Acquisition of pitch in Chinese by Danish learners

Marjoleine Sloos[1], Jie Liang[2], Mengzhu Yan[3], Chun Zhang[3]

[1]Fryske Akademy, [2]Tongji University ,[3]Aarhus University

Abstract

Native speakers recognize a second language accent mainly by prosodic features. Pitch, pitch range, and pitch variability are language-specific and have to be acquired in L2 acquisition (usually without explicit teaching). Until now, results remain inconclusive as to whether L2 speakers are able to acquire a pitch range that is wider than their native pitch range. The present paper investigates the acquisition of mean pitch, pitch range, and pitch variability in Mandarin Chinese by native speakers of Danish. This is particularly interesting since Chinese uses a relatively wide pitch range whereas Danish has an extremely small pitch range. We show that Danish students can largely acquire the mean pitch and pitch range of Mandarin Chinese. However, the pitch variability of Danish-accented Chinese turned out to be considerably lower than native Chinese, which we tentatively attribute to a poor acquisition of tone.

Keywords: Chinese, Danish, tone acquisition, pitch range, pitch variability.

1 Pitch, pitch range and pitch variability

Pitch range (the difference between the highest and lowest pitch) and average pitch drastically differ per language, as shown in a survey of the intonation systems of twenty languages in Hirst & Di Cristo (1998). For instance, English has a wider pitch range than Dutch (Chen, Rietveld & Gussenhoven 2001), and Chinese has a larger pitch range than English. The Danish pitch range is notoriously small (see section 1.2 below), and the average pitch of Chinese is higher than for English (Keating & Kuo 2012). These language-specific differences in pitch range and average pitch play a role in second language intonation, which have repeatedly been shown to negatively influence comprehensibility and to contribute to accentedness—more than segmental incorrect pronunciation (Rasier &

Hiligsmann 2007, Kang 2010). In an overview of pitch range studies from the perspectives of typology, bilingualism, and second language acquisition, Mennen (2007) observes the intriguingly small number of studies on L2 pitch range. The present contribution focuses on the average pitch, pitch range, and pitch variability of Mandarin Chinese by Danish students of Chinese as a second language. Given the particularly flat pitch range and remarkably monotonous intonation of Danish, we ask the question to what extent the Danish learners are able to widen their pitch range and use larger pitch variability when speaking Chinese. The remainder of this section provides background information about mean pitch, pitch range and pitch variability in Mandarin Chinese (1.1) and Danish (1.2) and the second language acquisition of these prosodic parameters (1.3). Subsequently, we report on an experiment on pitch, pitch range and pitch variability in Danish-accented Chinese.

1.1 Mean pitch, pitch range and pitch variability in Mandarin Chinese

In Mandarin Chinese, female speakers not only use a higher maximum Fo and mean Fo, but generally also use a larger pitch range and larger pitch variability than male speakers. The variability of pitch can be captured by the standard deviation, which is the statistical measure of the amount of variation or dispersion in the pitch values (cf. Chen 1974). Wang & Lin (2004) found a mean of 217.9 Hz with SD = 55.4 (25.4%) for females and 125.7 Hz with SD = 34.5 (27.4%) for males in their corpus study on 79 speakers. Keating & Kuo (2012) reported an average pitch of 213 Hz for females and 128 Hz for males, based on 20 speakers. The average pitch range as measured by Wang & Lin (2004) is 10.2 semitones (st) with a maximum of 26 st. Keating & Kuo (2012) report considerably higher values: 32 st for females and 24 st for males. The subjects in Keating & Kuo (2012) were mainly Taiwanese, but this does not explain the difference between the two studies, given that the pitch range of Mandarin and Taiwanese Mandarin speakers does not significantly differ (as can be seen in study on the prosodic properties of focus in these language varieties of Chen, Wang & Xu (2009)).

