinctions were some what "fuzzy".[40]

Due to this intimate relationship between language and music development, these researchers believe "it is important to consider the two areas of development

36 Deutsch et al. (2009), 2398; resp. Trevarthen & Mallock (2012), 250.
37 Deutsch et al. (2009), 2398; original sources: M. Dennis & H. A. Whitaker, "Language qcqisition following hemidecortication: Linguistic superiority of the left over the right hemisphere," *Brain Lang.,* (1976:3), 404-433; E. Bates, "Language development," *Curr. Opin. Neurobiol.,* (1992:2), 180-185; M. Duchowny et al., "Language cortex representation: Effects of developmental versus acquired pathology," *Ann. Neurol.,* (1996:40), 31-38; A. J. Doupe & P. K. Kuhl, "Birdsong and human speech: Common themes and mechanisms," *Annu. Rev. Neurosci.,*(1999:22), 567-631.
38 Deutsch et al. (2009), 2399.
39 Deutsch et al. (2006), 719; Deutsch et al. (2009), 2399.
40 Chen-Hafteck & Mang (2012), 266-267.

simultaneously [in early childhood education]".[41] Additionally, they also provide a different point of view that is important to address in this debate:

> Children are born with unlimited potentials to learn the language and music of any cultures (Eimas, 1985). However, the development of linguistic and music skills gradually narrow to focus on the language and music of the native culture and environment in which children live. They then gradually lose their abilities as natives to learn readily the sounds of music and languages that differ from their own.[42]

This might explain why *Nikki* did not seem to reap any benefits in learning Chinese or developing pitch sensitivity, despite living in China for two years before primary school in Sweden. She appears to have focused on the Swedish culture and environment in conjunction with the adoption in infancy. It would also be logical, if she held on to this "choice" during all her previous visits in China. This psychological dimension seems to have a powerful influence on her perception of Chinese.

According to the quote above, all children are born with same opportunities, it is rather the surrounding circumstances that govern the course of developments. To retain certain ability, for instance sense of pitch, requires a daily exposure to music, or a tone language related to this ability. [43] This is consistent with the findings that proved "continuity in speaking a tone language is an important factor in the probability of acquiring [AP]".[44]

In this line of reasoning, it is inviting to examine the Chinese interest in this correlational research. Due to the multiculturalism that characterizes China (PRC), a large percentage of the population is bilingual or multilingual, on a daily basis. Since all the Chinese languages are tonal,[45] such linguistic conditions would be ideal for research on questions such as: Does bi-/multilingualism in early childhood affect the genesis of AP, or acquisition of foreign languages beyond childhood?

41 Chen-Hafteck & Mang (2012), 267.
42 Ibid., 267.
43 Ibid., 267.
44 Deutsch et al. (2009), 2402.
45 Chen-Hafteck & Mang (2012), 269.

4.1 Chinese interest in the issue

As mentioned in section 1.2, not many academic texts written in Chinese were found. Most of the material studied solely the teaching of Chinese pronunciation for the purpose of promoting Mandarin, in the country or abroad. Studies on the link between sense of pitch and bilingualism were extremely difficult to find.

However, one major study made at Shanghai Conservatory of Music was found, and is interesting for this debate after all. This survey was conducted by Chinese researchers within disciplines of Psychology and Cognition, respectively Music psychology, it concerns ability of AP among students at three departments (see Appendix 2).[46] Interestingly, it questions the findings that showed a higher prevalence of AP among tone language speakers. It suggests that the much tougher musical training in China, which probably results in a strengthened pitch memory among students at the Chinese conservatories, could be the reason for previous findings. It argues that there is a problem with the comparisons in earlier studies, since different music traditions and systems were not taken into consideration. It is also worth noting that the question of bi-/multilingualism is excluded in the survey, by this simple description: "[t]he subjects came from more than ten different provinces in China, and had the tone language Chinese as their native language."[47]

Two years after publication of this Chinese article, Deutsch managed an extensive survey at the same conservatory, in cooperation with the Chinese researchers mentioned above.[48] This study became as successful as her earlier projects. Among several other findings, it reconfirms this connection between prevalence of AP and tone language speaking, as well as it leads to the conclusion that "the note A plays a special role in pitch identification judgments"[49].

