Mergers and near-mergers in Hong Kong Cantonese Tones

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Introduction

- Hong Kong Cantonese (HKC) stands out from other tone languages by having a rich system of tonal contrast.
- There are six contrastive tones.
- In addition, three tones occur only in syllables ending in /p, t, k/.
- They are shorter variants of three of the six contrastive tones.
- These are shown in the table on the next slide.

Tonal inventory of Hong Kong Cantonese

Tone number	Description	Chao's tone letters	Example	English Gloss
T1	High-level	55	jɐn^{55}	'because of'
T2	High-rising	35	jɐn^{35}	'bear with'
T3	Mid-level	33	jɐn^{33}	'mark'
T4	Low-falling / Extra Low-level	21 / 11	jɐn$^{21/11}$	'people'
T5	Low-rising	23	jɐn^{23}	'to cause'
T6	Low-level	22	jɐn^{22}	'fetus'
T7 (=T1)	High-Stopped	5	jɐt^{5}	'one'
T8 (=T3)	Mid-Stopped	3	jip^{3}	'to fold'
T9 (=T6)	Mid-Stopped	2	jɐt^{2}	'day'

The Six Contrastive HKC Tones :

Upper Register	T1 [55]	T2 [35]	T3 [33]
Lower Register	T4 [21/11]	T5 [23]	T6 [22]

Evidence of Tones Merging (1)

Possible T3 & T5 merging reported in

- Killingley (1985)
- Cheung (1986)
- Chang (1993)
- Wong (2006, 2008)
- Cheng (2002, 2003)
- Leung (2007)

Evidence of Tones Merging (2)

- Possible T2 & T5 merging reported in:
  - Fok (1974)
  - Kei et al. (2002)
  - Bauer, Cheung and Cheung (2000, 2003)
  - Mok and Wong (2010a, 2010b)
- Other pairs reported:
  - T3 & T6
    - Fok (1974)
    - Kei et al. (2002)
    - Mok and Wong (2010a, 2010b)
  - T4 & T6
    - Fok (1974)

To sum up the possible mergers in HKC :

Upper Register	T1 [55]	T2 [35]	T3 [33]
Lower Register	T4 [21/11]	T5 [23]	T6 [22]

Issues being explored

- Q.1 How many tonal categories in HKC exhibit phonetic variations and mergers?
- Q.2 What are the directions of the mergers?
- Q.3 What are the possible factors?

Methodology (1)

- Subjects
  - 120 subjects in total
  - 3 different age groups:
    - Gp A: 20-25 yrs old (50 subjects; 26 F, 25 M)
    - Gp B: 35-45 yrs old (50 subjects: 25 F, 25 M)
    - Gp C: 50-58 yrs old (20 subjects: 10 F, 10 M)
  - All were born and raised in Hong Kong with Cantonese as their L1.
  - None of them has known hearing or speech disorder.

Methodology (2)

- Test Materials—48 syllables.
- Only open syllables are used.
- One set consists of syllables that have all 6 tones realized as existing HKC words—the 'Full Tone' set with 24 items.
- The other set consists of syllables that do not have a full-fledged realization of all 6 tones—the 'Deficient Tone' set with 12 items.
- The test items are shown in Table 2.
- All the 48 syllables formed the stimuli of the perception task but only the 36 syllables with existing HKC words were used for the production task.

Test Items

	T1	T2	T3	T4	T5	T6
Full tone set						
/fu/	呼 ‘call’	苦 ‘bitter’	富 ‘rich’	扶 ‘hold’	婦 ‘woman’	付 ‘pay’
/sɛ/	些 ‘some’	寫 ‘write’	赦 ‘pardon’	蛇 ‘snake’	社 ‘society’	射 ‘shot’
/si/	師 ‘teacher’	史 ‘history’	嗜 ‘hobby’	時 ‘time’	市 ‘market’	示 ‘notice’
/ji/	醫 ‘cure’	椅 ‘chair’	意 ‘meaning’	兒 ‘son’	耳 ‘ear’	二 ‘two’
Deficient tone set						
/ku/	姑 ‘aunt’	古 ‘ancient’	固 ‘stable’	*	*	*
/p^hø/	*	頗 ‘quite’	破 ‘worn’	婆 ‘ grandma’	*	*
/ja/	吔 (interjection)	*	*	*	也 ‘also’	廿 ‘twenty’
/jɛ/	*	*	*	椰 ‘coconut’	野 ‘wild’	夜 ‘night’

* indicates a syllable that does not have any lexical realization in HKC.

