

The Organization of Speech Motor Behaviors as Observed Cross-Linguistically

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Summer 2009 Research

- ▣ Research Question
 - ▣ What are the articulatory differences among bilingual, Spanish- English speakers and monolingual, English speakers?

Background

- ◎ /p/ is a bilabial, stop consonant
 - Place: Lips
 - Manner: Stop
 - Voicing
 - /p/ is voiceless

Background

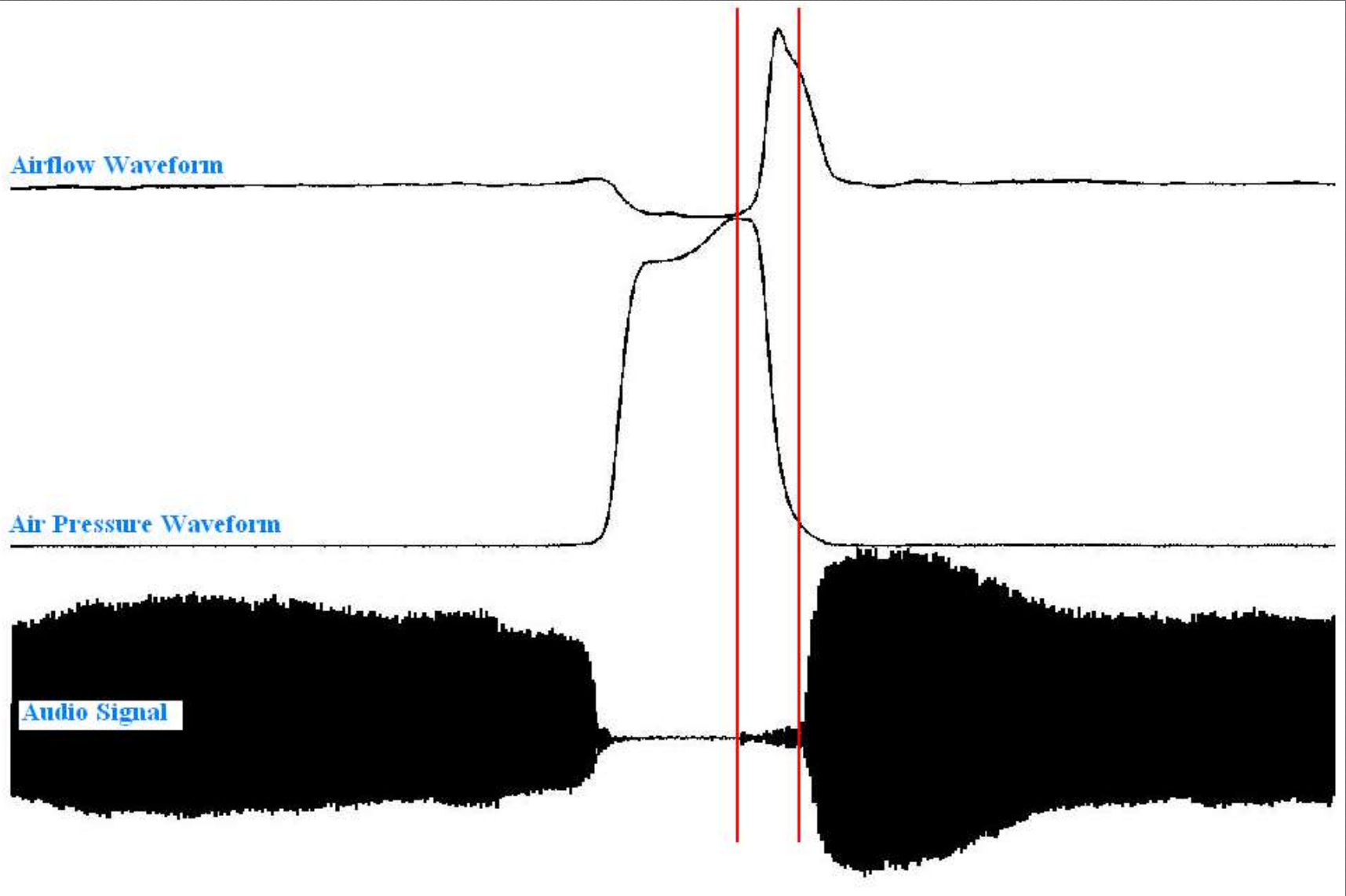
- Differences Between Languages
 - /p/ is produced with slightly different motor behaviors within a language
 - /p/ has shorter voice onset time (VOT) in Spanish than in English (Lisker, & Abramson, 1964).
- VOT is the duration of silence between the opening of the oral cavity and when vibration of the vocal folds begins

