The effect of speech timing on velopharyngeal function

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Speech

• Respiration (Breathing)
• Phonation (Vocal cord vibration)
• Articulation (Movement of oral and pharyngeal structures)
Velopharyngeal Mechanism
Previous Research: Speech Rate

• When speech rate is increased, articulatory movements demonstrate one of two strategies:
  – Decrease in duration of articulatory movements (moving faster) (Kent et al, 1974; Gay, 1978)
  – Articulators move a reduced distance (decreased displacement to-and-from target) (Lindblom, 1963)
Previous Research (cont.)

- Kuehn (1976)
  - Studied velar movement as a function of increased speaking rate
  - Velum either moved faster or shorter distances
Previous Research (cont.)

• Limitation of Kuehn study
  – Only soft palate movement was measured, not the opening and closing of the velopharyngeal port
  – The velopharyngeal mechanism moves in a sphincteric fashion
Purpose

• To study the effect of speech timing on the opening and closing of the velopharyngeal port in individuals with normal anatomy and normal speech.
Hypothesis

• As speech rate is increased, speakers will either:
  a) close the velopharyngeal port faster, or
  b) reduce the range of velopharyngeal port opening

• The findings may have implications for speakers with abnormal palatal structures
Subjects

- Five males and five females
- Mean Age: 22 years
- American English speakers
- No history of speech disorders
- Perceived as exhibiting normal speech
Instrumentation

- Nasal airflow
- Nasal pressure
- Oral pressure
- Microphone

- All signals digitized at 1000Hz
Speech Sample

• Phrase “we were a pamper away”
  –2 Speech Conditions
    • Conversational speech rate
    • “Fast” speaking rate
  –Target word: “pamper”
  –Rate conditions randomized
  –Generalization
Procedure

• Speech phrases were modeled
• ~15 repetitions produced
• Corrections during data collection
• 10 tokens were measured at each rate
Key Data Calculations

- Velopharyngel Port Area
- Maximum Flow Declination Rate (MFDR)
  - Velocity of velopharyngeal closure
Warren & DuBois (1964)

Velopharyngeal Port Area

Open less with increased rate?
Max Flow Declination Rate (MFDR)

\[ MFDR = \frac{(dV/dt)_{\text{peak}}}{V_{\text{peak}}} \]

Dotevall (2000)

Closed faster with increased rate?
Results
Hypothesis

• As speech rate is increased, speakers will either:
  a) close the velopharyngeal port faster, or
  b) reduce the range of velopharyngeal port opening
Speakers 1, 3, 4, 5, 6, 9, 10 (7/10) increased velopharyngeal port closing velocity with increased speaking rate
Speakers 3, 4, 5, 9 (4/10) decreased velopharyngeal displacement with increased speaking rate.
Discussion

• The majority of the speakers (7/10) closed the velopharyngeal port with increased velocity as rate increased.

• 4/10 speakers opened their velopharyngeal ports to a lesser extent (decreased displacement).
  – These 4 speakers also moved faster.

• None of the speakers decreased velopharyngeal displacement exclusively.
Discussion

• Speakers 2, 7, and 8:
  – Speech timing for “pamper” did not change significantly from Conversational Rate to Fast Rate
  – These speakers decreased speech timing in other aspects of the utterance
Conclusion

• Some speakers may use both strategies to accommodate faster speech rate
  – Move the velopharyngeal structures faster
  – Move the velopharyngeal structures a reduced distance
• Some speakers simply move faster
• Do speakers reduce displacement of velopharyngeal structures exclusively?
Implications

Nasal Septum

Bilateral Cleft Lip and Palate

Nasal Cavity
Post Palate Repair

Structural Limitations

- Palatal Scar Tissue
- Reduced Palatal Length
- Inadequate Palatal Muscle Bulk
Normal Velopharyngeal Closure

Velopharyngeal Insufficiency
Velopharyngeal Mechanism in Speakers with Cleft Palate

• Normal velopharyngeal function (75%)
• Velopharyngeal insufficiency
  – Hypernasal speech – More surgery
• “Borderline” velopharyngeal function
  – Mild, inconsistent nasalization
“Borderline” velopharyngeal function: looking forward

• How does “borderline” velopharyngeal function change as a result of speech timing?
• Are there therapy approaches that would help address negative affects of speech timing?
References


Questions?
Speakers 1, 2, 3, 5, 6, 8, 9, 10 opened velop port for **shorter duration** with increased speaking rate.