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Pitching in tone and non-tone second languages: Cantonese, Mandarin and English produced by Mandarin and Cantonese speakers

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Abstract

Comparing pitch range in Mandarin, Cantonese and English produced by Mandarin and Cantonese speakers, this study provides evidence on speakers of tonal L1 resisting pitch range compression in tone and non-tone L2. Both Mandarin and Cantonese speakers' L2 Cantonese/ Mandarin and L2 English are of comparable pitch ranges in their respective L1. This pattern contrasts with what was found in non-tone language pairs such as Dutch speakers' L2 English or Finnish speakers' L2 Russian, supplementing research on L2 prosody. Furthermore, as a preliminary study on tri-linguals' use of pitch range, this study also showed that speakers may employ different pitch ranges for different language, and that pitch range during L2 speech is more than a general compression phenomenon; rather, many patterns are possible, depending on the speaker group, the languages under discussion and with what/which (L1 or another L2) we are drawing the comparison.

Index Terms: pitch range, second language acquisition, Cantonese, Mandarin, English

1. Introduction

In speech comprehension and accent ratings, prosody is more important than segmentals. Inappropriate use of prosody may result in miscommunication linguistically as well as para-linguistically. For example, [1] and [2] reported that English listeners perceive less amount of emphasis and surprise in L2 English produced by Dutch speakers than Dutch listeners do, because English has a larger pitch range than Dutch or L2 English produced by Dutch speakers.

Important as prosody is, it is notoriously difficult to acquire [3-6]. Even highly fluent speakers could rarely manage contrasts in intonation such as peak alignment across languages [7]. Difficulties in prosody acquisition are not only found in specific structures such as focus realization, but are reflected on the macro level as well. L2 speakers typically demonstrate a slower speech rate [8], and longer, more frequent and unnatural pauses [9]. Moreover, L2 speakers deviate from native speakers in pitch range.

Languages may inherently differ in their pitch ranges [10, 11]. [12] reported that a bi-dialectal Thai speaker adopted a smaller pitch range when speaking standard Thai. [13] found similar cases in Chinese female speakers.

Cross-linguistically, Cantonese is found to have a similar pitch range as American English [14]. [15] reported larger pitch range in English than Mandarin in narrative speech from young Mandarin-American English bilinguals. The opposite was found in [16] where 20 males and 20 female speakers of Mandarin showed larger pitch range than American English speakers in reading words and sentences. The conflicting results may have been due to the differences in tasks and materials. [17] demonstrated that in spontaneous short utterances Mandarin speakers' larger pitch range is larger than English speakers', but in prose reading pitch ranges from Mandarin and English speakers are comparable, only that Mandarin speakers have a higher mean F0.

Studies on L2 acquisition of pitch range have observed plenty cases of L2 speakers showing a narrower pitch range than native speakers. Among the earliest, [18, 19] reported Dutch learners of English used a smaller pitch range than native English speakers. Spanish [6] and Italian [20] learners of English, Dutch learners of Greek [21], Finnish learners of Russian [22] were found to exhibit similar patterns. However, [23] reported that Arab speakers did not demonstrate pitch range narrowing in L2 English. It is therefore still unclear if such pitch range compression is limited to language pairs investigated or is a more general tendency with few exceptions.

L2 pitch range compression is not only found on inter-speaker level, i.e. comparing L2 speaker with native speakers, but also on intra-speaker level. Comparing pitch range in French and German speakers' production of L2 German and L2 French with their respective L1 pitch range, [24] showed both groups of speakers used a smaller pitch range in L2 than in L1. The trend persists with speakers of high L2 proficiency.

It would then be interesting to examine the effects of tone in L2 pitch range compression. One the one hand, although there were multitudes of studies on L2 prosody of tone language speakers, few have addressed L2 pitch range compression. Since pitch is used to denote lexical distinction as well as intonation, frequent pitch fluctuation is compulsory in tone languages. It would be likely that speakers of tone languages would retain such fluctuation in L2, resulting in an absence of pitch range compression as observed with speakers of non-tone languages such as Dutch, Italian, Spanish and others.