Methodology (3)

- Tasks—both perception and production tasks were designed to elicit data.
- Both tasks were administered to the subjects using a computer program specifically developed for this study.
- Instructions of the tasks were written in Chinese on the computer screen and were read aloud in Cantonese to each subject. Trials were given to the subjects at the beginning of each task.
- The production task was conducted before the perception task to eliminate priming effect.

Methodology (4)

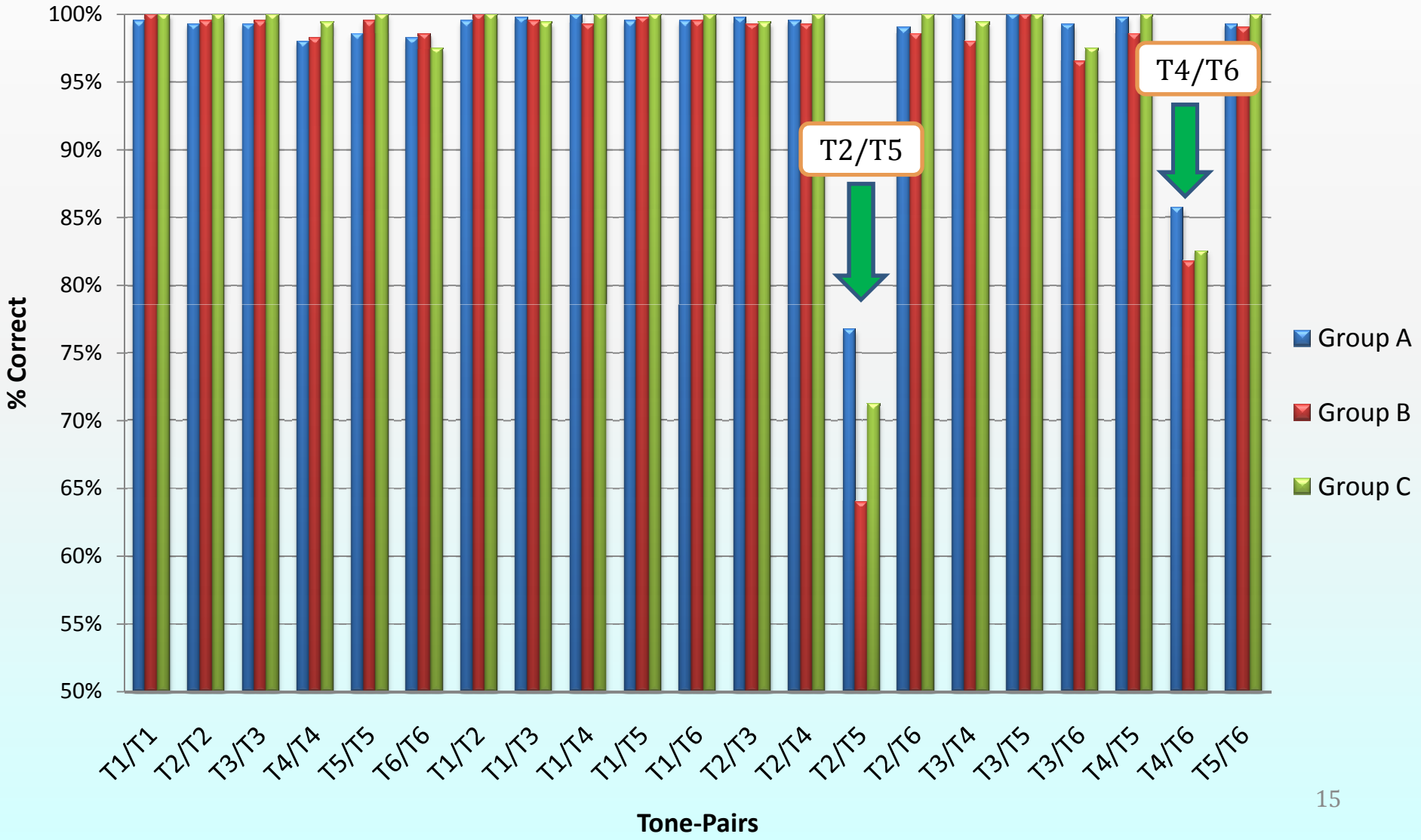
- Perception Task
  - The AX discrimination test was administered in the perception task.
  - A total of 168 pairs of syllables were then presented to the subjects aurally.
  - The subjects were to indicate whether the two syllables presented were identical or not by clicking the ‘same’ or ‘different’ button on the computer screen accordingly.

