Profiling Speech Motor Control:
Validation of Novel and Existing Acoustic Features

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Introduction

Background

*Articulatory features account for most of intelligibility loss [1]
*HOWEVER articulation is broadly defined and few measures have been validated

Critical need for framework to characterize articulatory motor control using quantitative, interpretable, and validated measures [2,3,4]

*Rowe & Green (2019) proposed acoustic-based framework of motor control [2]
*Goal to identify articulatory phenotypes of speech motor disorders to improve: (1) differential diagnosis and (2) the development of new treatments

Coordination **Consistency** **Speed** **Distinctiveness** **Rhythm**

Primary Objective

*Need to assess construct validity of five components in order to establish framework as reliable and accurate tool
*THUS in current study, used speech rate manipulation as validation technique, as prior research has shown that changes in rate impact five proposed components

Research Question

Are there differences in performance on the acoustic-based articulatory features between healthy controls when speaking Fast, Normal, and Slow?

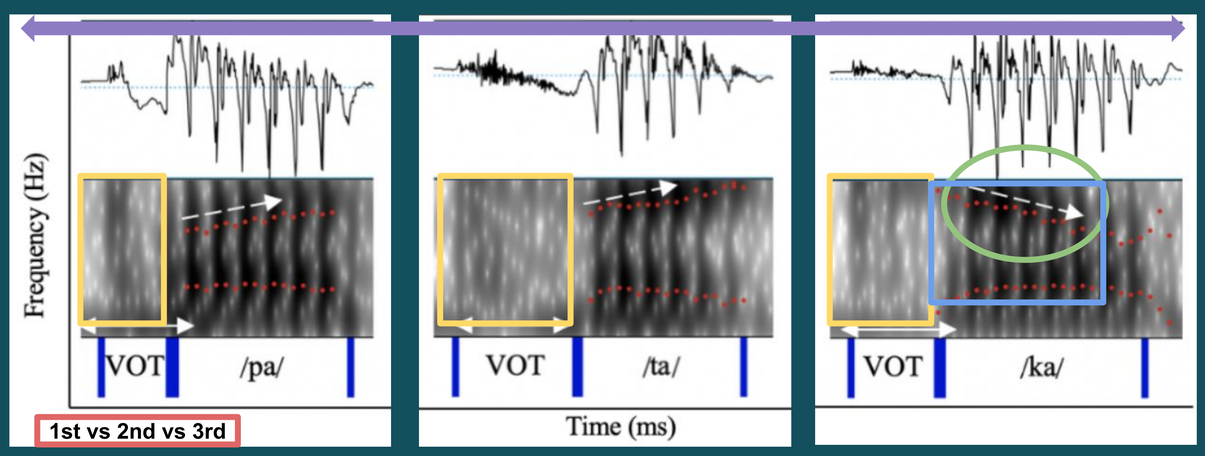
Method

Participants *6 healthy English-speaking controls (1 M, 5 F) between 25-35 yo

Procedures *Participants produced 3 repetitions of sequential motion rate (SMR) task in 3 different rate conditions [5,6] with auditory models:

1. Normal rate
2. 1/2 normal rate
3. 2x normal rate

Measurements



Coordination (F1xF2 Corr)	Consistency (Btwn-Rep Var in VOT)	Speed (F2 Slope)	Distinctiveness (Btwn-Con Var in Spectrum)	Rhythm (Spectral Peak Prominence)
◆Proxy for coupling of lingual movements[7,8,9]	◆Sensitive to populations with instability in repeated productions[10]	◆Represents rate of change in vocal tract configuration[11,12]	◆Each consonant burst has unique energy density spectra depending on place of closure[13]	◆Novel application of cepstral peak prominence to assess aperiodicity of consonant bursts[14]

Coordination correlation between the time series of F1 and F2 in /kuh/ [7]