On the other hand, with majority of the work on L2 pitch range acquisition focusing on L2 English, few have examined pitch range compression in tonal L2. The pitch range compression was speculated to reflect speakers' lack of confidence, or their strategy to compromise accuracy on pitch range (i.e. intonation in previous studies) so as to allocate enough effort to timing, stress and correct segmental pronunciation [24]. If that was the case, the tendency of being cautious and reducing pitch contrasts would be faced with the compulsory linguistic need to maintain tonal contrast when L2 is tonal. Furthermore, the effort of making pitch fluctuation would contribute to making lexical distinction, which would propel speakers not to compress pitch range in tonal L2.

The current study attempts to address the unexplored role of tone in L2 pitch range compression by examining Mandarin and Cantonese speakers' production of Cantonese, Mandarin

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and English. The first question this study addresses is whether speakers of a tone language exhibit intra-person pitch range compression in their L2. Second, this study wishes to examine if speakers would compress their pitch range (on intra-person level) when L2 is a tone language. It is hypothesized that tone language speakers would not compress their pitch range in L2 on intra-speaker level, especially when L2 is a tone language, as tone language speakers are accustomed to pitch fluctuations and that they needed to maintain their pitch range to achieve tonal contrasts in tonal L2. In other words, Mandarin and Cantonese speakers are expected to show no pitch compression in L2 English, L2 Mandarin or L2 Cantonese in comparison with their respective L1.

Additionally, if L2 pitch range compression is truly a prevalent phenomenon, it would be interesting to examine the pitch ranges in two or more second languages. Hence the third research question in this preliminary study asks if speakers use the same pitch range in different second languages. I hypothesize that it would not be the case, for what motivated speakers to employ a different pitch range in one L2 from the L1, such as confidence, could affect speakers' use of pitch range in different L2s. Specifically, Mandarin and Cantonese speakers are expected to demonstrate different pitch ranges for L2 English and L2 Cantonese (for Mandarin speakers) or L2 Mandarin (for Cantonese speakers), with a smaller pitch range in L2 English which they have more confidence in, and a relative larger one for the tonal L2 which they have less confidence in.

2. Method

2.1. Participants

Participants were of a convenience sample from the Chinese University of Hong Kong. Since males were too few, only female data are reported here. There were nine female Mandarin speakers (mean age 27.78). Born and raised in Mainland China, they are considered to be native speakers of Mandarin. They all have started English classes at around age 10. To pursue graduate studies, they have on average been living in HK for 5.06 years; all of them are able to converse in simple daily Cantonese. Their self-reported score for English and Cantonese proficiency on average are 3.5 and 1.94 respectively on a 1-5 Likert scale (1 means least competent, 5 means highly competent).

There were eight female native Cantonese speakers (mean age 21.75). Although all of them have started English classes from around age 3, they are not strictly simultaneous or early bilinguals, as their use predominantly Cantonese in daily life and in school. Their exposure to Mandarin began with Mandarin classes in primary schools at around 7, but like the case with English, their use of Mandarin is highly limited. On a 1-5 Likert scale (1 means least competent, 5 means highly competent), they rated their English proficiency 3.25 and Mandarin proficiency 2.87 on average.

2.2. Task, material and procedure

All participants were asked to read aloud Mandarin, Cantonese and English versions of 'The North Wind and the Sun' (see Appendix). I used Latin square to counter-balance their order for reading the three versions (for lack of participants, three Cantonese speakers read English first, three read Cantonese first, two read Mandarin first). After recording, they filled out a form on language background (including proficiency rating) and personal information.

