

# Interlanguage Speech Intelligibility Benefit and the Mental Representation of Second Language Speech Sounds

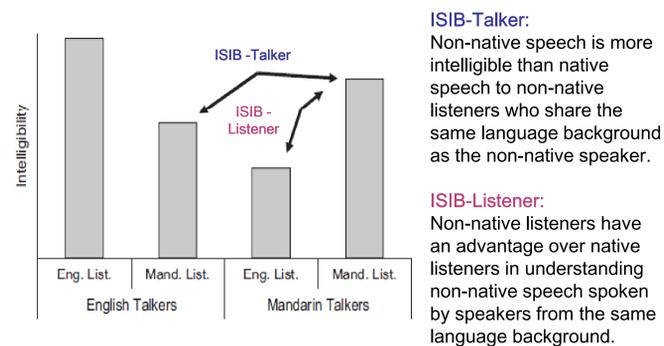
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## Introduction

Interlanguage Speech Intelligibility Benefit (ISIB) is where non-native speakers have an advantage over native speakers in understanding accented speech (Bent & Bradlow, 2003).

Two kinds of ISIB (Hayes-Harb et al., 2008):



## Previous studies investigating ISIB

Studies	Languages	Task / variables	ISIB - Talker	ISIB - Listener
Bent & Bradlow (2003)	Mandarin & Korean	Sentence transcription	✓/* (HP talker)	✗
Stibbard & Lee (2006)	Korean & Arabic	Sentence transcription	✗	✗
Imai et al. (2004)	Spanish	Word transcription: WF & neighborhood density	✗	✓ (dense neighbourhood)
Munro, Derwing & Morton (2006)	Japanese & Cantonese	Sentence transcription	N/A	✓ (Japanese)
Bent et al. (2008)	Mandarin	FCI: Vowel length before voiced and voiceless obstruent	✓	✓ (LP talker)
Hayes-Harb et al. (2008)	Mandarin	FCI: Word final voicing	✗	✓ (LP talker and listener)
Smith et al. (2009)	German	FCI: Word final voicing	✗	✗

WF: Word frequency FCI: Forced choice identification HP: High proficiency LP: Low proficiency

Most studies failed to find evidence for ISIB-Talker, indicating non-native listeners usually find native speech more intelligible than non-native speech. Inconsistent results concerning ISIB-Listener may be due to the particular words chosen as items.

Words spoken by L2 speakers can actually be classified into 4 types:

- No phonological errors
  - Cantonese accented speech: 'low' /lou/
  - Interpreted by both native and Cantonese listeners as: 'low'
- Phonological errors producing a nonword
  - Cantonese accented speech: 'give' /gɪv/ → /gɪf/
  - Interpreted by native listeners as: 'give' or '???'
  - Interpreted by Cantonese listeners as: 'give'
- Phonological errors producing a more frequent word
  - Cantonese accented speech: 'buzz' /bʌz/ → /bʌs/
  - Interpreted by native listeners as: 'bus'
  - Interpreted by Cantonese listeners as: 'buzz' less often than 'bus'
- Phonological errors producing a less frequent word
  - Cantonese accented speech: 'thin' /θɪn/ → /fɪn/
  - Interpreted by native listeners as: 'fin'
  - Interpreted by Cantonese listeners as: 'thin' more often than 'fin'

We hypothesize that ISIB-Listener will be clearly observed when the intended words have a higher word frequency than the mispronounced word.

## Assumptions about the mental representation of L2 speech sounds

The cause of foreign accent is due to second-language learners' difficulty/inability in perceiving second-language phonemic contrasts. As a result, L2 phonemes are assimilated into native categories.

For example, English phoneme /θ/ is assimilated to Cantonese phoneme /f/ and the words 'thin' and 'fin' are therefore homophones for Cantonese listeners. The former will be activated first when they hear either /θɪn/ or /fɪn/ because of its higher frequency.

In other words, there is a single phonological system for the two languages.

## Alternative hypothesis about the mental representation of L2 speech sounds

Listeners can perceive the L2 contrasts that are absent in their first language and their foreign accent is due to articulatory difficulty.

This suggests that there are two separate phonological systems for each language.

## Experiment 1

Aim:

1. Test whether ISIB-Talker and ISIB-Listener can be found in Cantonese speakers and listeners.
2. Examine whether ISIB-Listener effect is governed by relative word frequency.

Task: Monosyllabic word transcription

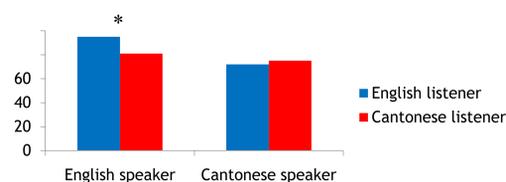
Native languages of the speakers:  
Cantonese and English (1 of each)  
Native languages of the listeners:  
Cantonese and English (20 of each)

## Experimental Design

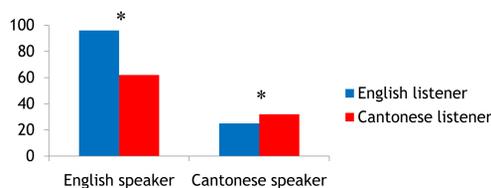
Conditions	Cantonese speaker	English speaker
Unambiguous items	'low' /lou/	'low' /lou/
Low frequency (LF) baseword	'buzz' /bʌs/ (c.f. 'bus')	'buzz' /bʌz/
High frequency (HF) baseword	'thin' /θɪn/ (c.f. 'fin')	'thin' /θɪn/