At any event, it indicates an active Chinese interest and coverage of latest findings. China seems to be involved, and has a certain influence in this field of research, although it is quite an unexplored area among the Chinese scientists

46 Li, Yue & Zhou 李小诺，乐竟泓，周佩佩. "The correlations between sense of absolute pitch, native language and early music training" 绝对音高感形成与母语作用及早期训练的关系. *Chines Society for Music Psychology* 中国音乐心理学学会 30.7.2011. Text available on http://www.musicpsy.com/_d271708932.htm.
47 Ibid.
48 Deutsch, Li & Shen (2013), 3853-3859.
49 Ibid., 3853.

themselves. Indeed, this absence of research on the link between pitch sensibility and bilingualism makes it interesting to follow possible future collaborations between researchers in the West and in China.

4.2 Musical training

It is shown in the present study that four of five respondents have had music lessons with various durations, and that pitch sensibility and language skills are correlated positively with early onset of musical training. It is further conjectured that total absence of musical background, as in the case of *Fay*, affects development of these abilities negatively. This accords for instance with a study by Wong *et al.,* that suggests "musical experience tunes basic auditory sensory processing circuitry in the brain, which has consequences for language processing."[50] Technique used in this study was EEG (electroencephalography), the recording of electrical activity along the scalp.[51] The study was generally focused on lexical tones that significantly differ between tone and non-tone languages (see Chapter 1). The findings are "probably relevant to studies that have found links between musical training and pitch-related prosodic abilities."[52]

As daily exposure to music or a tone language is an important factor of maintaining a good sense of pitch, music lessons have positive impact on cognitive abilities as well. Aside from the already proved importance of early onset of musical training, some studies also showed that the positive effects related to music lessons "disappeared a year later for the children who stopped taking lessons, but they continued to increase for children who continued taking music lessons (Rauscher, 2002)."[53]

Thus, this could be an explanation of the observed differences between *Nikki* and

50 Patel & Iversen (2007), 370;
original source: Wong, P.C.M. e*t al.* "Musical experience shapes human brainstem encoding of linguistic pitch patterns", *Nature Neuroscience* 10 (2007), 420-422.

51 Patel & Iversen (2007), 370.

52 Ibid., 371.

53 Glenn E. Schellenberg, "Exposure to music: the truth about the consequences", in Gary E. McPherson (ed.), *The child as musician: A handbook of musical development,* New York: Oxford University Press, 2006, 122;
original source: F. H. Rauscher, "Mozart and the mind: Factual and fictional effects of musical enrichment", in J. Aronson (ed.), *Improving academic achievement: Impact of psychological factors on education,* San Diego: Academic Press, 2002, 267-278.

Joy, since *Joy* was still taking piano lessons when the experiment was implemented, and delivered higher scores in the LT. This may also partially explain the inferior results of *Lily*. Apparently, the early age of onset of musical training had a positive effect on her ability of RP. The excellent oral pronunciation skills that were observed, as well as her distinctive ability of imitating sounds, could be a result of this ability. However, she lacks patience and study motivation required for LT. This is also reflected in her practice habit during the single year she played the clarinet. I wonder: If she had enough patience and motivation to continue her musical training, would she have achieved better scores in the LT?

Circumstances surrounding *Lily* seem to be more complicated than the others. Nevertheless, the supplementary question does touch an important point of view of the connection between music lessons and cognitive abilities: "[it] does not allow researchers to conclude that music lessons are actually *causing* increases in intelligence. […] children with better cognitive abilities might be more inclined than other children to take music lessons."[54] This limitation is after all worth mentioning, since all correlational studies suffer from it.[55]

54 Schellenberg (2006), 120.
55 Ibid., 120.

5. Conclusion

This paper has shown that the sense of pitch is not the only factor that affects learning ability of Chinese pronunciation. The interactions between use of language(s), age and duration of musical training, cultural and environmental factors, are intimate and complex.

