

# CROSS-LINGUISTIC INFLUENCE AND OBSTRUENT SEQUENCE PERCEPTION IN SPOKEN, WHISPERED, AND NOISY SPEECH

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## INTRODUCTION

- Whispered speech is close-contact speech
- It occurs across many cultures and human languages
- Is characterized by several acoustic differences from modal speech
  - Lack of F0
  - Reduced speech signal amplitude
- No language uses whispering as the default mode during communication (Cirillo & Todt, 2005)

## BACKGROUND

- Previous studies have examined the prosodic patterns of whispered speech production and influences on spectral characteristics of voiceless consonants (Grabe, 1998; Niebuhr, 2008; Niebuhr et al., 2012; Żygis et al., 2017).
- Few studies investigated consonant perception in whispered speech
- And fewer have investigated whispered consonant perception in multilinguals
- Language-specific phonotactic probabilities are expected to interfere with consonant sequence perception in an L2/L3 (Kilpatrick et al., 2019)
- Whispered speech also postpones lexical access via wait-and-see processing (Hendrickson & Ernest, 2022).

## RESEARCH QUESTIONS & HYPOTHESES

- Q1. How do phonation mode (whispered, modal speech) and noise (clean speech, noise-masked speech) influence multilingual perception of obstruent sequences?
- H1. Whispered and noisy modes will decrease intelligibility and increase response times linked with lower signal-to-noise ratio (Shojaei et al., 2016)
- Q2. Are certain obstruent sequences more difficult to perceive across phonation modes or in noise (e.g. /vzd/ vs /fst/ vs /psk/ vs /dʒd/, etc.)?
- H2. There will be variation in accuracy/response time across consonant sequences, since perception of obstruents in noise depends on the place of articulation, vowel context, and interaction between voicing and manner of articulation (Alwan, Jiang, & Chen, 2011)
- Q3. Does language background (L1/L2/L3) influence perception of obstruent sequences in a given language?
- H3. Consonant sequences present in L2/L3 but not in L1 will have lower accuracy and longer response times than sequences shared between L1 and L2/L3

## METHODOLOGY

### PARTICIPANTS (PROJECTED)

- L1 Polish, L2 English, L3 Norwegian (n = 40)
- 1 Polish, L2 English (n = 40)
- 1 Azerbaijani, L2 Farsi, L3 English (n = 40)
- L1 Farsi, L2 English (n = 40)

### STIMULI

- Two-word phrases generated for an upwards of 25 unique obstruent sequences and 4 conditions per language
- Speech modes:
  - Modal (M), noisy modal (NM), whispered (W), noisy whispered (NW)
- Consonant clusters across word boundaries, since not all languages allow complex obstruent sequences within words (e.g., #CCCV...)
- Consonant sequences structures:
  - 1C: V#CV
  - 2C: VC#CV / V#CCV
  - 3C: VCC#CV / VC#CCV

### RECORDINGS

- Polish, English and Norwegian stimuli were produced by a functionally trilingual Polish (L1), English, Norwegian speaker (male, mid fifties)
- Azerbaijani, Farsi, and English stimuli to be recorded by a functionally trilingual speaker as well
- Spoken and whispered word tokens were serially recorded in several sessions
  - Shure SM-35 unidirectional cardioid head-worn condenser microphone (~3 cm diagonally away from speaker's mouth)
  - Marantz PMD620 portable solid-state recorder. All audio files were recorded as .wav files at 48 kHz (24-bit)
- Noisy conditions (NM, NW) were masked by 55 Hz of pink noise

### PERCEPTUAL EXPERIMENTS

- 2-alternative forced choice speech identification task
- Randomized trial order per participant, randomized position of correct response per trial
- Language experiments designed in PsychoPy, hosted on Pavlovia

### RESULTS & ANALYSIS

- Mean accuracy (%) & response times (ms) per trial
- Analysis using GLMM approach (see Jörges, 2021)
- GLMs:
  - $MEAN\_ACC \sim CCSeq * mode + CCSeq * LangGroup + (1 | Participant) + (1 | Phrase)$
  - $RT \sim CCSeq * mode + CCSeq * LangGroup + (1 | Participant) + (1 | Phrase)$

## EXPERIMENT SAMPLES

### ENGLISH VERSION



### POLISH VERSION



## DISCUSSION

- Data collection IN PROGRESS for L1 Polish, L2 English
- To be collected:
  - L1 Polish, L2 English, L3 Norwegian
  - L1 Azerbaijani, L2 Farsi, L3 English
  - L1 Farsi, L2 English
- Possible expansion to include other subtractive groups
  - I.e., L1 Norwegian, L2 English; L1 English
- The English version of this experiment can be used as a baseline to compare across any number of language backgrounds that include English, e.g.:
  - L1 Japanese, L2 English
  - L1 English L2 French, L3 Chinese
  - L1 Ukrainian, L2 Russian, L3 English, etc.

## REFERENCES



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