Carmen Florina Savu
University of Bucharest, Romania

More on the Rhotic Tap and the Implications of Its Structure

Abstract

The topic of this paper is the rhotic segment with one constricted interval, the tap. This sound is typically considered to be, from the phonetic point of view, a simple small constricted interval because this is how it appears on a spectrogram when it is in intervocalic context. More recent studies (Stolarski 2011; Savu 2011, 2012) consider and argue that the tap is actually comprised of two vowel-like elements flanking this small constriction. After presenting the argument leading to this conclusion and briefly discussing the quality of the tap's vocoids as shown by phonetic experiments, I approach the implications of this sound having the aforementioned structure. Specifically, I address the consequences for the status of syllabic /r/ in Macedonian and the different perception of /C(ɨ)rC/ sequences by speakers of Romanian and Slavic languages with syllabic /r/. In addition to this, I show how this structure of the tap suggests a possible phonetic account for vowel-rhotic metathesis between consonants as the migration of the constriction on a vocalic continuum provided by the tap and the full vowel.

Keywords: rhotics, tap, vocalic elements, constriction, syllabic consonant, acoustic phonetics.

1. Introduction

The tap, represented in IPA by the symbol [ɾ], is the rhotic sound involving "a fast, ballistic tongue-raising gesture and a short apicoalveolar contact" (Recasens & Espinosa 2007: 1). At first sight, it would appear that, on a spectrogram, this is translated as a brief constricted interval. In some studies (Stolarski 2011 and references cited therein) it is maintained that the tap actually contains two vocalic elements, one on each side of the constriction. Savu (2011, 2012) concurs with this claim and explains why this should be so. Section 2 of this paper is dedicated to the discussion of this argument, showing how different phonetic

contexts can hide one or both of these vocalic elements. In section 2 I also briefly elaborate on the quality of the vocoids of the tap, showing them to be, on average, mid-high and relatively central.

Section 3 is dedicated to the implications of the tap being partly comprised of mid-high central vocalic elements. I suggest that this vocalic character of the tap is the cause of the difference in how speakers of Romanian and speakers of Slavic languages with syllabic /r/ perceive the same acoustic input. With regards to the status of syllabic /r/ in Macedonian, the vocoids of the tap provide an explanation for why this should not be an issue. Finally, the structure of [ɾ] suggests a possible phonetic explanation for vowel-rhotic metathesis between consonants.

2. On the phonetic structure of the tap

This section of the paper is dedicated to the phonetic structure of the tap. Specifically, I present the argument that [ɾ] contains more than one brief constricted interval. It actually encompasses one vowel-like element on each side of said constriction. I then proceed to the description of the quality of the aforementioned vocoids.

2.1. Putting together the puzzle

When [ɾ] is in intervocalic position (context VrV), spectrograms show it to be a single closure of about 20ms (Ladefoged & Maddieson 1996, cited in Baltazani 2009), characterizing the quick articulatory gesture that is made to produce it (see Figure 1). As can be seen from Figure 1, there is a short interruption in the acoustic energy in the vocalic background provided by the two full vowels flanking the rhotic. The conspicuous constriction would therefore make [ɾ] look like a short (alveolar) stop, which means that the sound would belong to the natural class of obstruents, as argued by Baltazani (2009). The tap would also look like the closure phase of a trill (Lindau 1985). In fact, Lindau (1985: 166) suggests that "a trill can be regarded as a series of taps."
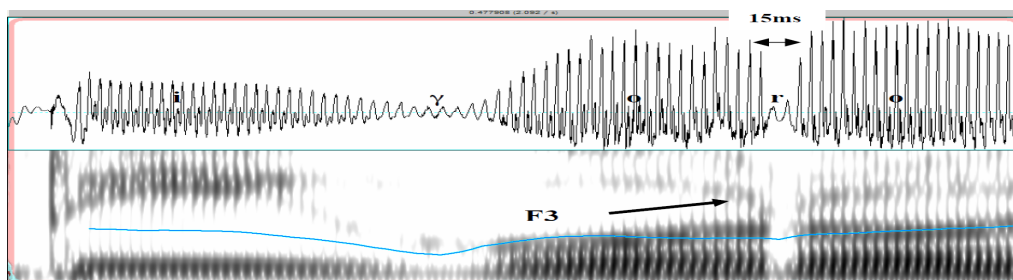

Figure 1. The ending of the Greek word ɣriɣoro 'fast' with a tap in context VrV (Baltazani 2009)