Regarding the reliability of this experiment, it is important to address a couple of shortcomings of this study. The minimum number of respondents was mentioned as a limitation in section 1.2 . The results would have naturally been more reliable, if the resource for covering larger group/groups was accessible. On the other hand, this small experiment provided the privilege of following each respondent at close quarters. This contributed to more dimensions of the analytical material that showed to be essential to cover another deficiency. The respondents were not able to attend the PBHT all at once, my own observations and qualitative analysis were thus necessary as a complement in the study. Nevertheless, the limited number of respondents could have caused a small margin of errors, in terms of the generalization of individually conditioned phenomenons.

With this in mind, the present findings support the following statements:

1. Pronunciation of Chinese tones has an increased severity compared to the Chinese sounds.
2. Learning of Chinese sounds does not require a good sense of pitch.
3. Musical training enhances receptivity of Chinese tones, the earlier the age of onset, the greater the effect of the pronunciation skills.
4. Ongoing music lessons provide positive effects on pronunciation skills in Chinese, since continuity of effect rewarding activity is crucial to maintenance of the actual ability.
5. Pitch sensibility is more general and is not limited to highly trained musicians.
6. Ethnicity and genes are insignificant for the results of the Chinese study. It is rather the cultural environment and learning motivation that are determining factors.

7. Bilingualism within the speech-related critical period enhances susceptibility to second language.

When considered as a whole, the speech-related critical period has been shown to play a central role in many of the issues discussed here. Moreover, item 6 argues strongly for the common phrase: "practice makes perfect". It is, indeed, impossible to grasp all factors that come into play in the development of our linguistic and musical skills. These "natural" abilities emerge "not only through the support of intrapersonal and environmental catalysts, but also through systematic learning and extensive practice".[56]

56 Gary E. McPherson & Aaron Williamon, "Giftedness and talent", in Gary E. McPherson (ed.), *The child as musician: A handbook of musical development,* New York: Oxford University Press, 2006, 241;
original sources: F. Gagné, "Constructs and models pertaining to exceptional human abilities, in K. A. Heller, F. J. Monks & A. H. Passow (eds), *International handbook of research and development of giftedness and talent,* New York: Pergamon, 1993, 69-87; F. Gagné, "Understanding the complex choreography of talent development through DMGT-based analysis, in K. A. Heller, F. J. Monks, R. J. Sternberg, & R. F. Subotnik (eds), *International handbook of giftedness and talent,* New York: Elsevier, 2000 (2nd edn), 67-79.

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Appendix 1: Interview questions

1. What is your native language?
2. What is your father's native language?
3. What is your mother's native language?
4. Do you play/have played any music instrument(s)? Or sing/have sung?
5. Why did you start playing? (And why did you stop playing?)
6. How long did you play/have played your music instrument(s)?
7. How often do/did you practice?
8. What is your father's profession?
9. What is your mother's profession?
10. What is your ethnic background?
11. Which culture do you identify with most?
12. Have you ever been to China?
13. If yes, how long did you visit the country?
14. If you have been there more than once, how often have you been to China?
15. Anything else you consider important?

Appendix 2: Main results and excerpts of the Chinese survey[57]

The group for this on-site test made by academics in China consisted of music conservatory students in Shanghai, at department for piano (22 subjects), orchestral instruments (58 subjects) resp. folk music instruments (52 subjects). The subjects came from more than ten different provinces in China, and had the tone language Chinese as their native language.

The method was similar to those of Deutsch's. The subjects were presented with a set of 36 tones within a range between C-C2, and they were asked to make notes on the stave. To minimize the use of relative pitch as a cue, intervals between notes in succession were all larger than an octave. The subjects were also asked to fill out a questionnaire, concerning their music education.