Methodology (5)

- Production Task
  - Each of the 36 existing syllables was embedded into 2 carrier sentences forming 72 stimuli.
  - The stimuli were randomly drawn by the computer program and presented visually to the subjects.
  - The speech output was recorded digitally for acoustic analysis by Praat.
  - A total of 8,640 speech samples were collected.
  - The speech samples collected were transcribed by the investigators.

Results on Perception (1)

Figure 1: Accuracy rate for tone pair discrimination in perception among age groups

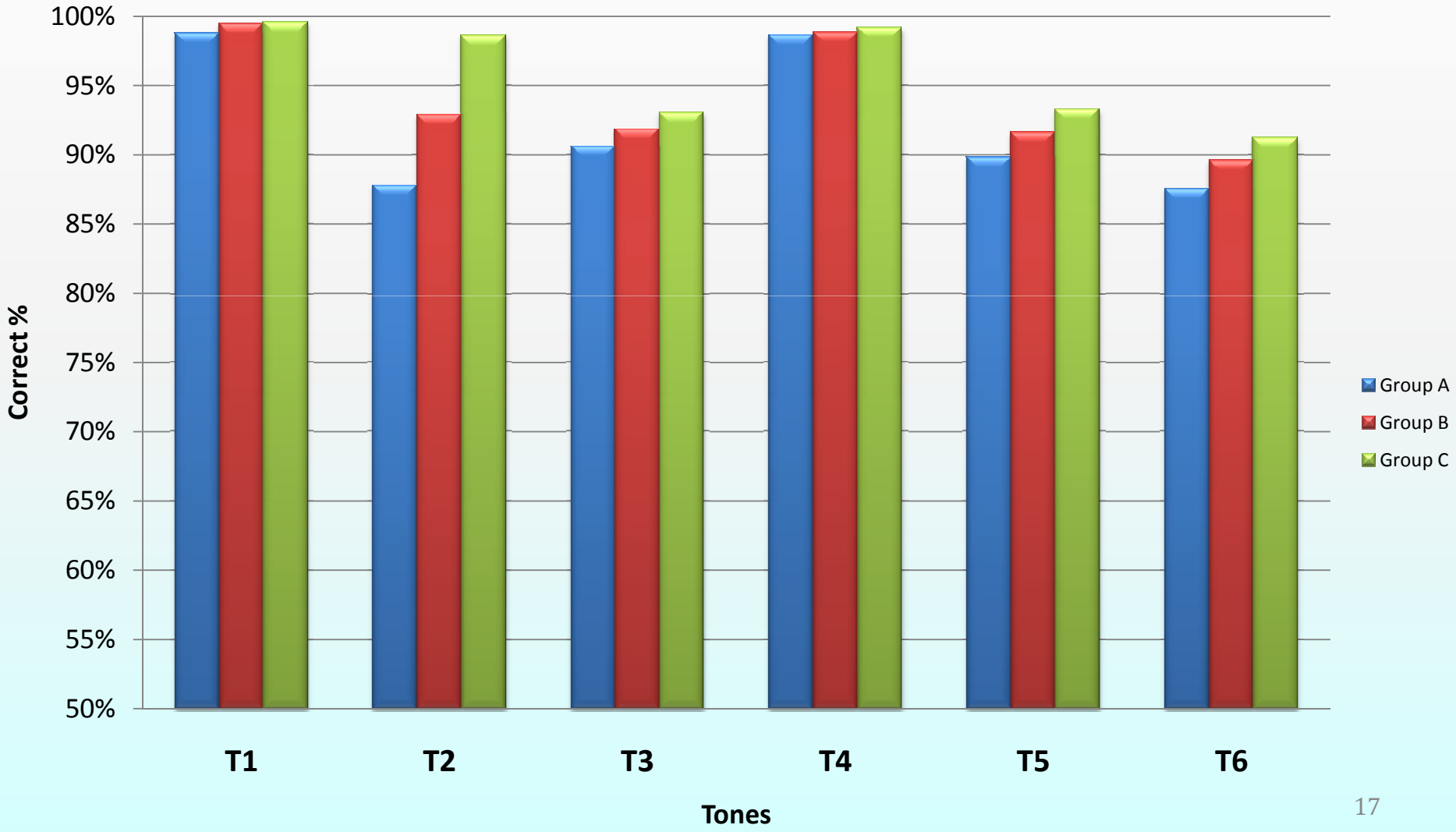


Results on Perception (2)