1.2 Pitch range and pitch variability in Danish

Danish intonation is remarkably flat or, as described in Grønnum (1994), "prosodically little expressive". She compared a Swedish speaker and a German speaker with speakers of different Danish regiolects and concluded that in general, Danish had less "local sentence intonation, compulsory default accents, compulsory focal accents … word tones, and large Fo movements in (non-accented) stress group patterns". From the figures in Grønnum (1985), we deduct that the

maximum pitch range of Danish speakers is usually around 10 semitones. For Copenhagen speakers (recorded in 1996), Tøndering (2003) reports a pitch range of no more than five semitones. Data on mean pitch for Danish are unfortunately not available. Furthermore, Thorsen (1981) reports a relative standard deviation between 0.5% and 5.2%. As compared to the Chinese values (namely, 217.9 Hz with an SD of 25.4% for females and 125.7 Hz with an SD of 27.4% for males (see section 1.1 above), the pitch variation of Danish intonation is thus remarkably small.

1.3 Pitch, pitch range and pitch variability in second language acquisition

The mean pitch of Chinese-accented English in Ran & van de Weijer (this issue) is 229.0, which is comparable to the mean pitch reported by Wang & Lin (2004) (217.9 Hz for females) and Keating & Kuo (2012) (213 Hz for females). This suggests that mean pitch is subject to L1 transfer. Previous research on L2 acquisition of mean pitch and pitch range has shown contradictory findings. It is often assumed that L2 pitch range is smaller than the pitch range of the target language (Busà and Urbani 2007). In fact, Dutch learners of Modern Greek and Finnish learners of Russian turned out to have significant narrower pitch ranges in their L2 than in their L1, although the pitch range of the target language is larger than in the native languages of the learner (Mennen 2007, Ullakonoja 2007). Whereas it seems plausible that L2 learners, by lack of proficiency, adopt a narrower pitch range, this is not necessarily the case. This was shown by Zimmerer, Andreeva, Jügler & Möbius (2015) in a comparative study on L1 and L2 French and German, two languages which have similar pitch ranges. In this light, it is interesting to consider an early study which showed that the pitch range of native speakers of Chinese was 1.5 times larger than the pitch range of native speakers of English, but when English speakers spoke Chinese, their pitch range increased, although not enough to reach native-like values (Chen 1974).

It is still unclear how these differences in L2 pitch ranges, especially with regard to the speaker's L1 can be explained. It seems likely that the proficiency level plays a role but results so far are inconclusive. As for Danish learners of Chinese, it is evident that the difference between the pitch range of their L1 and L2 is relatively large. We hypothesize that, like the English speakers of Chinese in Chen (1974), they adopt a pitch range that is in between that of the two languages. Given that the Danish pitch is notoriously flat (section 1.2. above) we also hypothesize that the pitch range of Danish-accented Chinese is smaller than native Chinese, although it may be larger than native

Danish. To investigate this, we recorded short sentences in Mandarin Chinese as spoken by Danish undergraduate students of Chinese and analysed their mean pitch, pitch range as well as pitch variability.

2 Methodology

2.1 Approach

We asked Danish learners of Chinese to read simple sentences aloud, which were recorded. We chose read speech instead of spontaneous speech because the students were not very advanced L2 speakers of Chinese (third year undergraduate students): by providing them with the opportunity to prepare the sentences before reading them aloud, the speech was supposedly more fluent than if they had spoken spontaneously. We selected eight simple statement sentences with the same structure, in which all four lexical tones, and also To, occurred several times. These target stimulus sentences were alternated with 81 other sentences of the same length but with different structures. The target stimulus sentences were the following:

(1)

我伯伯是医生	*Wǒ bóbo shì yīshēng.*	My uncle is a doctor.
我弟弟是老师	*Wǒ dìdi shì lǎoshī.*	My younger brother is a teacher.
我哥哥是老师	*Wǒ gēge shì lǎoshī.*	My elder brother is a teacher.
我婶婶是老师。	*Wǒ shěnshen shì lǎoshī.*	My aunt is a teacher.
我爸爸是医生。	*Wǒ bàba shì yīshēng.*	My father is a doctor.
我爷爷是老师。	*Wǒ yéye shì lǎoshī.*	My grandfather is a teacher.
我妈妈是医生。	*Wǒ māma shì yīshēng.*	My mother is a doctor.
我姐姐是医生。	*Wǒ jiějie shì yīshēng.*	My elder sister is a doctor.