Voice Onset Time

Airflow Waveform

Air Pressure Waveform

Audio Signal



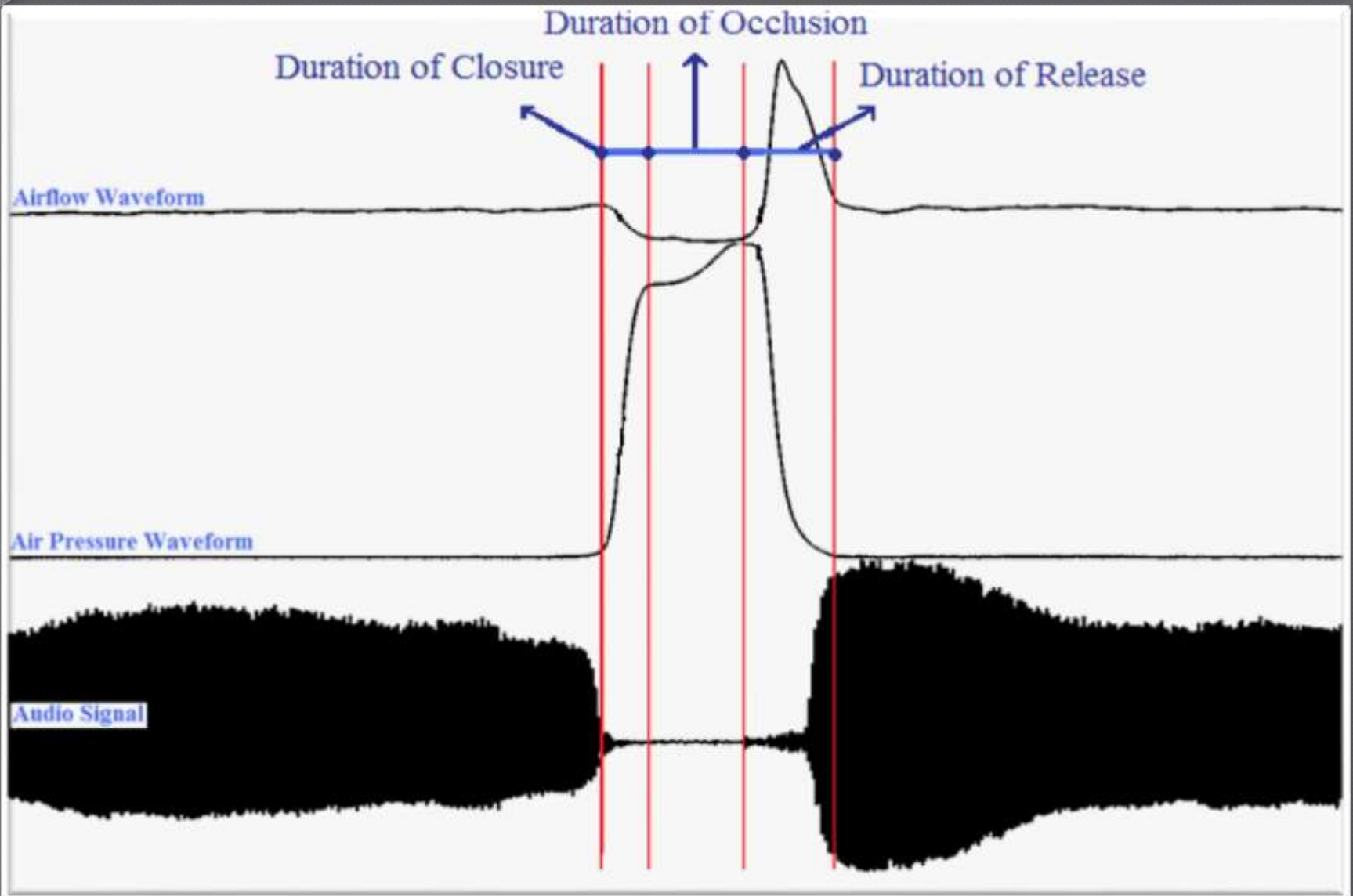
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◎ Statement of Problem:

- We do not know how jaw and lip kinematics may be different for production of /p/ as observed cross-linguistically.