- Figure 1 shows the discrimination accuracy of all the 21 tonal contrasts across age groups.
- Friedman's one-way (score) repeated-measures (21 tone pair) show that the accuracy rate was significantly different among different types of tonal contrast, $\chi 2\ (20)=947.34\ p < .001$.
- Pairwise comparisons show that the discrimination accuracy mean of T2/T5 (mean=.71 S.D. =.33) and that of T4/T6 (mean=.84, S.D. =.20) were significantly lower when compared with other tonal contrasts (p <.001 for all).
- Kruskal-Wallis one-way ANOVA showed that age group differences were not significant (for instance, for T2/T5 p=.189, for T4/T6 p=.133).

Results on Production (1)

Figure 2: Accuracy rate of tone production among age groups



Results on Production (2)

- Figure 2 shows the accuracy rate of the production of tones among three age groups.
- A significant effect of tone type on the production accuracy was found, $\chi 2\ (5)=109.51$ $p < .001$.
- The post-hoc tests revealed that the means of percent correct were significantly lower for T2, T3, T5 and T6, all have $p < .001$
- Unlike perception, age DID have an effect on the production accuracy.

Results on Production (3)

- The age groups show differences in their production of the 6 tones (in descending order in terms of difficulty):
  - Group A: T2 > T6 > T5 > T3
  - Group B: T6 > T5 > T3 > T2
  - Group C: T6 > T3 > T5
- Overall speaking, T3, T5 and T6 presented challenges to all age groups.
- T2 was well preserved by Group C subjects, became shaky among Group B subjects and presented the greatest challenge to Group A subjects.
- The age effect was found significant only in the production of T2 $\chi 2\ (2) = 8.164$, $p < .05$.

Results on Production (4)

- The error patterns of all three age groups are shown in the next three confusion matrix tables.
- The confusion matrix of Group A and Group B was relatively straightforward.
- Mutual confusion was found between T2/T5 and T3/T6 respectively.

Confusion matrix of Group A (20-25 yrs)

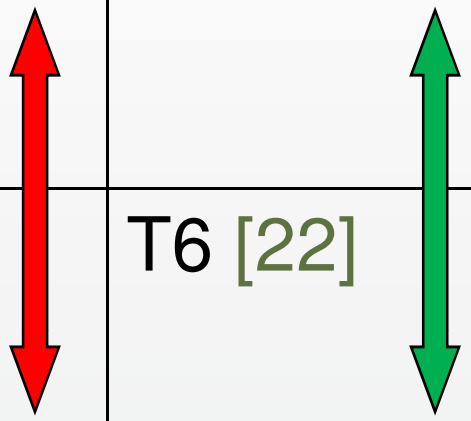
Produced / Target	T1	T2	T3	T4	T5	T6
T1	98.8		0.4 (0.6)	0.2		
T2		87.7	0.2		10.4 (1.7)	
T3		0.3	91.1	0.2 (0.2)	1 (0.2)	6.7 (0.3)
T4		0.2	0.8	98		0.8 (0.2)
T5	0.2	7.4 (0.8)	0.5		89.8	1.3
T6			7.8	2.4	1.9	87.8

Confusion matrix of Group B (35-45 yrs)

Produced / Target	T1	T2	T3	T4	T5	T6
T1	99.4		0.2	0.4		
T2		92.5	0.3		6.5 (0.3)	0.3
T3	0.2	0.5	92.1	0.3	1.3	5.6
T4	0.4			99		0.6
T5	0.2	7.0	0.5	0.2	91.6	0.5
T6	0.2		6.6	1.2 (0.2)	2.2	89.6

Possible mergers found in Group A & Group B

Upper Register	T1 [55]	T2 [35]	T3 [33]
Lower Register	T4 [21/11]	T5 [23]	T6 [22]



- It can be concluded that Group A and Group B speakers found tones of similar contour but different heights confusing.