2.2 Subjects

Twelve undergraduate students (8 females and 4 males) enrolled in the Chinese Studies program at Aarhus University in Denmark took part in the study. All students were Danish native speakers and

had spent one semester in Beijing as part of their studies. At the time of the recordings, all participants were about to graduate. Some of them had studied only 3 years at university, while others had been taught Chinese in highschool as well. All subjects volunteered to participate in the experiment and were not compensated either financially or by course credit. None of the subjects reported any hearing, vision, or reading deficiencies.

2.3 Design

The subjects were instructed to read the sentences from a Microsoft PowerPoint presentation. Each sentence was presented on a single slide in both Chinese characters and in pinyin orthography (tones were indicated with standard diacritics, like mā, má, mǎ, mà, ma). The experiment was self-paced and took 15-20 minutes on average. The speech was recorded with a Tascam DR05V2 recorder in the linguistics lab at Aarhus University.

3 Results

The rhymes were annotated with Praat speech processing software (Boersma & Weenink 2015) and the pitch was tracked by using a Praat script (Xu 2013). We speaker-normalized the pitch values by Herz-to-semitone conversion (formula: 12*log2(Hz), following Patel (2006)). Like in native Chinese, the minF0, maxF0, and meanF0 were higher for female speakers than for male speakers, and pitch range and standard deviation were larger for female speakers than for male speakers. The average minF0 was 78.4 st for the female speakers and 75.4 st for the male speakers. The average maxF0 was 98.4 st for the female students and 91.3 st for the male students. The grand mean for female subjects was 91.5 st (149.4 Hz) and the grand mean for the male subjects was 81.4 st (138.4 Hz). The pitch range was 20.0 st for the female participants and 15.8 st for the male participants. Finally, the females also had a larger standard deviation (SD = 3.6) than the males (SD = 3.0), indicating that female speakers produced a larger pitch variability than male speakers. We observed considerable individual variation in pitch range and SD of our subjects: the speakers' pitch ranges varied between 11.2 and 23.7 and the SD varied between 1.9 and 4.7. We present the values for each individual speaker in Table 1.

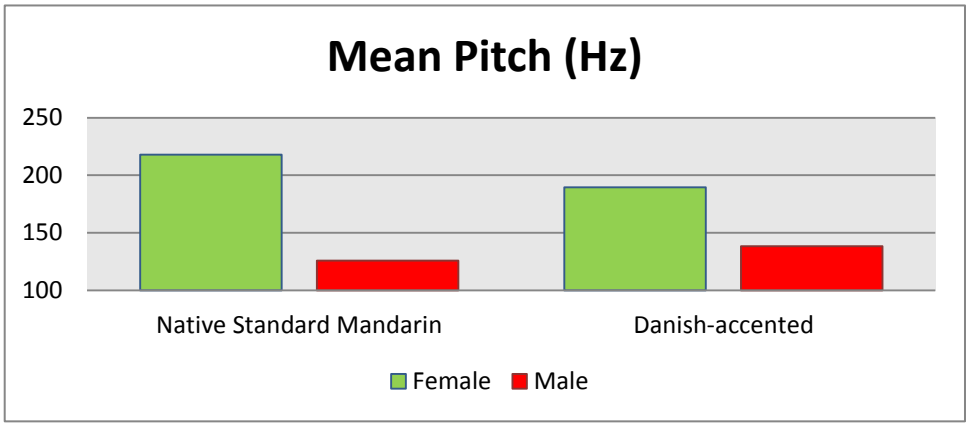
Table 1. FoMin, FoMax, mean pitch, pitch range, and standard deviation in semitones for each subject.