Main results of this test are translated below, as well as excerpts of the conclusions that are relevant for the present study.

Comparison between three departments

Calculation of scores in the statistics: with accurate identification of a pitch, 3 points; with octave error, 2 points; with semitone error, 1 point; others, 0 point. The maximum score that every individual subject could get was 108 points.

Scores

Department / Scores	Folk music instruments	Piano	Orchestral instruments
Mean	36,69	93,14	62,28
Median	29	100,5	71
Higher than 54	21,15%	90,91%	55,17%
Higher than 100	0,00%	54,55%	24,14%
108 (full score)	0,00%	32,82%	0,05%
Lowest	7	20	1
Highest	99	108	108
Standard differential	24,18	22,21	37,49

The table above shows that piano students made up the largest proportion for categories of “Mean”, “Median”, “Higher than 54”, “Higher than 100” and “108 (full score)”, followed by students studying orchestral instruments, and then folk music instruments. In

57 Li, Yue & Zhou 李小诺，乐竟泓，周佩佩. "The correlations between sense of absolute pitch, native language and early music training” 绝对音高感形成与母语作用及早期训练的关系. *Chines Society for Music Psychology* 中国音乐心理学学会 30.7.2011. Text available on http://www.musicpsy.com/_d271708932.htm.

comparison of data, folk music students were outperformed by both other groups.

It indicates that the ability of AP among folk music students are inferior to piano students and those with orchestral instruments. And the gap is significant.

Age of onset of musical training

Department / Age	Folk music instruments	Piano	Orchestral instruments
Before 5	25,00%	66,67%	32,26%
Between 6 and 10	65,38%	28,57%	48,39%
After 10	9,60%	4,80%	19,35%
Mean	7,4	4,95	7,85
Median	7	5	7
Youngest	3	2	3
Oldest	13	12	17
Standard differential*	2,5	1,99	3,36

* Data of this category was originally 2,499, 1,987 resp. 3,358.

This table shows that more than 80% of all students started their musical training before the age of 10. Percentages of piano students and folk music students in this category are respectively over 95 and 90. With 66,67%, piano students made up the largest proportion for category of onset of musical training before the age of 5. These were followed by "Orchestral instruments" with its 32,26%, and then 25,00% for the "Folk music instruments". The majority of the folk music students started their training at the ages between 6 and 10, and these were 65,38% of the whole group at that department.

Data from this table shows that piano students began their musical training earliest. Most of them received their training before the age of 5. This was to be one of the main reasons why the group received the highest score.

Conclusion

The majority of the folk music students with relatively high performance level on the AP test started their music training within the speech-related critical period. This is consistent with previous researches.

This survey examined the ability of AP among music students at three departments, and has found that the performance level of folk music students was significantly lower than those who studied piano or orchestral instruments. Thus, this finding questions the previous research conclusion that prevalence of AP for music is higher among tone language speakers than among speakers of non-tone languages. Chinese music students

who participated in previous studies might have had a much harder musical training within the speech-related critical period, in comparison with the traditional Western music training. The previous results might have been influenced by Chinese students' strengthened pitch memory as a consequence of the early and hard musical training. To ensure reliability of the comparison between tone language speakers and non-tone language speakers, and their abilities of AP, intensity, method, repertoire and process of the musical training should also be comparable. Are these terms really fulfilled at present?

Most of the previous surveys have used piano sounds for the AP tests. This points to a couple of problems: 1) In the present study, the piano students outperformed the students at other departments. Could it be related to their memory of the specific timbre of piano? 2) The current AP tests are almost exclusively based on the chromatic scale (i.e. twelve-tone scale), while there are numerous music traditions, systems and styles worldwide that involve a different concept of pitch comprehension. To study sense of pitch by using only the chromatic scale, certainly limits the scientific basis of the study. Therefore, how to study the sense of pitch among people with different ethnic backgrounds is an interesting and proposed research area.

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