Confusion matrix of Group C (50-58 yrs)

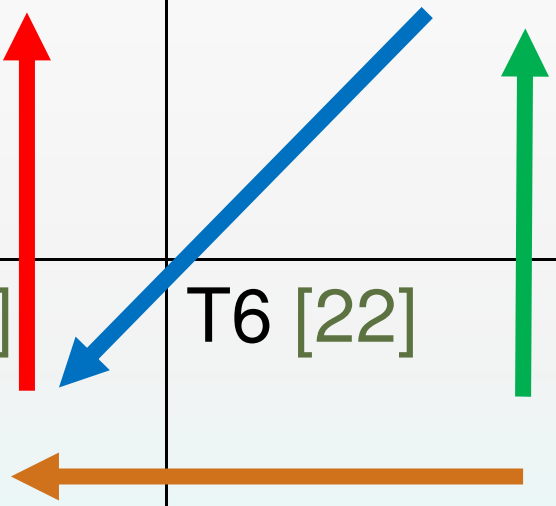
Produced / Target	T1	T2	T3	T4	T5	T6
T1	99.5			0.5		
T2		98.7	0.4	0.4	0.4	
T3	0.4	0.8	93.7	0 (0.4)	3.4	0.9 (0.4)
T4				99		1
T5	0.4	5.8	0.4		93.3	
T6			3.4	0.4	5.1	91

Results on Production (5)

- Group C shows a completely different picture.
- No mutual confusion between any tone pair was found.
- Instead, unidirectional mergers were attested:
  - T2/T5 (T5 merged to T2),
  - T5/T6 (T6 merged to T5),
  - T3/T6 (T6 merged to T3) and
  - T3/T5 (T3 merged to T5).
- The destinations of the errors made in T6 tended to split into two categories: the major one was T5 and the other was T3.

Possible mergers found in Group C

Upper Register	T1 [55]	T2 [35]	T3 [33]
Lower Register	T4 [21/11]	T5 [23]	T6 [22]



Acoustic Analysis of Production (1)