This particular piece was chosen because it's been widely used in linguistic research for its simplicity in story and words used. In particular, it has been used in prosodic studies before, e.g. [25]. It also offers consistency in task (e.g. spontaneous vs. read) and sentence type (e.g. questions vs. statement), which if not controlled could entail differences in pitch range [17, 20]. More importantly, recordings of this story would be around one minute, which is the duration proved to yield valid and reliable measurements of maximal and minimal pitch level, mean pitch and pitch range [26, 27].

2.3. Measurements

Following [16, 17, 20], I took long term distributional measures, i.e. maximal pitch, minimal pitch, mean pitch (register/level), and calculate pitch range (span) by subtracting minimal pitch from maximal pitch (all in raw Hertz). Recordings were first segmented manually in Praat [28] to mark out read speech. A Praat script ProsodyPro [29] was run to manually correct octave errors in pitch tracking. Creaky parts in the recordings were retained, as their extreme low pitch along with creakiness is often considered as part of the low tones in Mandarin and Cantonese. (Creaky voice occurs frequently during native speakers' production of Mandarin and Cantonese low tones; and in perception, creakiness is an important cue for low tone.) Then, ProsodyPro is run to automatically take measurements.

3. Results

3.1. Intra-speaker comparison: Mandarin speakers

A one-way repeated measures ANOVA was conducted for pair-wise comparison between Mandarin speakers' pitch range in Mandarin, Cantonese and English. As shown in Figure 1, their pitch range in L1 Mandarin (M = 246.62, SD = 61.46) was larger than that for L2 English (M = 239.46, SD = 56.33) which was in turn larger than that for L2 Cantonese (M= 227.61, SD = 45.04). But these differences were not statistically significant.

A one-way repeated measures ANOVA was conducted to compare Mandarin speakers' mean pitch in the three languages, as shown in Figure 2. There was a significant effect of language spoken (F (2, 16) = 59.01, p < .0001). Post hoc tests using the Bonferroni correction revealed that Mandarin speakers' mean pitch for L1 Mandarin (M = 220.49, SD = 33.37) was significantly higher than that for L2 English (M = 211.57, SD = 34.33) (p = .033). Their mean pitch for L2 English was also significantly higher than that for L2 Cantonese (M= 196.73, SD = 31.91) (p < .0001).

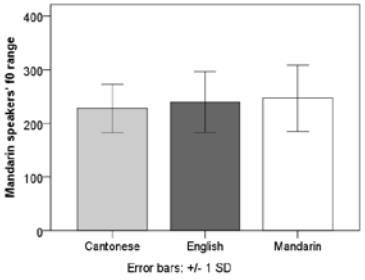

Figure 1: Mandarin speakers' pitch range in Mandarin, Cantonese and English.

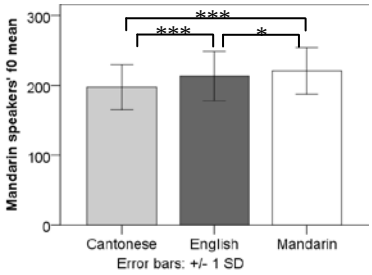

Figure 2: Mandarin speakers' mean pitch for Cantonese, English and Mandarin.

These results indicate that Mandarin speakers do not compress their pitch range in tonal and non-tonal L2, as their pitch ranges in the three languages do not differ significantly. Analysis of their mean pitch further revealed that Mandarin speakers adopted significantly lower pitch level in L2 English and L2 Cantonese than in L1 Mandarin.

3.2. Intra-speaker comparison: Cantonese speakers

A one-way repeated measures ANOVA was conducted to compare Cantonese speakers' pitch range in Cantonese with their mean pitch in Mandarin and English, as shown in Figure 3. No effect of language was found (F (2, 14) = .108). Their pitch range for L1 Cantonese (M = 277.95, SD = 36.05) was similar to that for L2 English (M = 287.30, SD = 86.43) or that for L2 Mandarin (M = 274.49, SD = 44.44).

