Control of duration and magnitude in speech imitation

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Subphonemic detail is imitated in speech mirroring tasks

(Fowler et al. 2003)
What is imitated? What is not?

• extended VOT in English voiceless stops
• reduced VOT in English voiceless stops
• presence of prevoicing in Dutch voiced stops
• amount of prevoicing in Dutch voiced stops
• vowel formants
• vowel duration
• F0
• Syllabic liquids vs schwa in German
• Dark vs. clear /l/ in English onset

Spanish stops vary in duration and constriction degree
Research questions:

Is articulatory movement detail in Spanish stops imitated?

Are duration and constriction degree imitated equally?
Speech imitation and control

- Experiment design
- Results
- Analysis
Delayed repetition task

stimulus

response
Experiment stimuli

/aba/ and /apa/
  (/aga/ and /aka/ used as distractors)

duration and CD of /b/ and /p/ varied in 6 steps
duration: 40-140 ms (20ms step)
CD target: 0.3, 0, -0.3, -0.6, -0.9, -1.5mm

vowel duration held constant:
  V1: 230ms       V2: 200ms
Experiment stimuli

Target LA

-1.5
-0.9
-0.6
-0.3
0
0.3

stimulus duration

stimulus LA
Speech imitation and control

experiment design

results

analysis
All subjects imitate duration
Durations much longer than in normal speech

P1

M1

M2

Total duration (ms)

/spirantization/

/b/ phrase boundary

/p/ word-internal

/b/ word-boundary

/40 60 80 100 120 140/
Effect of stimulus consonant differs between subjects

P1*

M1

M2

Produced Duration

Stimulus Duration
Subjects imitate Lip Aperture

P1

/b/

Produced LA

Stimulus LA (achieved)

R² = .17

M1

/p/

Produced LA

Stimulus LA (achieved)

R² = .03

M2

R² = .08

R² = .07

R² = .05

R² = .07

R² = .03

R² = .05

R² = .07

R² = .08
Stimulus consonant does not affect Lip Aperture

Produced LA

/p/ /b/
Why is imitation unequal?

Are duration and Lip Aperture independent?
No consistent correlation between produced LA and duration

Produced LA vs. Produced Duration for different speakers:
- P1
- M1
- M2

Plots show scatter of data points with line of best fit, indicating no strong correlation.

Examples:
- /b/ produced LA vs. duration
- /p/ produced LA vs. duration
Why is imitation unequal?

Are duration and Lip Aperture independent?  

*YES*

What is special about duration?

constriction degree (LA): phonological  
duration: (mostly) prosodic
Prosodic changes in duration

Lengthening is a hallmark of prosodic boundaries

Modeled by changes in stiffness parameter of a mass-spring control model

Increased stiffness $\rightarrow$ longer duration, longer time from onset to peak velocity

Duration is correlated with gestural stiffness

**P1**

- $R^2 = .23$

**M1**

- $R^2 = .80$

**M2**

- $R^2 = .25$
Conclusions

Subjects show large imitation of duration, less of Lip Aperture

Imitation may be mediated by existing phonological categories

Imitation in prosodic vs phonological domains may be unequal