The interesting phenomena happen when the tap is not in an intervocalic context. When [ɾ] has a full vowel on one side, but a consonant or a pause on the other, a brief vowel-like element systematically appears between the constriction of the tap and said consonant or pause (see Figures 2 and 3). The phenomenon is especially salient if what [ɾ] borders with is a pause or a stop consonant. This is because pauses and stop consonants are alike in that they appear as interruptions in the acoustic energy, contrasting with vowel-like material, thereby emphasizing the latter and making it clearly delimited.
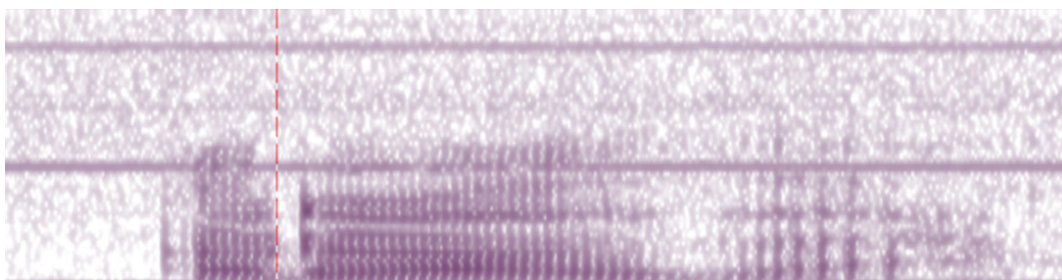
Figure 2. The Greek word *roða* 'wheel' showing a tap in context #rV, with the vocoid clearly visible (Baltazani & Nicolaidis 2011)

In Figure 2, the brief vocoid appears right before the constriction of [ɾ], since it borders with a non-vocalic component on the left. Thus, the structure is consonant/pause – vocoid – constriction – full vowel.

Figure 3 below shows the vocoid appearing after the constriction because the rhotic is bordered by the consonant on the right (VrC). This structure is the reverse of that in Figure 2, namely full vowel – constriction – vocoid – consonant/pause.
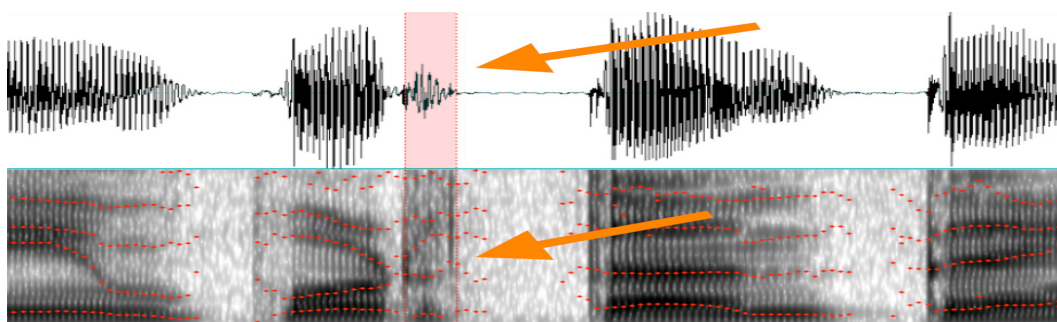

Figure 3. The Spanish word *importante* 'important,' with the vocoid after the constriction delimited (Schmeiser 2009)

In each of the contexts #rV, Vr#, CrV, VrC there is one salient, clearly delimited vocoid separating the short constricted interval of [ɾ] from the consonant or pause flanking it. The vocoid has been systematically observed in these contexts in many languages (see Baltazani 2009; Baltazani & Nicolaidis 2011 for Greek; Ramírez 2006 among others for Spanish; Avram 1993 for Romanian).

The vowel-like element has received various interpretations in the literature. Traditionally, it is considered epenthetic[1] (Ramírez 2006, among others). This term implies that it is not part of the tap, but an extra element that may not appear. However, its systematic cross-linguistic appearance suggests that this is not the case.

Schmeiser (2009) uses the term "vowel intrusion" to describe the phenomenon. In his view, an epenthetic vowel would add a syllable to the word, while the vocalic element in question does not. Bradley and Schmeiser (2003) consider the vocoid as the result of a less than maximal overlap between adjacent consonantal gestures. It is in this sense that the brief vocoids are intrusive.

Another interpretation given to the vocoid is that of a part of another realization of the rhotic phoneme (Avram 1993; Baltazani 2009). In this view, the rhotic is realized as a simple tap in intervocalic

---

1   Other terms that are used to describe the vocoid are "*svarabhakti* vowel" and "excrescent vowel" (Schmeiser 2009, footnote 2).

context, but as tap plus vocoid in other contexts. This interpretation would again place the vocoid outside the tap, making it an "extra" element.

