

Aspects of rhotic production in /Cr/ clusters in Greek

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Introduction

- The Greek /r/ is a tap in intervocalic position (Arvaniti 1999; Nicolaidis 2001; Baltazani 2009).
- In consonant clusters it is a tap + a vocalic element (Baltazani 2009).
- Similar realization in clusters in Catalan, Spanish, Romanian, and Hungarian (e.g., Bradley & Schmeiser 2003; Bradley 2004; Recasens & Espinosa 2007; Vago & Gósy 2007; Savu 2012).

The questions

- (a) is the vocoid systematically present in /Cr/ clusters?
- (b) what is the range of duration variability for the tap and the vocoid?
- (c) is there an influence of the place and manner of articulation of the preceding C on the rhotic?
- (d) is there an influence of the vocalic environment on the rhotic?
- (e) is there evidence suggesting a tap vs trill production in /Cr/ clusters?

Methodology

Materials: Words with a /VCrV/ sequence (C=[p, t, k, f, θ, x], V=[i, e, a, o, u]) embedded in the carrier phrase [i 'leksɪ ___ 'ine a'pli] 'The word ___ is simple'.

Participants/tokens: 5 Greek speakers repeated the material 5 times. Corpus: 750 tokens (6 Cs x 5 Vs x 5 repetitions x 5 speakers).

Measurements: *Acoustic data:* Duration of the rhotic constriction and vocoid, F1 and F2 frequencies at the midpoint of the vocoid.

Electropalatographic (EPG) data: point of maximum contact/constriction during the constriction phase of the rhotic; selected data are reported here, more detailed EPG data are presented in Nicolaidis & Baltazani (2011). System used: Articulate Instruments.

Statistics: Factorial ANOVAs on duration, F1, F2 with subject (1-5), consonant manner (stop vs. fricative), consonant place (labial, dental, velar) and vowel context (i, e, a, o, u) as factors.

Segmentation criteria: (a) vocoid boundaries: onset and offset of formant structure (Figure 1); (b) constriction boundaries: onset and offset of preceding and following formants.

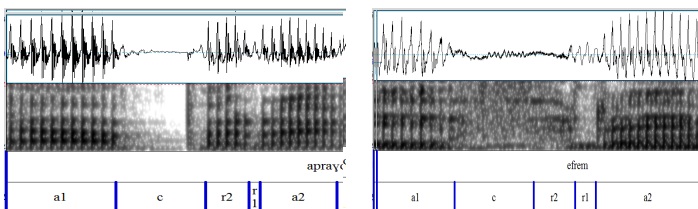


Figure 1. A vocoid with modal quality in the word [apraye] (left) and a whispered vocoid in the word [e'trem] (right). The sequence V1-C-vocoid-V2 is marked as a1-c-r2-r1-a2.

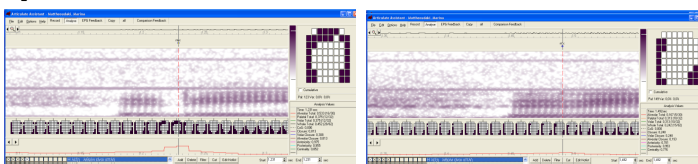


Figure 2. Spectrograms, EPG palatograms and alveolar totals displays for [θri] in two repetitions of the word [li'θrin] showing complete and incomplete constriction during the rhotic.

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Results

Production: tap vs. trill

- Acoustic and EPG data show a single constriction which indicates the production of a tap in /Cr/ clusters.
- EPG analysis shows only five tokens with a possible second constriction out of 748 (in Nicolaidis & Baltazani 2011).
- Large production variability: 47% of tokens produced with incomplete constriction (Figure 2).
- Vocoid was typically present
- These findings clearly showed that /Cr/ clusters typically involve a single tap-like gesture, not a trill, followed by a vocoid.

Duration

- Constriction duration ranges between 11 - 50 ms
- Vocoid duration ranges between 11 - 55 ms
- The duration of vocoid was quite substantial and similar to the duration of the constriction (see Table 1).

Speaker	vocoid	constriction
Speaker 1	20 (8)	22 (10)
Speaker 2	22 (13)	21 (13)
Speaker 3	28 (9)	34 (13)
Speaker 4	23 (7)	29 (13)
Speaker 5	20 (10)	17 (9)
Average	22.6	24.6

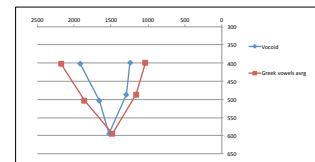


Table 1. Vocoid and constriction phase durations and standard deviations in parentheses for the 5 speakers (averages across consonantal and vocalic contexts and repetitions).

Figure 3: The vocoid qualities (blue) are relatively similar to that of the qualities of the Greek vowels (red) (as averaged from previously published data) with somewhat more centralized F2 values for the high and mid vowels.

- Significant speaker induced variability for the constriction ($F(4, 750) = 28.733, p < .0001$) and for the vocoid ($F(4, 750) = 54.518, p < .001$).
- The vocoid was significantly longer next to fricatives than stops ($F(1, 750) = 14.854, p < .001$) and among fricatives, next to alveolars ($F(2, 325) = 41.894, p < .001$).
- The duration of the rhotic constriction was significantly longer in the context of /i/; vocoid duration was also longer in the /i/ context when C=stop.

Formant Frequencies

- The vocoid qualities are relatively similar to the qualities of the Greek vowels with somewhat more centralized F2 values for the high and mid vowels (Figure 3), (cf. Recasens and Espinosa (2007) for Catalan).

Conclusions

An alveolar tap is produced with a very rapid ballistic action of the tongue tip/blade against the alveolar ridge, with reported duration 18-40 ms (Recasens & Pallarès 1999). Overall our durational data agree with these findings.

Acoustic data show that /r/ in /Cr/ clusters consists of a tap typically accompanied by a vocoid, whose duration and formant frequencies vary as a function of speaker and context.

Acoustic and EPG data show production of a single constriction. Realisations vary: tap and approximant productions are present.

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