Measures

- ◎ Closure & Occlusion Durations
 - Represents jaw and lip kinematics for stopping the production of /p/
- ◎ Release Duration & Voice Onset Time
 - Represents jaw, lip and laryngeal coordination



This figure represents the aerodynamic measures of duration. The waveforms show the duration of closure, occlusion and release of the /p/ sound. These measures will be compared across the speakers.

Research Question

- What are the articulatory differences among bilingual, Spanish- English speakers and monolingual, English speakers?
 - Do jaw and lip kinematics differ for production of /p/ across languages?

Experimental Questions

- ◉ What is the difference in duration of oral closure and occlusion for /p/ as observed cross-linguistically?
- ◉ Is the duration of release and VOT shorter for Spanish than English productions of /p/?

Fall 2009 Research

◎ Research Question

- Do speakers alter their motor behaviors if they hear a speech production not within their primary language?

Fall 2009 Research

◎ Statement of Problem

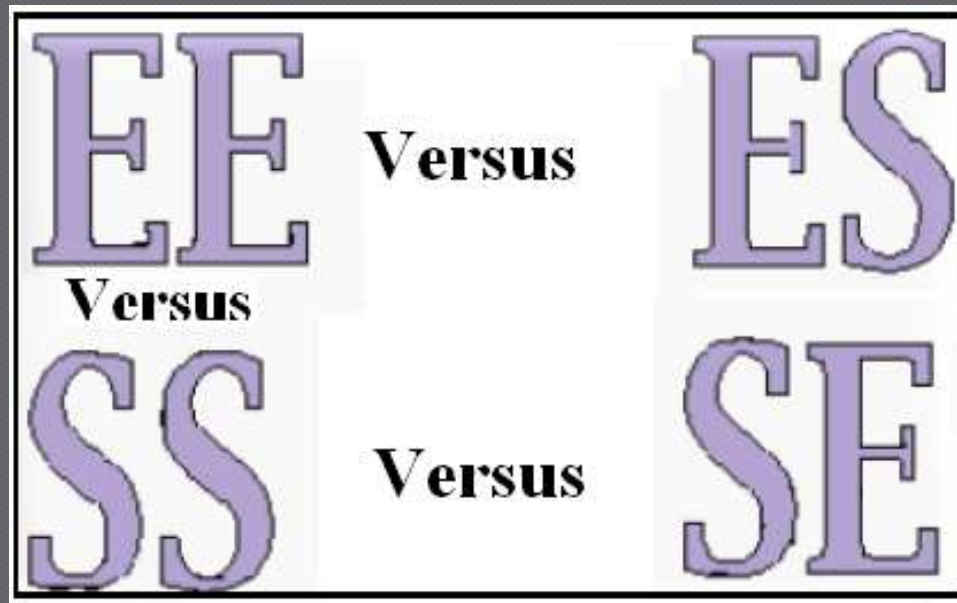
- We do not know if motor control is influenced by speech stimuli, or how perception of a language influences the production.

Research Design

○ Four conditions were tested:

1. Monolingual, English speakers hearing English /apa/ stimuli (EE)
2. Bilingual, Spanish- English speakers hearing Spanish /apa/ stimuli(SS)
3. Bilingual, Spanish-English speakers hearing an English /apa/ stimuli (SE)
4. Monolingual, English speakers hearing a Spanish /apa/stimuli (ES)

Data Analysis



- Kruskal-Wallis One Way Analysis of Variance on Ranks ($\alpha = .01$)
 - Tested Main Effects
- Dunn's Method ($\alpha = .05$)
 - Made Pairwise Comparisons

Participants

16 total participants

- 8 monolingual, English speakers
- 8 bilingual, English- Spanish speakers
 - All Women
 - No history of a speech or language disorder

Methods

- Each participant produced /apa/ speech samples after hearing an example speech stimuli
 - 15 productions of /apa/ within English and Spanish
 - Participants first heard speech stimuli within their primary language, then non-primary language.