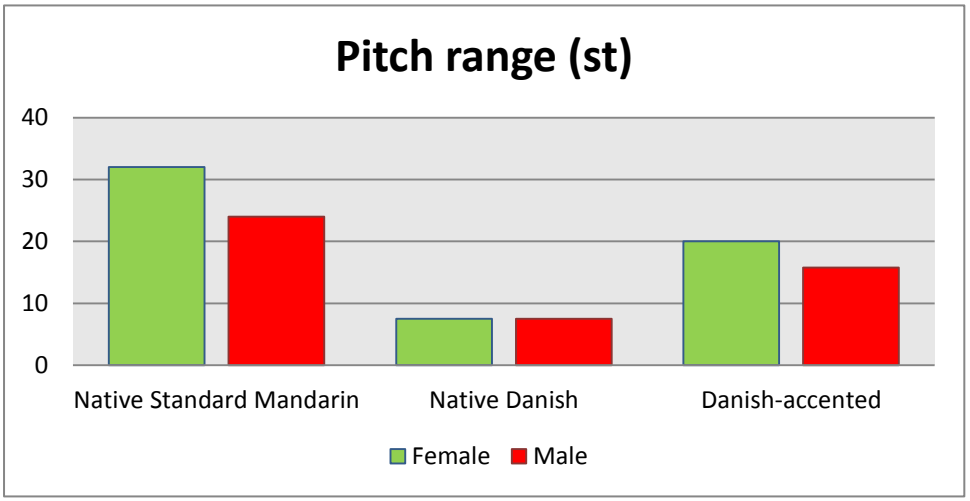
Subject		*minF0*	*maxF0*	*pitch range*	*mean pitch*	*standard deviation*
Female	1	80.0	96.5	16.5	92.6	2.6
	2	80.9	100.7	19.8	92.0	3.8
	3	77.3	98.1	20.8	88.1	4.2
	4	76.2	96.3	20.1	89.8	4.7
	5	77.6	101.4	23.7	93.2	3.3
	6	77.4	98.7	21.4	92.2	3.3
	7	80.9	98.1	17.2	93.2	2.6
	8	77.0	97.2	20.2	90.6	4.3
	Average	**78.4**	**98.4**	**20.0**	**91.5**	**3.6**
Male	1	75.2	89.0	13.8	80.6	3.3
	2	75.0	93.4	18.4	83.0	3.6
	3	75.1	95.1	20.0	81.1	3.2
	4	76.3	87.5	11.2	81.0	1.9
	Average	**75.4**	**91.3**	**15.8**	**81.4**	**3.0**

4 Discussion

We investigated to what extent the mean pitch, pitch range, and standard deviation in Danish-accented Chinese approaches native-like production. In order to compare our results with the mean pitch, pitch range, and relative standard deviation[1] in the target language and the native language of the speakers, we show the relevant values in Figure 1 (the values for native Mandarin and Danish are based on Wang & Lin (2004) and Thorsen (1981), respectively (unfortunately, for native Danish, mean Fo is not available and SD is not divided by gender)).

[1] Relative standard deviation is the standard deviation divided by the sample mean times 100.