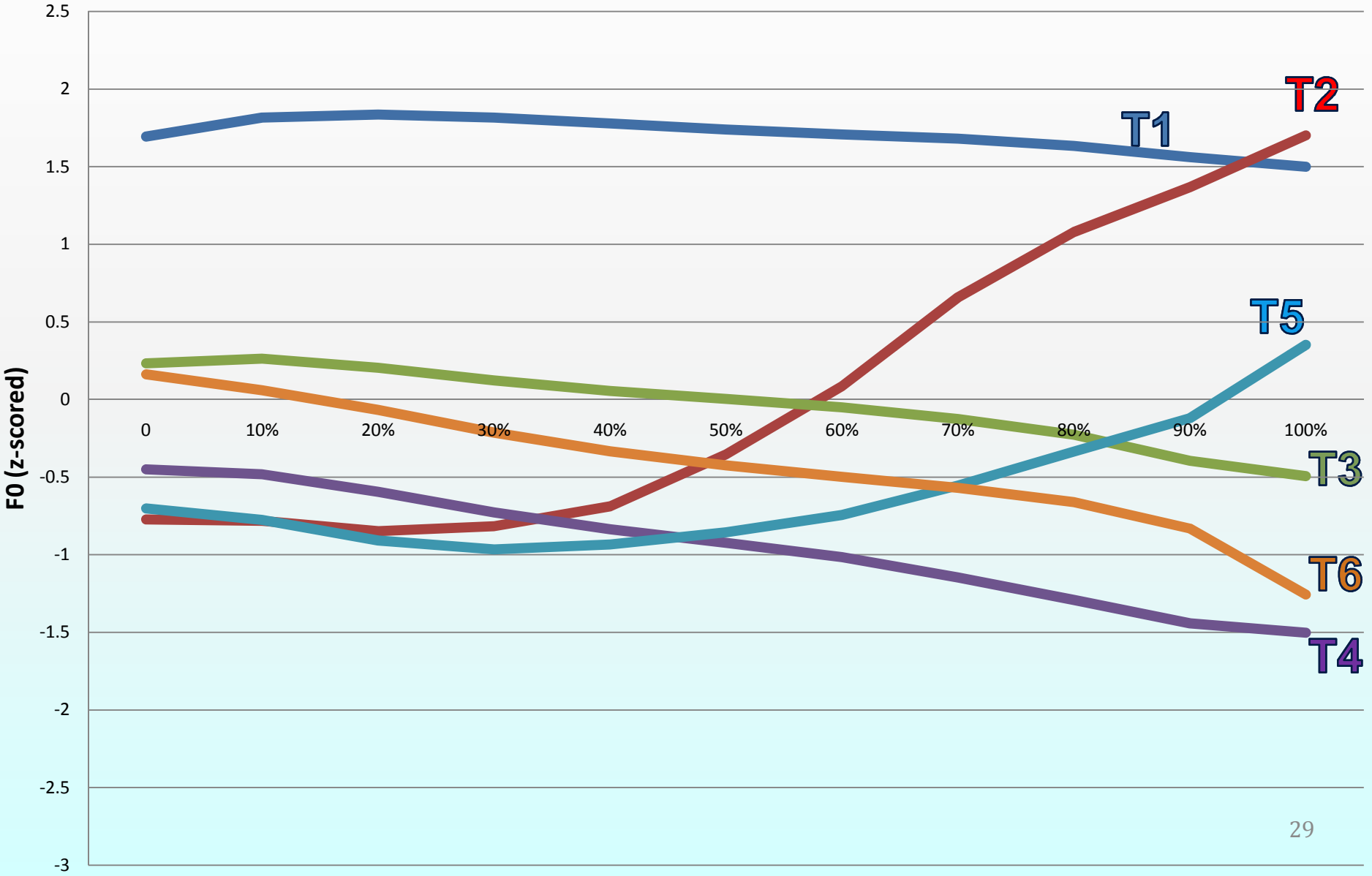
- Acoustic analysis was performed on some of the speech samples for each age group.
- F0 for each target syllable was extracted at 10 evenly-spaced time points from the beginning to the end of the voiced segment of each target syllable using the autocorrelation algorithm in Praat (Version 5.1.20. Boersma & Weenink, 2009).
- The raw score was normalized according to the LZ method developed by Zhu (2006): Transform the raw F0 readings into log scale and conduct a Z-score normalization.

Acoustic Analysis of Production (2)

- The six contrastive tones are usually well spread for subjects with high accuracy rate of perception and production.

- For example, Figure 3 shows the normalized F0 values of a non-merger in Group B in which six contrastive tones were clearly identified by the F0 trace.

Figure 3 Normalized F0 values of six tones by a non-merger, subject number 043 (Group B)