A one-way repeated measures ANOVA was conducted to compare Cantonese speakers' mean pitch in Cantonese, Mandarin and English. As shown in Figure 4, their mean pitch in L1 Cantonese (M = 231.15, SD = 17.67) was similar to their mean pitch in L2 English (M = 232.27, SD = 13.09) or their mean pitch in L2 Mandarin (M= 238.88, SD = 15.49). But none of the differences was statistically significant.

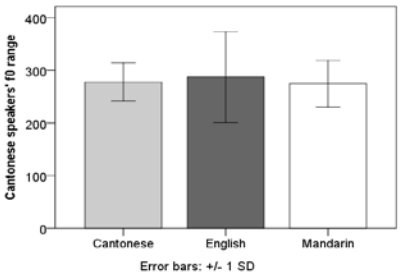

Figure 3: Cantonese speakers' pitch range in Cantonese, English and Mandarin.

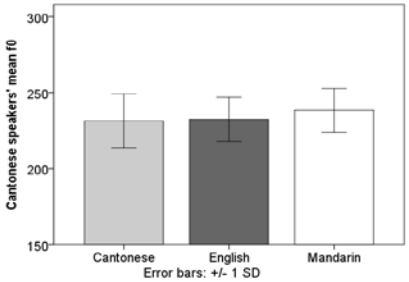

Figure 4: Cantonese speakers' mean pitch for Cantonese, English and Mandarin.

These results indicate that Cantonese speakers do not compress their pitch range in L2 either, as their pitch range in L2 English/Mandarin was not significantly different from that for their L1 Cantonese. Analysis of their mean pitch further revealed that Cantonese speakers adopted higher pitch level in L2 Mandarin and L2 English than in L1 Cantonese.

3.3. Inter-speaker comparison

One-way MANOVA comparing Cantonese and Mandarin speakers' pitch ranges in Cantonese, Mandarin and English respectively revealed that the two groups did not differ significantly in pitch range in the three languages (F (3,13) = 3.007, p = .069; Wilk's Λ = 0.59, partial η^2 = .41).

Such results show that in addition to absence of pitch range compression on intra-speaker level, Mandarin and Cantonese speakers did not show narrower pitch range in their tonal L2s on inter-speaker level as well. It provides further support for the hypothesis that a tonal L1/tonal L2 resists pitch range compression in L2.

3.4. A closer look: individuals

Results so far suggest that as speaker groups, Mandarin and Cantonese speakers behave similarly: they both adopt the same pitch range for L1 (Mandarin or Cantonese) and L2 (Cantonese or Mandarin, English), irrespective of the L2 being tonal or not. Yet close examination of individual speakers' pitch range in each of the three languages (in Figure 5 and Figure 6) demonstrate that the two speaker groups are strikingly different. Considerable individual variation within each speaker group also highlight that pitch range in L2 speech is more complex than compression.

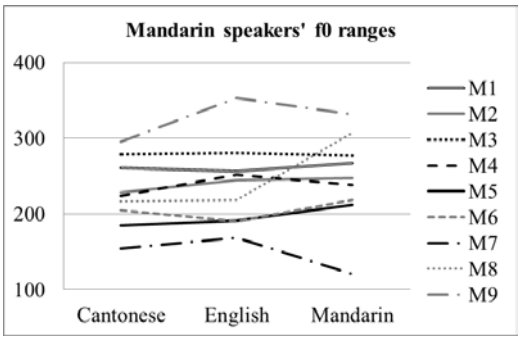

Figure 5: Individual Mandarin speakers' pitch range in Cantonese, English and Mandarin.

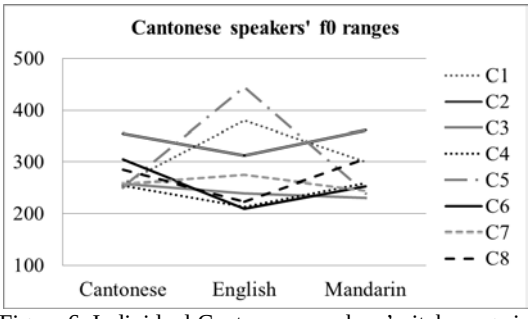

Figure 6: Individual Cantonese speakers' pitch range in Cantonese, English and Mandarin.

