

Relationships between the intelligibility and acoustic properties of native English and Mandarin-accented English

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INTRODUCTION

- Linguistic backgrounds of talkers and listeners play important roles in speech intelligibility
- Native listeners find native speech more intelligible than non-native speech (e.g., van Wijngaarden 2001)
- Interlanguage Speech Intelligibility Benefit (ISIB; Bent & Bradlow 2003): Non-native listeners can be as accurate recognizing words *in sentences* produced by a proficient non-native speaker of English with whom they share the same native language as words produced by a native English speaker
- Two types of ISIB** (reported in the literature but not explicitly distinguished):

Interlanguage Speech Intelligibility Benefit for Non-Native Talkers (ISIB-T)	<i>Non-native speech is at least as intelligible as native speech</i> to non-native listeners (i.e., for non-native listeners, non-native talkers > native talkers)
Interlanguage Speech Intelligibility Benefit for Non-Native Listeners (ISIB-L)	<i>Non-native speech is at least as intelligible to non-native listeners as to native listeners</i> (i.e., for non-native speech, non-native listeners > native listeners)

RESEARCH OBJECTIVES & HYPOTHESES

- Test the predictions of the ISIB-T and the ISIB-L with word-final consonant voicing in a 2-alternative forced-choice listening task
 - Hypothesis 1:** Non-native listeners will be at least as accurate at determining the intended voicing of word-final stop consonants produced by non-native talkers as by native talkers (ISIB-T)
 - Hypothesis 2:** Non-native listeners will be at least as accurate as native listeners determining the intended voicing of word-final stop consonants produced by non-native talkers (ISIB-L)
 - Hypothesis 3:** Native listeners will be at least as accurate at determining the intended voicing of word-final stop consonants produced by native talkers as by non-native talkers
- Investigate the relationship between intelligibility data and acoustic properties of final consonant voicing in the speech of native and non-native speakers of English

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INTELLIGIBILITY STUDY

Listeners

- 15 native English (NE) and 15 native Mandarin (NM) speakers

Stimuli

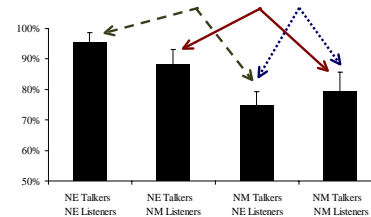
- 3 different tokens of each of 8 target words produced by each of 6 NE and 6 NM talkers
- Target words formed 4 English minimal pairs contrasting /b/-/p/ and /g/-/k/ in word-final position ('cub'-'cup'; 'cab'-'cap'; 'peg'-'peck'; 'pig'-'pick')

Procedure

- Listeners identified words *in isolation* in a forced-choice task
- The two choices available formed a minimal pair relating to the target word (e.g., hear 'cub'; identify as 'cub' or 'cup')

Results

Average percent correct word identification, by talker and listener group



- NM Listeners: NE talkers > NM talkers (p<.001)** ———
→ Not consistent with Hypothesis 1 (ISIB-T)
- NM Talkers: NM listeners > NE listeners (p<.02)**
→ Consistent with Hypothesis 2 (ISIB-L)
- NE Listeners: NE talkers > NM talkers (p<.001)** - - - -
→ Consistent with Hypothesis 3

Discussion

- Lack of ISIB-T is counter to previous findings, which might be due to:
- Task demands:** Previous studies used word identification in sentence context; here, words were identified *in isolation*
 - Talker proficiency:** ISIB-T previously found only for high-proficiency talkers (e.g., Bent & Bradlow 2003); talkers here may have had lower proficiency than talkers in other studies

Acoustic Properties of NE and NM English Speech

Average values in msec for four acoustic measures by word-final consonant and talker group; (st. dev.); * indicates that the talker groups differ at $p < .05$, unpaired t-test with Welch-correction.

Word-Final Consonant	Talker Language	Preceding Vowel Duration	Closure Duration	Voicing Duration	Burst Duration
Voiced (b,g)	NE	182 (38)	71 (16)	53 (26)	40 (30)
	NM	147 (28)	79 (23)	25 (14)	36 (18)
Voiceless (p,k)	NE	136 (42)	87 (18)	3 (6)	66 (35)
	NM	127 (28)	97 (28)	14 (12)	66 (27)

→ NE and NM talkers differed in the acoustic properties they manipulated to produce English word-final voicing contrasts

Relationship between Acoustic and Intelligibility Data

Spearman rho correlations for intelligibility results (% 'voiced' response) and acoustic data for each combination of talker and listener group; * indicates significance at $p < .05$.

Talker Language	Listener Language	Preceding Vowel Duration	Closure Duration	Voicing Duration	Burst Duration
NE	NE	.738*	-.857*	.635	-.643
	NM	.929*	-.833*	.635	-.595
NM	NE	.263	-.714*	-.714*	-.667
	NM	.263	-.714*	-.714*	.667

- Both listener groups' intelligibility scores correlated with:
 - Preceding vowel duration for NE talkers but not NM talkers**
 - Closure duration for both NE and NM talkers**
 - Voicing during stop closure for NM talkers but not NE talkers**
- Differences in how talkers manipulated these acoustic features may have had implications for listeners' use of these cues

CONCLUSIONS

- Support for ISIB-L but not ISIB-T (for words *in isolation*)
- NE and NM talkers differed in the acoustic properties they manipulated to produce English word-final voicing contrasts
- NE and NM listeners responded similarly to differences in acoustic cues produced by NE and NM talkers

REFERENCES

- Bent, T., and Bradlow, A. R. (2003). "The interlanguage speech intelligibility benefit," *J. Acous. Soc. Am.* 114, 1600-1610.
van Wijngaarden, S. J. (2001). "Intelligibility of native and non-native Dutch speech," *Speech Commun.* 35, 103-113.