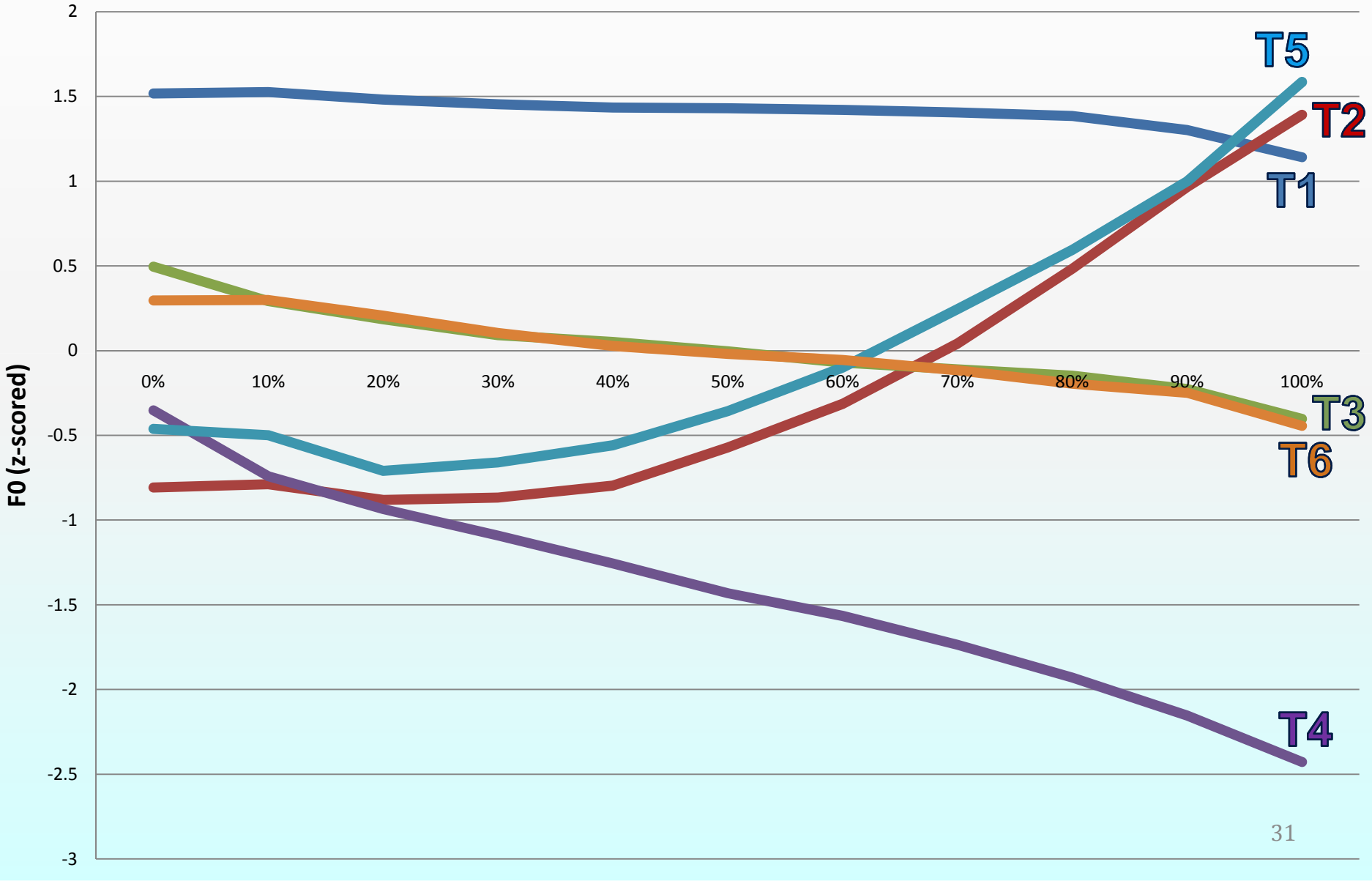


Acoustic Analysis of Production (3)

- On the other hand, overlap of tone space was exhibited by subjects who have low accuracy rate.

- Figure 4 shows the normalized F0 values of a potential merger also in Group B. In the figure, only four contrastive tones could be identified as the F0 of T2 merged with T5 and the F0 of T3 merged with T6.

Figure 4 Normalized F0 profiles of six tones by a possible merger, subject number 072 (Group B)



Discussion (1)

- 3 age groups reflecting different stages of tone merger
  - Group C (50-58): an earlier stage
  - Group B (35-45): an intermediate stage
  - Group A (20-25): the current stage
- We will now discuss the tone merger pairs.

Discussion (2)

High Rising/Low Rising (T2/T5)

- The distinction of this tone pair is not well maintained in either perception or production.
- And correlation between perception and production is found in the intermediate and current stages.
- We propose that T2/T5 should be a full merger in a sub-community of HKC.

Discussion (3)

Mid Level/Low Level (T3/T6)

- The distinction of this tone pair in perception is maintained but not in production.
- However, we have to point out that its perception accuracy is the third lowest among all tone pairs.
- We propose that T3/T6 is a quasi full merger.

Discussion (4)

Low Falling/Low Level (T4/T6)

- The distinction of this tone pair is preserved in production but not in perception.
- We propose that T4/T6 should be a near-merger.

Discussion (5)

Low Level/Low Rising (T3/T5)

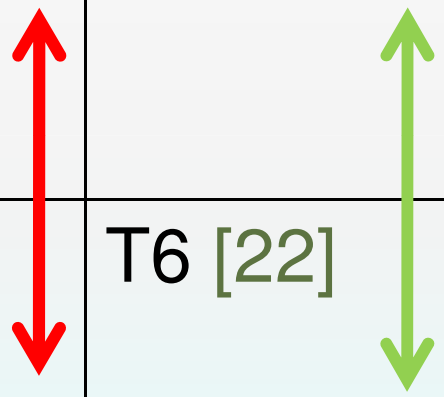
- The speakers maintain the distinction of this tone pair contrast in perception and production in the intermediate and current stages.
- However, the production of the contrast is comparatively weaker in the earlier stage: T5 tended to merge to T3.
- We propose that T3/T5 is a suspended merger.