Whereas most Mandarin speakers on an individual level did show a similar pitch range in the three languages (except for Speaker M9, M8 and M7), most Cantonese speakers did not. These Cantonese speakers seemed to fall into two sub-groups, with Speaker C5, C1 and C7 using a larger pitch range for English than for their L1 Cantonese or L2 Mandarin and the others opting for a moderately smaller pitch range for English than for L1 Cantonese. Further, while Mandarin Speaker M8 and M9 consistently extended or minimized their L1 pitch range (by nearly 100 Hertz) when they speak both second languages, Cantonese speakers readily used L1 pitch range for L2 Mandarin but treated L2 English in a different manner from L2 Mandarin.

These observations demonstrate that pitch range during L2 speech is more than a general compression phenomenon; rather, many patterns are possible, depending on the speaker group, the languages under discussion and with what/which (L1 or another L2) we are drawing the comparison.

4. Discussion

4.1. Effect of tone on pitch range compression

This study demonstrated the effect of tone in pitch range compression from two aspects. First, comparing Mandarin and Cantonese speakers' pitch range in L2 English with the pitch range in their respective L1, this study examined effect of tonal L1 on L2 pitch range compression on intra-speaker level. As predicted, patterns found from non-tone language speakers were not borne out with Mandarin and Cantonese speakers. These tone language speakers did not exhibit pitch range compression in L2 English. Rather, their pitch range in L2 (both English and Cantonese/Mandarin) was quite comparable to that for their L1.

Second, this study probed the effect of tonal L2 on pitch range compression on intra-speaker level (e.g. comparing Mandarin speakers' pitch range in L2 Cantonese with that in their L1 Mandarin) as well as inter-speaker level (e.g. comparing Cantonese speakers' pitch range in L2 Mandarin with that in native Mandarin). Results showed that Mandarin and Cantonese speakers did not narrow their pitch range in tonal L2. This finding is consistent with [30] which showed that pitch range in Japanese learners L2 Mandarin was not significantly smaller than pitch range in native Mandarin speakers' speech. Together, the findings point to the likely effect of tonal L2 resisting pitch range compression.

Why should tone have such an effect on pitch range compression? Some scholars have proposed that tone languages having both tonal and intonation contrasts would require larger pitch variations, hence larger pitch range, than non-tone languages which have only intonation contrasts [16]. Such claims are partially supported as typological studies found that languages with contour tones generally had a larger pitch range than languages with only level tones[31]. Studies have also found larger pitch range in tone languages, e.g. Mandarin than in non-tone languages, e.g. English in spontaneous short utterances [17]. These studies illustrate how having tone affects a languages' pitch range. It wouldn't be surprising then that pitch range in a tonal L1 is maintained in that language's speakers' L2. It is also possible that because intonation is overlaid on tone, for a given amount of pitch variation, tone language speakers perceive less amount of emphasis than non-tone language speakers do; that in turn led them to produce exaggerated pitch variation than necessary in L2.

As for tonal L2, not being able to put tones right in a tonal L2 would bring a much higher risk of miscommunication than speaking in a flattened fashion in a non-tone L2, hence speakers are motivated to display a larger-than-comfortable pitch range so that distinction of tones are possible. It is essentially a case where the need to make perceptual contrast meets with the predisposition to narrow pitch range [24]. Findings from this study showed absence of pitch range compression, providing evidence for linguistic needs outweighing psychological predispositions.

