The Perception of the English Alveolar-velar Nasal Coda Contrast *by Monolingual versus Bilingual Chinese Speakers*

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Research background

- The role of native language experience in non-native speech perception has been widely acknowledged (e.g. **SLM, PAM/PAM-L2, NLM and L2**LP).
  - The best known case: the perception of the English liquid contrast /l/ vs. /r/ by Japanese listeners whose L1 only permits a syllable-initial /r/
- The role of **L1** has largely been ignored in studies on **the perception** of English speech sounds by Chinese learners of English as **L3** (Wu & van de Weijer 2015; Wu 2016)

- The perception of the English alveolar-velar nasal coda contrast /n/ vs. /ŋ/ by bilingual Changsha Chinese learners of English as **L3**
  - Changsha Chinese as L1 **(without coda /ŋ/)**; Standard Mandarin as L2; English as L3

Table 1. *Examples of nasal coda contrasts in English.*

Vowel context	English	Glossary
/ɪ/	/sɪn/ vs. /sɪŋ/	'sin' vs. 'sing'
/ɔ/	/gɔn/ vs. /gɔŋ/	'gone'vs. 'gong'
/ʌ/	/sʌn/ vs. /sʌŋ/	'sun' vs. 'sung'
/æ/	/pæn/vs./pæŋ/	'pan' vs. 'pang'

Table 2. *Examples of nasal coda contrasts in Standard Mandarin.*

Vowelcontext	Standard Mandarin	Glossary
/i/	/pinˇ/ vs. /piŋˇ/	'sideburns'vs.'sickness'
/ə/	/pənˇ/ vs. /pəŋˇ/	'be stupid'vs. 'to jump'
/a/	/panˇ/ vs. /paŋˇ/	'to do'vs. 'be good'

Research questions

- (1). Do bilingual Changsha Chinese speakers perceive the English nasal coda contrast /n/ vs. /ŋ/ as well as monolingual Standard Mandarin Chinese speakers? Or:

- (2). Considering there is just an alveolar nasal coda /n/ in Changsha Chinese, do bilingual Changsha Chinese speakers show any bias to either of the two English nasal codas in their perception?

- (3).

  Given the variety of vowel contexts preceding the English nasal codas, do different preceding vowels affect the perception of these English nasal coda contrasts by bilingual Changsha Chinese speakers differently?

Method

- Participants
  - 15 Changsha Chinese bilinguals (CC group) vs. 15 Standard Mandarin monolinguals (BC group);
- Stimuli
  - Meaningless syllabic contrasts in L3 /ɪn/ vs. /ɪŋ/ (e.g. **Sin-Sing**), /ʌn/ vs. /ʌŋ/ and /æn/ vs. /æŋ/
- Procedure
  - *AXB discrimination* tests in *Praat*

Table 3. *Mean durations of each syllable and mean pitch and intensity values of each vowel for each contrast category.*

VC contrast	Duration (ms)	Vowel	
		F0 (Hz)	Intensity (dB)
/ɪn/	284.8	130.8	72.3
/ɪŋ/	273.3	128.7	72.4
/ʌn/	274.3	124.8	72.7
/ʌŋ/	278.6	126.8	72.9
/æn/	314.3	126.1	72.3
/æŋ/	345.1	127.0	72.5

A

X

B

Results

- A generalized linear mixed effects model (logistic regression) in R
- Fixed variables
  - Language group (BC group and CC group)
  - Vowel categories (/i ʌ æ/) fixed variables
  - The target nasal (in the X position in the AXB trials)
- Random variables
  - Participant and item

Table 4. *The results of the model with BC group, the vowel /æ/, and target nasal coda /n/ as baseline.*

	Estimate	SE	*z*	*P*
(Intercept)	-2.63	0.264	-9.94	< 0.001 *
CC group	1.21	0.253	4.78	< 0.001 *
Target nasal coda /ŋ/	-0.948	0.330	-2.87	0.004 *
/ɪ/	0.635	0.249	2.55	0.010 *
/ʌ/	1.42	0.238	5.95	< 0.001 *
/ŋ/:/ɪ/	1.35	0.396	3.42	< 0.001 *
/ŋ/: /ʌ/	0.385	0.390	0.987	0.324