Conclusion

- Q.1 How many tonal categories in HKC exhibit phonetic variations and mergers?
- ANS: Four categories : T2, T3, T5 and T6
- Q.2 What are the directions of the mergers?
- ANS: simplifying the numbers of tones
  - the 2 Rising tones merged into one
  - the Mid-Level tone merged with the Low Level
- As a result, there may be only four contrastive tones remained:
  - High Level,
  - Falling,
  - Rising (High Rising merged with Low Rising), and
  - Low Level (result of a merger of Mid Level and Low Level)
- Q.3 What are the possible factors?
- ANS: Age reflects the possible stages of tone mergers

The possible direction of HKC tone mergers

Upper Register	T1 [55]	T2 [35]	T3 [33]
Lower Register	T4 [21/11]	T5 [23]	T6 [22]



The possible tonal inventory of HKC after the completion of the mergers

Upper Register	T1	T2/T5	T3/T6
Lower Register	T4		

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References (1)

- Bauer, R.S., Cheung K.H. & Cheung P.M. (2003). Variation and Merger of the Rising Tones in Hong Kong Cantonese. Language Variation and Change, 15 (2003), 211–225.
- Bauer, R.S., Cheung, K.H. & Cheung, P.M. (2000). An acoustic description of lexical tones in Hong Kong Cantonese. Paper presented at Annual Research Forum, Linguistic Society of Hong Kong, City University of Hong Kong, December, 2000.
- Chang C.Y. (1993). Some issues on the reading of characters in Hong Kong Cantonese《香港粵語字音存在的一些問題》.Proceedings of the First International Conference on Yue Dialects. Hong Kong: Modern Education Research Society.
- Cheng, S.K. (2002). Yangshang-Yinqu alternation in Modern Cantonese: Irregularity in pronunciation or diffusion through lexicon? Paper presented at the Annual Research Forum of Linguistic Society of Hong Kong, University of Science and Technology. 14-15 December 2002.

References (2)

- Cheng, K.S.K. (2003). 3a-2b Tonal Alternations: An on-going sound change in Hong Kong Cantonese. Paper presented to Lelab members, CityU June 17, 2003.
- Cheung, K.H. (1986). The phonology of present day Cantonese. PhD thesis, University of London.
- Fok Chan, Y. Y. (1974). A perceptual study of tones in Cantonese. Hong Kong: University of Hong Kong, Centre of Asian Studies.
- Kei, J., Smyth, V., So, L.K.H., Lau, C. C., & Capell, K. (2002) Assessing the accuracy of production of Cantonese lexical tones: A comparison between perceptual judgement and an instrumental measure. Asia Pacific Journal of Speech, Language and Hearing, 7, 25–38.
- Killingley, S. Y. (1985). A New Look at Cantonese Tones: Five or Six? Newcastle upon Tyne: Grevatt & Grevatt.

References (3)

- Leung, W.M. (2007). The phenomenon of tone changes in Hong Kong Cantonese. Cantonese Studies, 2, 48-53.
- Mok, P and Wong, P(2010a), Perception of the merging tones in Hong Kong Cantonese: preliminary data on monosyllables, Speech Prosody.
- Mok, P and Wong, P(2010b), Production of the merging tones in Hong Kong Cantonese: preliminary data on monosyllables, Speech Prosody.
- Wong, T.S. (2006)〈香港粵語陽上陰去相混之始〉[The Beginning of Merging of the Tonal Categories B2 and C1 in Hong Kong Cantonese]. Presented in the 7th Phonetic Conference of China and International Forum on Phonetic Frontiers, Peking University, Péking, P. R. of China, October 2006.

References (4)

- Wong, T.S. (2008). The Beginning of Merging of the Tonal Categories B2 and C1 in Hong Kong Cantonese, Journal of Chinese Linguistics, Vol. 36(1), pp. 155-174, January 2008.
- Zhu, X.N. (2010), <語音學> [Yu Yin Xue]. Beijing: The Commercial Press.