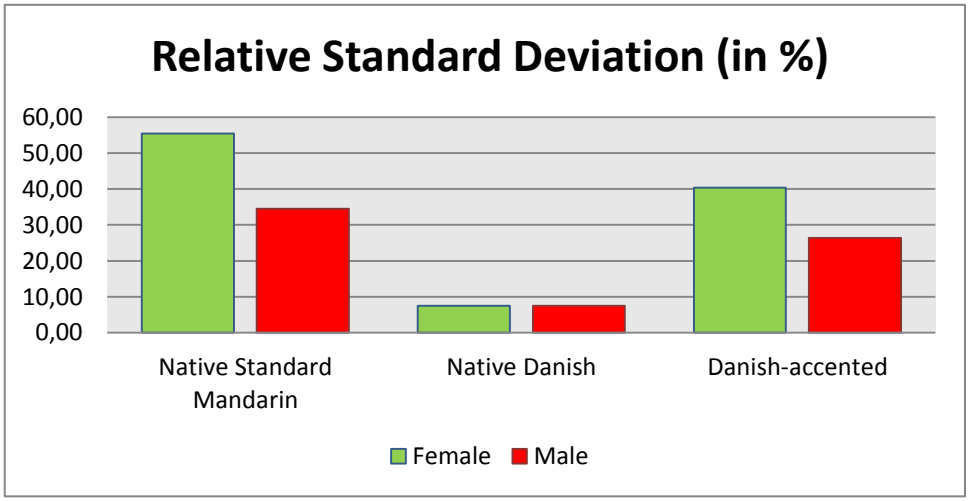


Figure 1. Mean pitch, pitch range and relative standard deviation in Danish, and Standard Mandarin by native and Danish speakers, divided by males and females.

Figure 1 shows that the *mean pitch* for Danish females when speaking Chinese is somewhat lower than that of Chinese females (the difference is 13%). This is likely to result from L1 transfer, but note that the Danish males have a *higher* than native mean (a difference of 10%). The *pitch range* for native Standard Mandarin and Danish-accented Chinese is sometimes comparable, depending on individual differences. Given that the pitch range in Danish is much smaller (5-10st), our results show that pitch range in Chinese is to a large extent acquired by the Danish learners. If we also take into account that Lin & Wang (2004) is, most likely, based on a more varied set of sentence types (since the material was collected from phone calls), including questions, which have a wider pitch range (Shen 1990), the net result of our Danish speakers for statements may be even slightly better. We leave the investigation of statement versus question intonation in Danish-accented Chinese for future research.

Our finding is in agreement with Chen (1974), who showed that the pitch range of native speakers of Chinese was 1.5 times as large as the pitch range of English, but when these English speakers spoke Chinese, their pitch range increased, although not as much as that of the native speakers. We suggest that if the students were more proficient in Chinese and would be made aware of this difference, they could possibly reach native-like average pitch and pitch range. A longitudinal acquisition study of pitch range or a comparison of groups with different levels of proficiency is planned for future research, including a comparison of the pitch range of the same speakers in Danish and Chinese and that of a control group.

The standard deviation for both male and female Danish speakers turned out considerably lower than the standard deviation of native speakers (27% for females and 23% for males), indicating that the Danish L2 speakers show considerably less pitch variability than the native speakers. This is likely the result of native language transfer. The flat intonation of Danish makes it plausible that Danish-accented Chinese also has a relatively flat intonation.

Pitch range and variability of pitch are of course related to the realization of local pitch contours of tones. We assume that a poor realization of tonal pitch contours is strongly related to the pitch variability on the global (sentence) level as investigated here. However, tonal contrasts can be realized within larger or smaller pitch ranges and, vice versa, native-like pitch range and pitch variability on the global (sentence) level may be reached without a correct implementation of local

(tonal) pitch contours. We are therefore currently also investigating the realization of tonal pitch contours in Danish-accented Chinese.

5 Conclusion

We investigated the acquisition of pitch, pitch range, and variability of pitch in Chinese as a second language by Danish speakers. Danish is a language with an extremely flat intonation whereas Chinese is a language with a considerable large pitch range and much more pitch variability, which poses a challenge to second language acquisition of intonation. We showed that the acquisition of mean pitch and pitch range is largely successful. But pitch variability, as expressed by the standard deviation of F0, was 23-27% smaller than in native speech. This is probably related to the production of tonal pitch contours.

References

Boersma, Paul, & David Weenink (2015). *Praat: Doing phonetics by computer* [computer program Version 5.4.17].

Busà, M. Grazia & Martina Urbani (2011). A cross linguistic analysis of pitch range in English L1 and L2. *Proc. 17th International Congress of Phonetic Sciences (ICPhS XVII), Hong Kong,* 380-383.