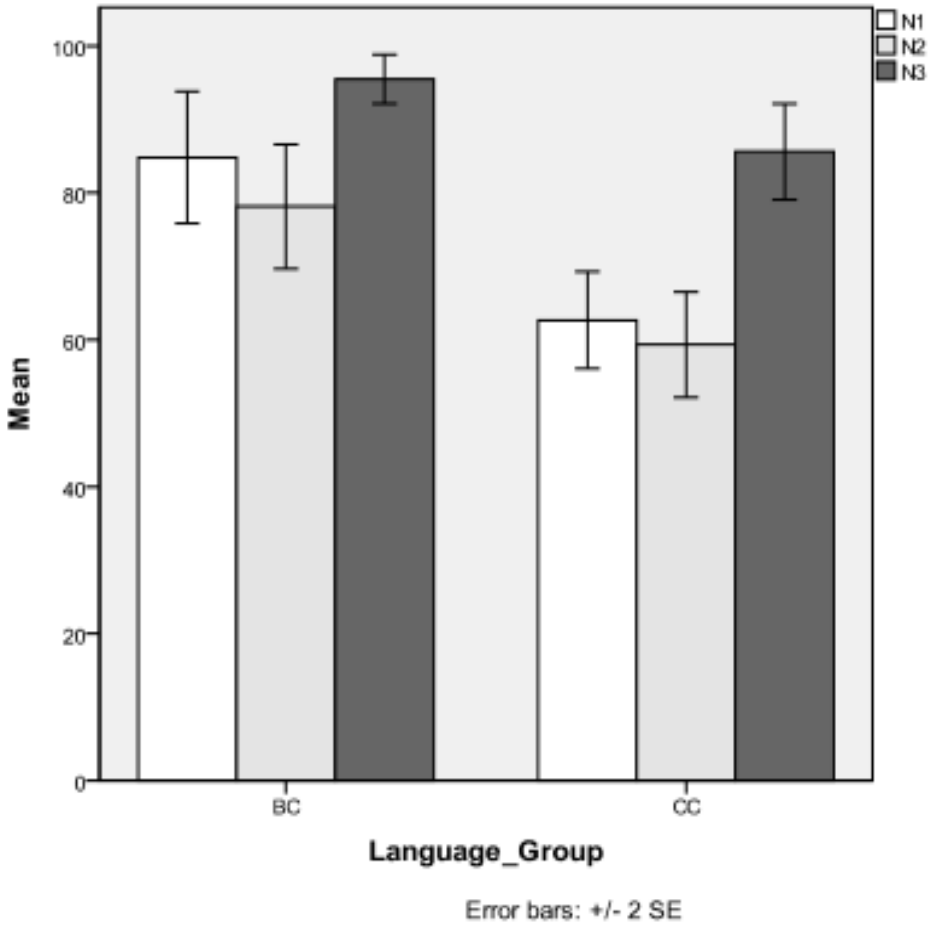

Figure 1. *The mean accuracy of the perception of English nasal coda contrasts by vowel category and language group* (*N1, N2, and N3 represent the English contrasts* /ɪn/ vs. /ɪŋ/, /ʌn/ vs. /ʌŋ/, and /æn/ vs. /æŋ/, *respectively*).

