



# Perception of the indexical properties of speech: Universal or language-dependent?

Susannah V. Levi, Stephen J. Winters, & David B. Pisoni  
Speech Research Laboratory, Indiana University  
svlevi, stwinter, pisoni@indiana.edu



## Introduction:

### Background

The speech signal contains both **linguistic** and **"indexical"** properties.

**Definition:** Indexical Properties of Speech (Abercrombie, 1967) provide the listener with information about the talker's identity (e.g., through dialect, age, gender, size/shape of the vocal tract).

### Big Picture Question:

Is the perception of indexical properties of speech language-dependent or language-universal?

- Does knowledge of a language facilitate talker identification?  
Yes: If the perception of indexical properties is language-dependent.  
No: If the perception of indexical properties is language-universal.
- Does knowledge of a speaker generalize across languages?  
Yes: If the perception of indexical properties is language-universal.  
No: If the perception of indexical properties is language-dependent.

### Previous Research:

 (answers question 1)

Linguistic knowledge/competence facilitates indexical (voice) identification.

- Voice identification:** Listeners are more accurate when stimuli are presented in their native language than in an unfamiliar language (Goggin, Thompson, Strube, & Simental, 1991; Schiller & Köster, 1996; Sullivan & Schlichting, 2000, Winters, Levi, & Pisoni, 2006).
  - Reiterant "ma"-speech:** When the linguistic content of the speech is eliminated, the effects of language familiarity disappear (Schiller, Köster, & Duckworth, 1997).
- These studies suggest that the perception of indexical properties of speech (i.e., speaker identity) are language-dependent.

### Research question

 (answers question 2)

Does perception of talker identity generalize across languages?

💡 Test discrimination of bilingual talker's voices, using a paired comparison discrimination paradigm, across languages.

## Methodology:

### Stimuli/Speakers:

- 10 bilingual L1 German/L2 English speakers (5 men, 5 women)
- Similar nativeness in English (Levi, Winters, & Pisoni, submitted)
- Similar native dialect
- 720 CVC words (360 English, 360 German)

### Listeners:

- 3 groups of listeners:
  - 15 listeners trained to identify the voices speaking in English (4 days of training)
  - 15 listeners trained to identify the voices speaking in German (4 days of training)
  - 20 naïve, untrained listeners
- no knowledge of German

### Procedure:

- Speeded 2 alternative forced choice task: "same talker" / "different talker"
- Four conditions language conditions:
  - English-English (both words are English)
  - German-German (both words are German)
  - English-German
  - German-English
- In the same-language condition, lexical items are never identical.
- No cross-gender comparisons.

## Results:

### Listener Sensitivity, A' (Figure 1):

- Main effect of Language Pair:  $p < .001$  (EE > GG)
- Main effect of Listener Group:  $p < .001$  (English trained, German trained > untrained)
- Interaction: n.s.

### Listener Response Bias (Figure 2):

- Main effect of Language Pair:  $p < .001$
- Main effect of Listener Group:  $p = .024$
- Language Pair X Listener Group interaction:  $p < .001$

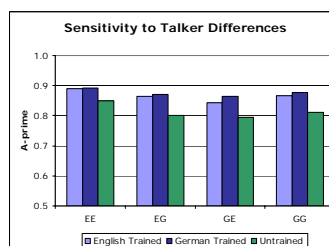


Figure 1

- Listeners can discriminate voices in the cross-language condition,
- Listeners discriminate voices better in the EE condition than the GG condition.

- Suggests that the perception of indexical properties is partially language-universal.
- Suggests that language knowledge facilitates the perception of indexical properties.

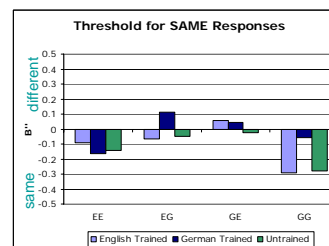


Figure 2

- Listeners showed more bias towards "same talker" responses in the same-language conditions (EE/GG vs. EG/GE).
- Listeners with no German-listening experience were more biased towards "same talker" responses for GG pairs than for EE pairs.

- Suggests that listeners are partly basing indexical responses on language information.
- Suggests that language knowledge affects response bias in the same-language condition.

Reaction Time Data: Untrained listeners responded more quickly than both groups of trained listeners (speed/accuracy trade-off).

## Discussion:

Evidence from this voice-discrimination task indicates that the perception of indexical properties of speech is partially mediated by language knowledge and experience. Listeners can extract language-universal voice information from the speech signal, but they also draw upon language-specific knowledge to help better discriminate voices. Their ability to do this depends on the nature of their experience with the language of the talker. If listeners know the language that is being spoken, they use that information to help them process indexical information; otherwise, voice processing operates largely independent of language.

### Evidence for language-universal indexical processing:

- All listeners are able to discriminate voices in cross-language conditions.
- No differences in sensitivity were found between the two training groups.

### Evidence for language-dependent indexical processing:

- Listeners are more sensitive to voice differences when they understand the language in which both words are spoken (i.e., in the EE pairs).
- Listeners are more biased towards "same" responses when the two words are spoken in the same language.
  - This bias is increased when the listeners are not familiar with the language.
  - Language-specific training can reduce this bias by increasing familiarity with voices in an unknown language.

### References/Acknowledgments:

Abercrombie, D. (1967). *Elements of General Phonetics*. Edinburgh: Edinburgh University.

Goggin, J.P., Thompson, C.P., Strube, G. and Simental, L.R. (1991). The role of language familiarity in voice identification. *Memory & Cognition*, 19 (5), 448-458.

Levi, S.V., Winters, S.J. & Pisoni, D.B. (submitted). Speaker-independent factors affecting the perception of foreign accent in a second language. *JASA*.

Schiller, N. O. & Köster, O. (1996) Evaluation of a foreign speaker in forensic phonetic: a report. *Forensic Linguistics*, 3(1), 176-185.

Schiller, N. O., Köster, O. & Duckworth, M. (1997) The effect of removing linguistic information upon identifying speakers of a foreign language. *Forensic Linguistics* 4(1), 1-17

Sullivan, K.P.H. and Schlichting, F. 2000. Speaker discrimination in a foreign language: first language environment, second language learners. *Forensic Linguistics*, 7(1), 95-111.

Winters, S. J., Levi, S. V., & Pisoni, D. B. (2006). The role of linguistic competence in cross-linguistic speaker identification. *LSA Talk*

This work was supported by NIH-NIDCD Research Grant R01 DC-00111 and NIH-NIDCD T32 Training Grant DC-00012.