Chen, Gwang-tsai (1974). The pitch range of English and Chinese speakers. *Journal of Chinese Linguistics, 2*(2), 159-171.

Chen, Aoju, Toni Rietveld & Carlos Gussenhoven (2001). Language-specific effects of pitch range on the perception of universal intonational meaning. *Interspeech,* 1403-1406.

Chen, Szu-Wei, Wang, Bei, & Xu, Yi. (2009). Closely related languages, different ways of realizing focus. *Interspeech*, 1007-1010.

Grønnum, Nina (1985). Intonation and text in Standard Danish. *The Journal of the Acoustical Society of America, 77*(3), 1205-1216.

Grønnum, Nina (1994). *The groundworks of Danish intonation*. Copenhagen: Museum Tusculanum Press.

Grønnum, Nina (1998). Danish. *Journal of the International Phonetic Association,* 28(1-2), 99-105.

Grønnum, Nina (2009). A Danish phonetically annotated spontaneous speech corpus (DanPASS). *Speech Communication,* 51(7), 594-603.

Hirst, Daniel & Di Cristo, Albert (1998). *Intonation systems: a survey of twenty languages*. Cambridge: Cambridge University Press.

Kang, Okim (2010). Relative salience of suprasegmental features on judgments of L2 comprehensibility and accentedness. *System*, 38(2), 301-315.

Keating, Patricia & Grace Kuo (2012). Comparison of speaking fundamental frequency in English and Mandarin. *The Journal of the Acoustical Society of America, 132*(2), 1050-1060.

Mennen, Ineke (2007). Phonological and phonetic influences in non-native intonation. In Jürgen Trouvin & Ulrike Gut (eds). *Non-Native Prosody: Phonetic Description and Teaching Practice.* (*Trends in Linguistics Studies and Monographs*, 186), 53-76. Berlin, NewYork: De Gruyter Mouton.

Patel, Aniruddh D. (2006). An empirical method for comparing pitch patterns in spoken and musical melodies: A comment on JGS Pearl's "Eavesdropping with a master: Leos Janácek and the music of speech." *Empirical Musicology Review* 1(3), 166-169.

Rasier, Laurent & Philippe Hiligsmann (2007). Prosodic transfer from L1 to L2. Theoretical and methodological issues. *Nouveaux cahiers de linguistique française*, 28, 41-66.

Shen, Xiao-nan Susan (1990). *The prosody of Mandarin Chinese. In Language Arts & Disciplines* 118. Berkeley, Los Angeles, Oxford: University of California Press.

Thorsen, Nina (1981). Intonation contours and stress group patterns in declarative sentences of varying length in ASC Danish -- supplementary data. *Annual Reports of the Institute of Phonetics, University of Copenhagen, ARIPUC 15, 13-47.*

Tøndering, John (2003). Intonation contours in Danish spontaneous speech. *Proc. 15th International Congress of Phonetic Sciences (ICPhS XV)Barcelona,* 1241-1244.

Ullakonoja, Riikka (2007). Comparison of pitch range in Finnish (L1) and Russian (L2). *Proc. 16th International Congress of Phonetic Sciences (ICPhS XVI) Saarbrücken,* 1701-1704.

Xu, Yi (2013). ProsodyPro--A tool for large-scale systematic prosody analysis. *Proceedings of Tools and Resources for the Analysis of Speech Prosody (TRASP 2013),* Aix-en-Provence, France.

Wang, Maolin & Maocan Lin (2004). An analysis of pitch in Chinese spontaneous speech. *Proceedings of the. International Symposium on Tonal Aspects of Languages: With Emphasis on Tone Languages.* Beijing.

Zimmerer, Frank, Bistra Andreeva, Jeana Jügler & Bernd Möbius. Comparison of pitch profiles of German and French speakers speaking French and German. *Proc. 18th International Congress of Phonetic Sciences (ICPhS XVIII)*, Glasgow, 2015.