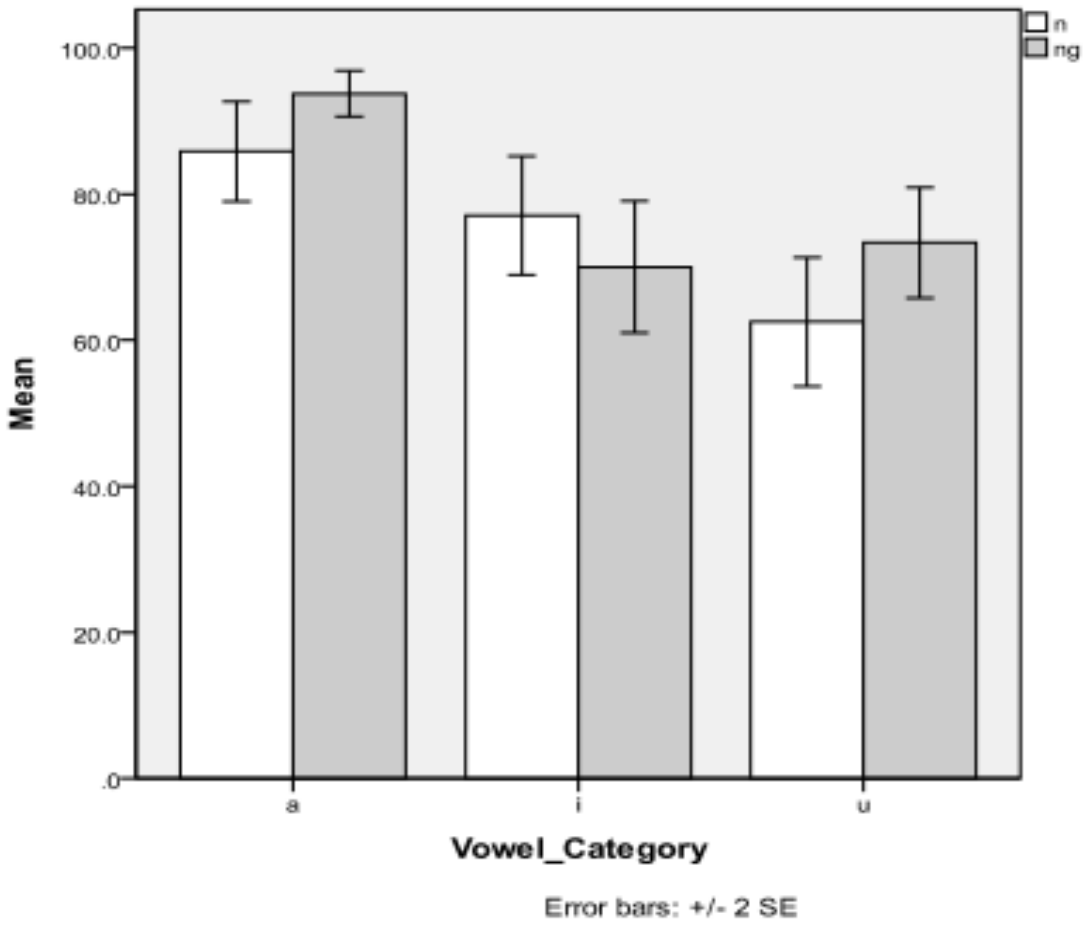

Figure 2. *The mean accuracy of the perception of the two target nasal codas by vowel category.*(*n and ng represent* /n/ and /ŋ/, *respectively; a, i, and u represent the vowels* /æ ɪ ʌ/)

Discussion

- **First,** we showed that the BC group outdid the CC group in perceiving the English nasal coda contrast,
  - Implying that L1-Changsha Chinese interfered with their L3 speech perception, which can be explained by the Perceptual Assimilation Model (PAM)
  - It would also be interesting to compare the BC group with native English speakers, to see whether and how the L1 of the BC group affects the perception of the English nasal coda contrasts.

- **Second**, no interaction between language group and vowel category was found in the present study
  - Suggesting different preceding vowels did not specially influence the bilingual Changsha Chinese speakers' perception of this English nasal coda contrast. **However,**
  - The perception of this contrast was generally affected by the vowel category

/ɪn/ vs. /ɪŋ/ << /æn/ vs. /æŋ/

- Consistent with various studies on L1 and L2 learning (e.g. Southern Min and Standard Mandarin: (Chen & Guison-Anderson 2011; Chen 2015)).

- **Coarticulation effects** of the preceding vowel /ɪ/ may cause the oral closure for the production of /ŋ/ to be shifted to the palatal region of the vocal tract, **changing murmur quality of /ŋ/,** which might have made **the fronted /ŋ/ sound similar to the alveolar nasal coda /n/,** resulting in the **perceptual confusion of the contrast** between /n/ and /ŋ/ (Zee 1981)

/ʌn/ vs. /ʌŋ/ << /ɪn/ vs. /ɪŋ/ and /æn/ vs. /æŋ/

- Poor acoustic cues for velar nasal /ŋ/ 【the convergence of F2 and F3: velar pinch】 when it occurs next to the vowel /ʌ/ in English

