



# An Articulatory (EMA) Study of English Voicing-Based Differential Vowel Duration

James M. Scobbie and Alice E Turk

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## Introduction: Differential Vowel Duration

Many varieties of English show a phonologically-conditioned pattern of phonetically **longer** vowels before phonologically **voiced** obstruents (relative to voiceless ones). This pattern is called voicing-based differential vowel duration ("DVD"). It is not a cross-linguistic universal; most British Englishes have an extreme pattern, at least in monosyllabic words.

✗ [u] in *rude* is much longer than [u] in *root* (>50%).

Differential vowel duration is unusual in Scottish English (and some related varieties). In Scottish, there are two patterns. The specifically Scottish part is called the "Scottish Vowel Length Rule".

✗ /i u ai/ undergo the SVLR. Each has 2 variants.  
✗ Other vowels have a more normal DVD system.

## The Scottish Vowel Length Rule (SVLR)

Two factors condition phonologically long and short variants of /i u ai/.

**Phonological.** Phonological /+V/ fricatives condition **long**. Tautomorphic stops condition **short**.

**Morpho-prosodic.** Open syllables condition **long**, even when they are suffixed by a stop (i.e. /d/).

Type	Word	English	Scottish
-V stop	<i>root</i>	<b>short</b>	<b>short</b>
+V stop	<i>rude</i>	<b>long</b>	<b>short</b>
-V fric	<i>Russe</i>	<b>short</b>	<b>short</b>
+V fric	<i>ruse</i>	<b>long</b>	<b>long</b>
# d	<i>rued</i>	<b>long</b>	<b>long</b>
# z	<i>rues</i>	<b>long</b>	<b>long</b>

## Articulatory control of the acoustic effect

Summers (1987) and de Jong (1991) found that the acoustic DVD between e.g. *root* and *rude* for speakers of American English involves a difference in

✗ steady state duration of the vowel.  
✗ velocity of the closing movement, for some subjects

## Method

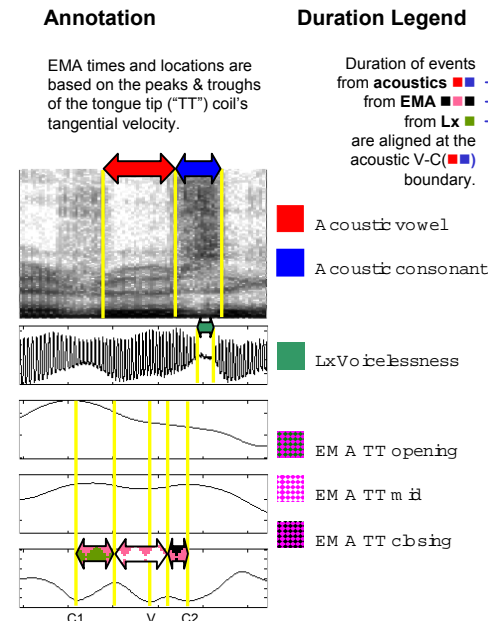
✗ EMA (Electromagnetic Articulography) analysis of single "TT" coil (approx 7mm back from tongue tip).  
✗ Acoustic analysis  
✗ Laryngographic analysis

✗ 2 Scottish subjects to date: JS (1st author) & JH  
✗ 3 English subjects: not discussed here  
✗ Materials = /t/ + /u/ + Final C  
✗ Carrier phrase "I can say \_\_\_ again"  
✗ Typically *n* = 18 reps of each word.

## Conclusions

Scottish and American English long and short vowels differ in function and in form.

They appear to differ in the articulatory mechanisms underlying the distinction between long and short vowels. Scottish speakers lengthen steady states and opening gestures, whereas American speakers lengthen steady states and closing gestures.



## Results 1: Durations and Relative Timing

✗ As predicted, Scottish vowels exhibit a shorter acoustic duration before /t d s/, and greater duration before /#d z #z/.

✗ The voicing contrast is partly cued by glottal activity.

✗ Articulatory differences between long and short show up mid-word (i.e. the vowel "steady state") and early in the word (i.e. between the minimum velocity of [ɪ] and the peak velocity in the [ɪu] transition).  
*Unlike American English, there are no differences in the late portion of the closing gesture into the post-vocalic consonant.*

✗ For the fricative materials, both speakers appear to have later TT events relative to the acoustic VC boundary before /s/. Only JS shows this voicing-based difference in the stops series.

Figure 1: Durations & Relative Timing

## Results 2: Peak Tangential Velocity

Steady state lengthening can be achieved without changing peak velocity. To achieve increased duration early in the word, however, opening peak velocity ought to be lower. We did not observe this.

However, before /#d/ TT travels *further* than it does before /d/. This means peak velocity will tend to be higher due to general compensatory factors.

We can observe relatively slower opening gestures by looking at the peak velocity/distance relationship.

Figure 2: Stop Series Tangential Velocity long /#d/ & two shorts /t d/

Figure 3: Stop Series Total Distance short long

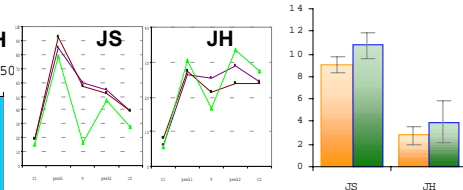


Figure 4: Opening Gesture Pk Velocity (mm/s) vs. Distance (mm) short long