Consistency between-repetition SD of VOT

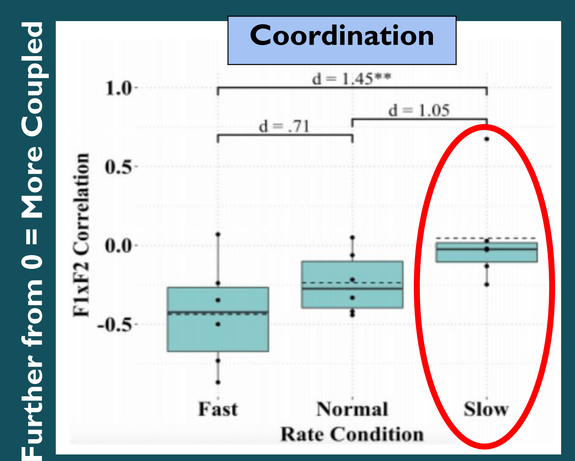
Speed slope of the second formant in consonant-vowel transition in /ka/

Distinctiveness slope of the second formant in consonant-vowel transition in /ka/

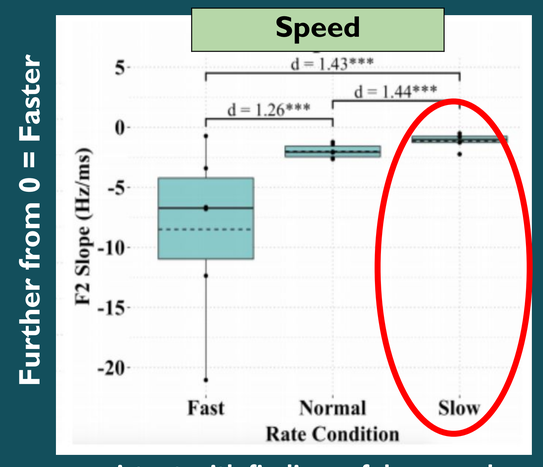
Rhythm frequency-dependent SD of amplitude in spectrums of /p/, /t/, and /k/

Results

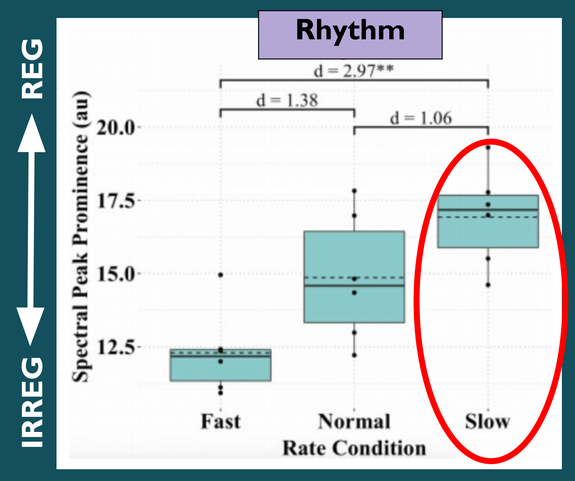
consistent with findings of increased specification at slower rates [5,6]



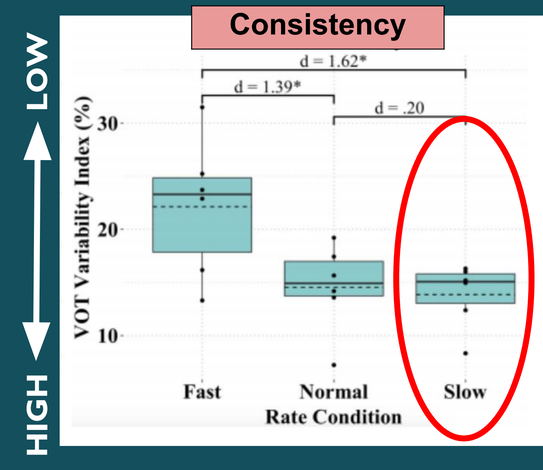
consistent with research illustrating destabilizing effect of slow articulatory rate on speech movements, as reduced formant correlation may correspond with less lingual coupling [12]



consistent with findings of decreased tongue movement at slower rates [11]



effect of articulatory rate on rhythm is less established [15], but our results demonstrated that rhythm regularity increased in slow condition



contrary to prior research [5], we noted decrease in phonetic variability upon decreases in rate → may be due to foci of consistency being measured (i.e., variability in subglottal/supraglottal coordination compared to variability in jaw movement)

Discussion

Takeaways and Limitations

*Framework has potential as valid tool for assessing distinct articulatory components
*Further research needed to validate acoustic features
A. Using larger sample sizes
B. Using biomechanical measures (e.g., kinematics)
C. Using speech motor disorders known to differ in articulatory deficits

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