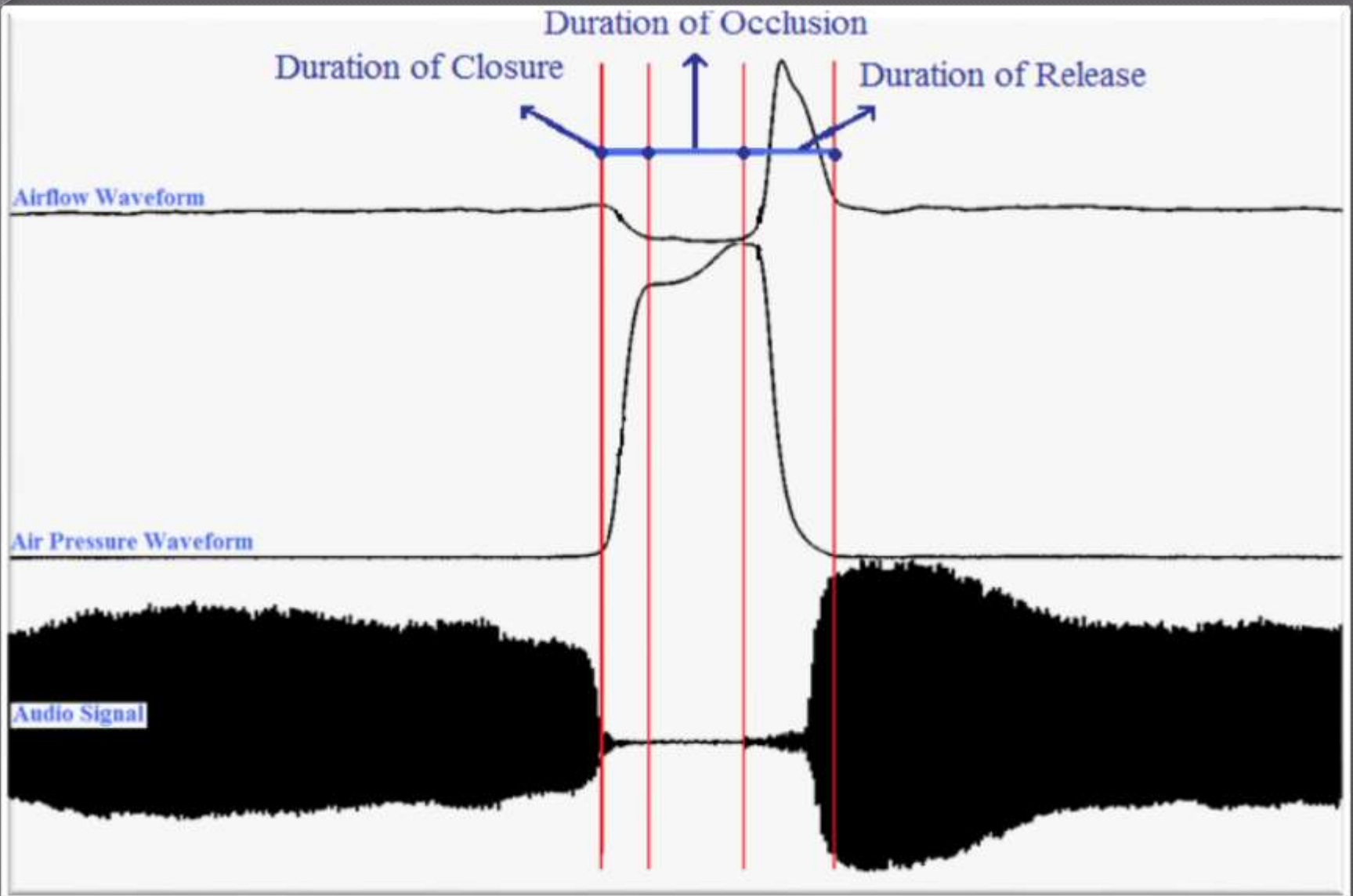
Methods

○ Aerodynamic measures of intra-oral air flow and air pressure were obtained

- Oral-nasal face mask
- Pneumotachometer
 - Oral Airflow
- Pressure Transducer Tube
 - Intra-oral Air Pressure
- Lapel Microphone
 - Audio Signal



- The 3 data streams were digitized onto a computer during the session.