4.2. Understanding pitch range compression in Mandarin and Cantonese

Absence of pitch range compression does not naturally follow that L2 prosody in terms of pitch range is perfect. As this study used long term distributional measures only, it may not capture the characteristics of Mandarin and Cantonese speakers' L2 pitch range. Some studies have suggested more linguistic measures, such as examining sentence-initial peaks, sentence-final lows, post-accent valleys to capture fine-grained prosodic differences between languages or between L1 and L2 [27]. Though some of these measures may not be directly applicable to Chinese languages, they may, when used well, yield fruitful findings. For example, German speakers' L2 English does not differ much from native English in overall pitch range or mean pitch, but deviates considerably in specific positions [32]. More studies in greater detail should be done to uncover characteristics of Mandarin and Cantonese speakers' L2 pitch range(s).

4.3. Pitch range in two second languages

By comparing Mandarin and Cantonese speakers' pitch range in their L2 English and L2 Cantonese/ Mandarin, this study inspected pitch range compression in multi-linguals' two second languages. As speaker groups both Mandarin and Cantonese speakers demonstrated varied pitch range for different second languages, though the difference is small. On individual level, some Cantonese speakers used much larger pitch range for L2 English then for L2 Mandarin, and some did the opposite.

Such findings on individual variation echoes [30]'s observation that speakers vary in their way to adjust pitch range, some moderated the maximal level while others manipulated the minimal level. To understand individual variation in L2 pitch range control, further studies are needed.

5. Conclusion

The current research supplements previous studies on L2 pitch range by inspecting tone language speakers' pitch range in tone and non-tone second languages. It is a preliminary investigation into pitch range in two second languages. It is also one of the first few to examine pitch range compression in L1 and L2 on intra-speaker level. Results suggest that speakers may vary their pitch ranges in different second languages, and that tones do play a role. Specifically, on intra-speaker level, tonal L1 may lead speakers to be more resistant to compress pitch range in L2.

6. References

[1] A. Chen, C. Gussenhoven, and T. Rietveld, "Language-specificity in the perception of paralinguistic intonational meaning," *Language and Speech*, vol. 47, pp. 311-349, 2004.

[2] A. Chen, "Perception of paralinguistic intonational meaning in a second language," *Language Learning*, vol. 59, pp. 367-409, 2009.

[3] T. Visceglia, C.-y. Su, and C.-y. Tseng, "Comparison of English narrow focus production by L1 English, Beijing Mandarin and Taiwan Mandarin speakers," in *International Conference on Speech Database and Assessments (Oriental COCOSDA)*, 2012, pp. 47-51.

[4] H. S. H. Fung and P. P. K. Mok, "Realization of narrow focus in Hong Kong English declaratives-- A pilot study," in *Speech Prosody*, 2014, pp. 964-968.

[5] C. Grover, D. G. Jamieson, and M. B. Dobrovolsky, "Intonation in English, French and German: Perception and production," *Language and Speech*, vol. 30, pp. 277-294, 1987.

[6] N. Backman, "Intonation errors in second language pronunciation of eight Spanish speaking adults learning English," *Interlanguage Studies Bulletin*, vol. 4, pp. 239-265, 1979.

[7] I. Mennen, "Bi-directional interference in the intonation of Dutch speakers of Greek," *Journal of Phonetics*, vol. 32, pp. 543-563, 2004.

[8] M. J. Munro and T. M. Derwing, "The effects of speaking rate on listener evaluations of native and foreign-accented speech," *Language Learning*, vol. 48, pp. 159-182, 1998.

[9] A. Riazantseva, "Second language proficiency and pausing: A study of Russian speakers of English," *Studies in Second Language Acquisition*, vol. 23, pp. 497-526, 2001.

[10] D. R. Ladd, *Intonational Phonology*. Cambridge: Cambridge University Press, 1996.

[11] A. Cruttenden, *Intonation*: Cambridge University Press, 1997.

[12] P. Rose, "Any advance on eleven? Linguistic tonetic contrasts in a bidialectal Thai speaker," in *5th Australian Intl. Conf. on Speech Science and Technology*, 1994, pp. 132-137.