## Results

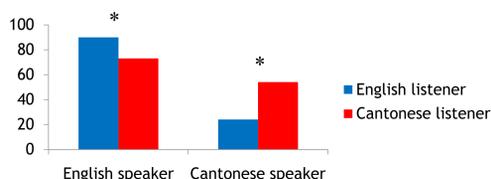
Accuracy rate: Unambiguous items



Accuracy rate: Low frequency baseword



Accuracy rate: High frequency baseword

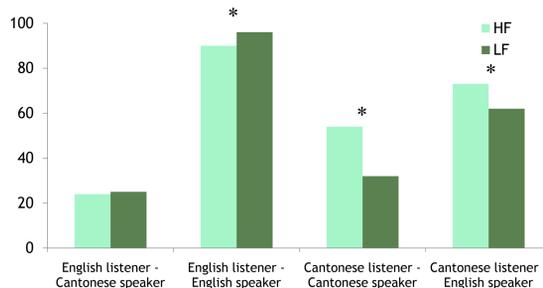


ISIB-Talker is not found as Cantonese listeners found native English speech more intelligible than Cantonese-accented speech in all conditions ( $p < 0.01$ ).

ISIB-Listener is not found for the unambiguous items as English listeners understood Cantonese-accented speech as well as Cantonese listeners ( $p = 0.128$ ).

However, ISIB-Listener is found in both the HF condition ( $p < 0.001$ ) and the LF condition ( $p = 0.032$ ), with a larger effect in the HF than LH conditions.

## Word Frequency Effect



The word frequency effect emerges for Cantonese listeners no matter whether they are listening to native English speech or Cantonese-accented speech ( $p < 0.05$ ).

This suggests that Cantonese listeners may assimilate L2 phonemes (e.g., /θ/, /z/) to L1 phonemic categories (e.g., /f/, /s/) such that 'thin - fin' and 'buzz - bus' become homophones. When they hear these homophones they tend to recognize it as the more frequent word, and hence a lower accuracy score is observed for the LF condition.

## Experiment 2

Aim: Whether native and Cantonese listeners can perceive phonemic contrasts made by native and Cantonese speakers.

Task: Monosyllabic word transcription

Participants: Native Cantonese and English listeners (20 each)

Hypothesis: If Cantonese listeners cannot tell the difference between two L2 sounds, then there should be no difference in their baseword response 'thin' when they hear either /θɪn/ or /fɪn/ spoken by Cantonese or English speakers.

## Experimental Design

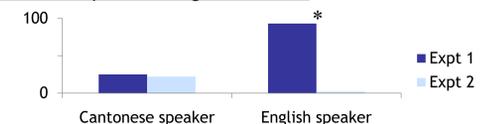
Conditions	Cantonese speaker	English speaker
Unambiguous items	'low' /lou/	'low' /lou/
Low frequency (LF) baseword	'bus' /bʌs/	'bus' /bʌz/
High frequency (HF) baseword	'fin' /fɪn/	'fin' /fɪn/

Results (Averaging LF and HF)

## Baseword responses: Cantonese listeners



## Baseword responses: English listeners



Cantonese listeners can perceive phonemic contrasts produced by native speakers and Cantonese speakers (to a lesser extent), while native listeners can only perceive phonemic contrasts produced by native speakers. However, the cues Cantonese listeners use to differentiate L2 contrasts may be different from native listeners.

## Conclusions

- In Experiment 1, word frequency effect is observed when Cantonese listeners perceive native and Cantonese-accented speech. This suggests there is a single phonological system for the two languages.
- In Experiment 2, Cantonese speakers can perceive second language speech contrasts and produce second language speech contrasts (in a non-native manner). This suggests there are two phonological systems for each language.
- One plausible explanation for the contradictory conclusions drawn from the two experiments is that non-native listeners are gradually developing two phonological systems from one single phonological system. This is in agreement with Flege's (1995) Speech Learning Model in which L2 learners are developing two separate categories for the "new" sounds while "similar" sounds in the L2 are still treated as a single category.
- If we divide the non-native listeners into high and low phonological proficiency, we expect the latter to show a greater word frequency effect, and the former to show a greater difference between Experiment 1 and Experiment 2 in baseword responses for native English speech.

## Selected References

- Bent, T., & Bradlow, A. R. (2003). The interlanguage speech intelligibility benefit. *Journal of the Acoustical Society of America*, 114, 1600-1610.
- Bent, T., Bradlow, A. R. & Smith, B. L. (2008). Production and perception of temporal patterns in native and non-native speech. *Phonetica*, 65, 131-147.
- Flege, J. E. (1995). Second-language speech learning: Theory, findings, and problems. In W. Strange (Ed) *Speech perception and linguistic experience: Issues in cross-language research*. Timonium, MD: York Press, Pp. 229-273.
- Hayes-Harb, R., Smith, B. L., Bent, T., & Bradlow, A. R. (2008) The interlanguage speech intelligibility benefit for native speakers of Mandarin: Production and perception of English word-final voicing contrasts. *Journal of Phonetics*, 36, 664-679.
- Imai, S., Walley, A. C., & Flege, J. E. (2004). Lexical frequency and neighborhood density effects on the recognition of native and Spanish-accented words by native English and Spanish listeners. *Journal of the Acoustical Society of America*, 117, 896-907.
- Munro, M. J., Derwing, T. M., & Morton SL. (2006). The mutual intelligibility of L2 speech. *Studies in Second Language Acquisition*, 28, 111-131.
- Smith, B. L., Hayes-Harb, R., Bruss, T., & Harker, A. (2009). Production and perception of voicing and devoicing in similar German and English word pairs by native speakers of German. *Journal of Phonetics*, 37, 257-275.
- Stibbard, R. M., & Lee, J. (2006). Evidence against the mismatched interlanguage speech intelligibility benefit hypothesis. *Journal of the Acoustical Society of America*, 120, 433-442.