From continuous data stream, each speech sample was parsed.

Summer 2009: Results

- Measures were compared cross-linguistically using a Kruskal-Wallis One Way Analysis of Variance on Ranks
 - Duration of consonantal closure ($p < .001$)
 - Duration of consonantal occlusion ($p < .001$)
 - Voice onset time ($p < .001$)
 - Duration of consonantal release ($p < .001$)

Results

- ◎ **Duration of Closure: Cross-Linguistic**
 - EE (Median= 0.0836)
 - SS (Median= 0.0626)
- ◎ **Dunn's Pairwise Comparisons ($p < 0.05$)**
 - Duration of consonantal closure was shorter for Spanish speakers than for English speakers.

Results

● Duration of Occlusion: Cross-Linguistic

- Speech stimuli in the dominant language
 - EE (Median= 0.0785)
 - SS (Median= 0.0725)

● Dunn's Pairwise Comparisons:

- Duration of consonantal occlusion was shorter for Spanish speakers than for English speakers.

Results

◉ Duration of Release

- EE (Median= 0.142)
- SS (Median= 0.0897)

◉ Voice Onset Time (VOT)

- EE (Median= 0.0691)
- SS (Median= 0.0598)

◉ Dunn's Pairwise Comparisons:

- Duration of consonantal release and VOT was shorter for Spanish speakers than English speakers.

Interpretation

⦿ Differences Between Speakers

- Cross-linguistic results show Spanish speakers produced /apa/ with shorter closure and occlusion duration measures, which is attributed to jaw and lip gestures that have shorter durations in Spanish than in English.

Research Design

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1. Monolingual, English speakers hearing English /apa/ stimuli (EE)
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3. Bilingual, Spanish-English speakers hearing an English /apa/ stimuli (SE)
4. Monolingual, English speakers hearing a Spanish /apa/stimuli (ES)

Fall 2009: Results

- Measures were compared cross-linguistically using a Kruskal-Wallis One Way Analysis of Variance on Ranks
 - Duration of consonantal closure ($p < .001$)
 - Duration of consonantal release ($p < .001$)
 - Voice onset time ($p < .001$)
 - Duration of consonantal occlusion ($p < .001$)

Results

◉ Duration of Closure

- EE (Median= 0.0836)
- **ES (Median=0.0678)**
- SS (Median= 0.0626)
- **SE (Median= 0.0696)**

◉ Dunn's Pairwise Comparisons

- When participant was presented Spanish stimuli, duration measures were shorter than when English stimuli was presented.

Results

◎ Duration of Occlusion

- EE (Median= 0.0785)
- **ES (Median= 0.0593)**
- SS (Median=0.0725)
- **SE (Median= 0.0801)**

◎ Dunn's Pairwise Comparisons

- When speaker was presented Spanish stimuli, duration measures were shorter than when English stimuli was presented.

Results

○ Release Duration

- EE (Median= 0.142)
- ES (Median=0.115)
- SS (Median= 0.0897)
- SE (Median= 0.114)

○ Voice Onset Time

- EE (Median= 0.0691)
- ES (Median =0.0639)
- SS (Median= 0.0598)
- SE (Median=0.0520)

• Dunn's Pairwise Comparisons

When speaker was presented Spanish stimuli, duration measures were shorter than when English stimuli was presented.

Interpretation

- ◉ When monolingual speakers heard Spanish stimuli, the duration measures became shorter.
- ◉ When bilingual speakers heard English stimuli, the duration of closure and occlusion became longer.
- ◉ Same changes occurred for release duration and VOT

Discussion

- Results support that motor behaviors do organize differently across languages.
- Perceptual characteristics of speech stimuli do alter organization of motor control of the vocal tract.
 - The languages approximated each other
 - Motor behaviors among speakers changed due to perception but still remained distinctly different.

The Next Step

○ Further Research:

- We now know that there are significant articulatory differences between Mexican-Spanish and American-English speakers
 - And perception of a language influences how a speaker will produce it...
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- How flexible are speech motor behaviors to the perceptual features of speech?