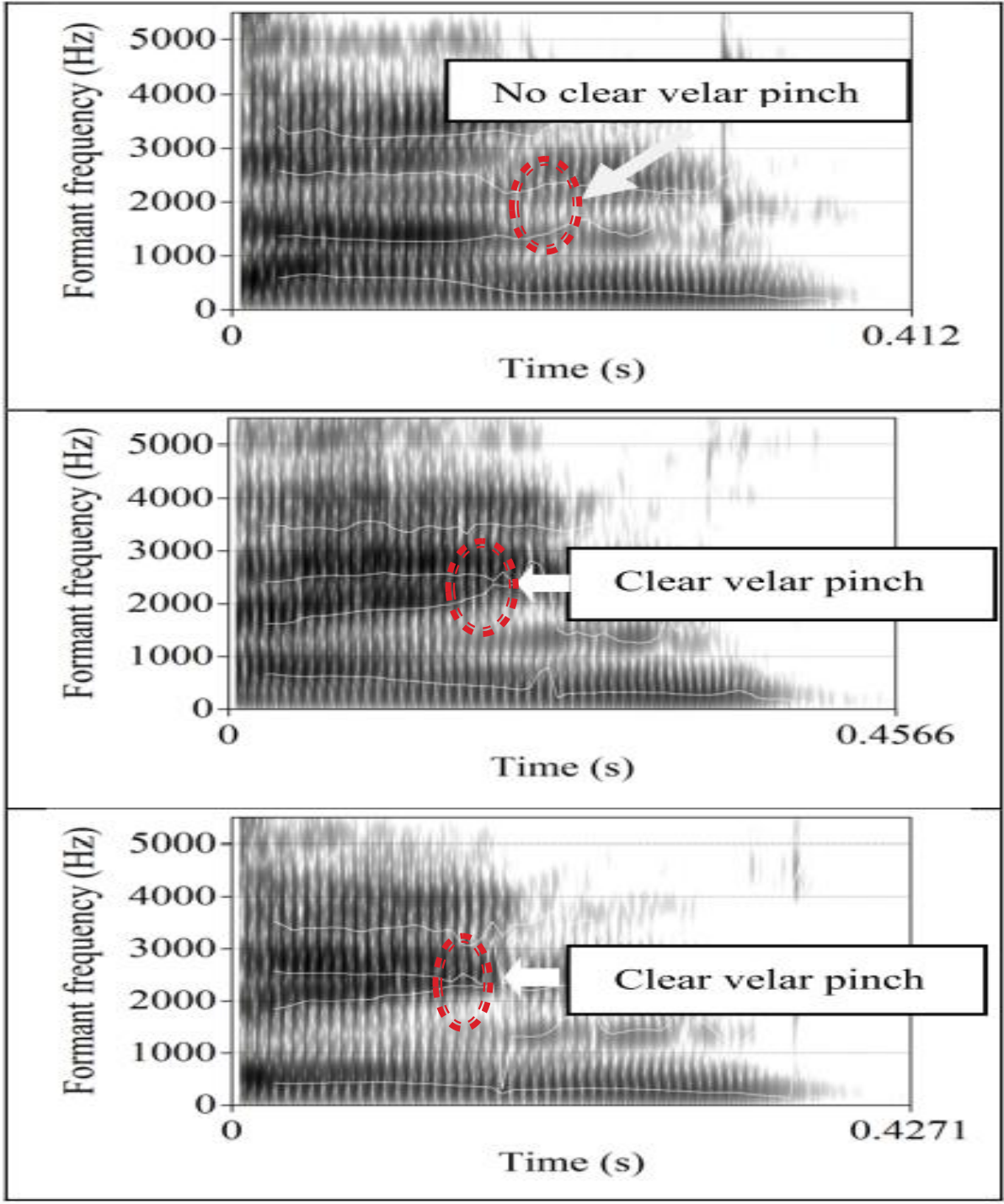

Figure 3.
Spectrograms of the English stimuli /ʌŋ/ **(upper panel)**, /æŋ/ and /ɪŋ/ (lower panels).

- **Lastly,** we did not find any interaction between language group and target nasal coda,
  - Suggesting that bilingual Changsha Chinese speakers did not show any bias to either of the two English nasal codas in their perception, **and yet**
  - Target nasal coda /n/ tended to be favored after the vowel /ɪ/ and the target nasal coda /ŋ/ was favored after the vowels /æ ʌ/**: was due to**
  - Phonological feature [-back] and [+back]: **The assimilation of place of articulation between /ɪ/ and /n/ and between /ŋ/ and /ʌ/**:

Conclusion

- The L1 of bilingual Changsha Chinese speakers interfered with their perception of the English nasal coda contrast.
- They did not show any bias to either of the two English nasal codas in their perception
- Different preceding vowels generally affected the discrimination of the English nasal coda contrast differently
- The perception of target nasal codas (/n/ or /ŋ/) was influenced by specific vowels.

- Future study should also investigate how native English speakers discriminate these contrasts.
- Interesting to see whether and how other English vowel categories such as /ɔ/ would affect the perception of the alveolar-velar nasal coda contrast, and extend the investigation to the contrasts /m/ vs. /n/ and /m/ vs. /ŋ/.

Thank you

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