[13] D. Deutsch, J. Le, J. Shen, and T. Henthorn, "The pitch levels of female speech in two Chinese villages," *J Acoust Soc Am*, vol. 125, pp. EL208-13, May 2009.

[14] E. P. Altenberg and C. T. Ferrand, "Fundamental frequency in monolingual English, bilingual English/Russian, and bilingual English/Cantonese young adult women," *J Voice*, vol. 20, pp. 89-96, Mar 2006.

[15] S. A. Xue, F. Hagstrom, and J. Hao, "Speaking fundamental frequency characteristics of young and elderly bilingual Chinese-English speakers: a functional system approach," *Asia Pacific Journal of Speech, Language and Hearing*, vol. 7, pp. 55-62, 2002.

[16] S. H. Chen, "The effects of tones on speaking frequency and intensity ranges in Mandarin and Min dialects," *The Journal of the Acoustical Society of America*, vol. 117, p. 3225, 2005.

[17] P. Keating and G. Kuo, "Comparison of speaking fundamental frequency in English and Mandarin," *J Acoust Soc Am*, vol. 132, pp. 1050-60, Aug 2012.

[18] B. R. A. Jenner, "Interlanguage and foreign accent," *Interlanguage Studies Bulletin*, vol. 1, pp. 166-195, 1976.

[19] N. Willems, *English intonation from a Dutch point of view*: Walter de Gruyter, 1982.

[20] M. G. Busà and M. Urbani, "A cross linguistic analysis of pitch range in English L1 and L2," in *ICPhS XVII*, Hong Kong, 2011, pp. 380-383.

[21] I. Mennen, "Can language learners ever acquire the intonation of a second language?," in *STiLL-1998*, Marholmen, Sweden, 1998, pp. 17-20.

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

[23] A. Abu-Al-Makarem and L. Petrosino, "Reading and spontaneous speaking fundamental frequency of young Arabic men for Arabic and English languages: a comparative study," *Percept Mot Skills*, vol. 105, pp. 572-80, Oct 2007.

[24] F. Zimmerer, J. Jügler, B. Andreeva, B. Möbius, and J. Trouvain, "Too cautious to vary more? A comparison of pitch variation in native and non-native productions of French and German speakers," in *7th Speech Prosody Conference*, Dublin, 2014, pp. 1037-1041.

[25] C.-y. Tseng and C.-y. Su, "Where and how to make an emphasis? L2 distinct prosody and why," in *9th International Symposium on Chinese Spoken Language Processing (ISCSLP)*, 2014, pp. 633-637.

[26] Y. Horii, "Some statistical characteristics of voice fundamental frequency," *Journal of Speech Language and Hearing Research*, vol. 18, p. 192, 1975.

[27] D. Patterson, "A Linguistic Approach to Pitch Range Modelling," PhD, University of Edinburgh, 2000.

[28] P. Boersma and D. Weenink, "PRAAT: Doing phonetics by computer," 2010.

[29] Y. Xu, "ProsodyPro — A tool for large-scale systematic prosody analysis," in *Proceedings of Tools and Resources for the Analysis of Speech Prosody (TRASP 2013)*, Aix-en-Provence, France., 2013, pp. 7-10.

[30] S. Shi, J. Zhang, and Y. Xie, "Cross-language comparison of F0 range in speakers of native Chinese, native Japanese and Chinese L2 of Japanese: Preliminary results of a corpus-based analysis," in *9th International Symposium on Chinese Spoken Language Processing (ISCSLP)*, Singapore, 2014, pp. 241-244.

[31] J. A. Alexander, "The Theory of Adaptive Dispersion and Acoustic-phonetic Properties of Cross-language Lexical-tone Systems," PhD, Northwestern University, 2010.

[32] I. Mennen, F. Schaeffler, and C. Dickie, "Second language acquisition of pitch range in German learners of English," *Studies in Second Language Acquisition*, vol. 36, pp. 303-329, 2014.