An important piece of the puzzle is provided by Slavic languages. They have /r/ in the rarer contexts where it is not in the immediate vicinity of any full vowel: CrC, #rC, Cr#. Studies done on Serbo-Croatian, Slovak, and Polish (Gudurić & Petrović 2005; Pavlík 2008; Stolarski 2011) report that in rhotics with one closure, there are two vocalic elements, one on each side of the constriction. This happens with syllabic, as well as non-syllabic /r/. An example from Slovak is given in Figure 4.
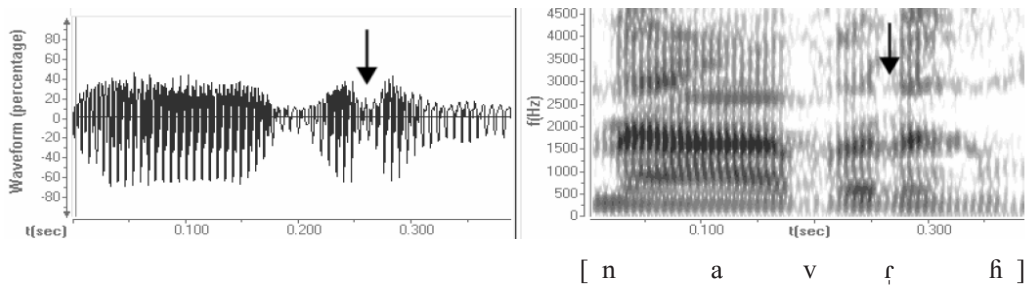

[n a v r̩ ɦ]

Figure 4. The Slovak word *navrh* 'proposal,' containing a syllabic tap in context CrC (Pavlík 2008)

Taking into account all the contexts described above, the picture that emerges is the following: a brief, clearly delimited vocoid appears flanking the constriction wherever the rhotic does not border with a full vowel. Thus, the short vocoids may appear only on the left of the constricted interval (CrV and #rV), only on the right (VrC and Vr#), on both sides (CrC, Cr# and #rC), or on neither side (VrV).

2.2. The general structure: vocoid – constriction – vocoid

The picture presented in section 2.1 suggests a possible unified view of the structure of the tap. This is arguably preferable to considering that there are different realizations of the rhotic containing one closure, depending on the phonetic context. In Savu (2011, 2012) it is argued that the structure of the tap is, in all cases, the one we see in contexts with no full vowels in its vicinity, namely vocoid – constriction – vocoid (see Figure 5). The reason we do not see both vocoids all the time is that the phonetic context may hide one of them, or even both.
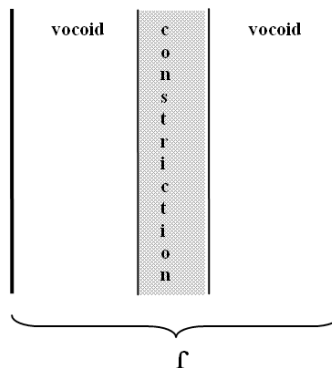

Figure 5. The structure of [ɾ]

This structure is easy to see only when [ɾ] has no full vowels around, since a consonantal environment would contrast with the vocoids, rendering them salient (see Figure 6). This is why contexts CrC, Cr# and #rC, found in the Slavic languages, are so important for the study.
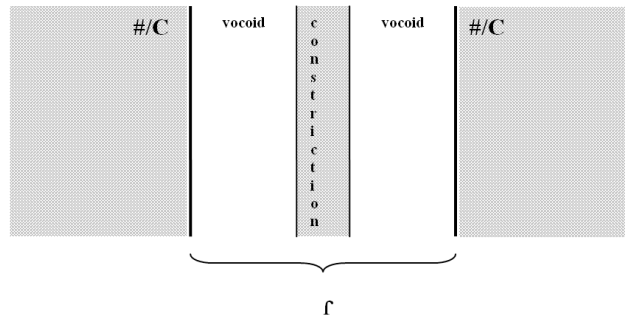

Figure 6. The tap's structure as viewed with no vowels in its vicinity

When [ɾ] has a consonant (pause) on one side and a full vowel on the other, only one vocoid is clearly delimited. The other one is still there, but it is indistinguishable from the full vowel.
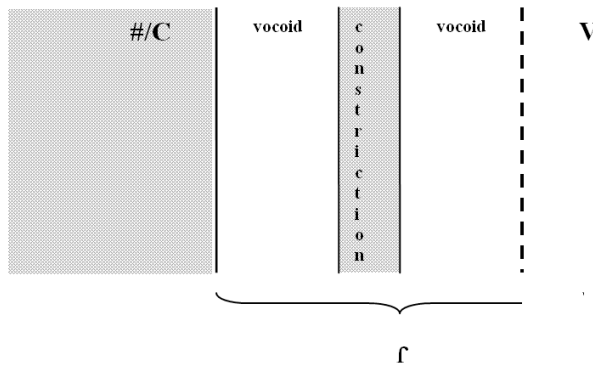

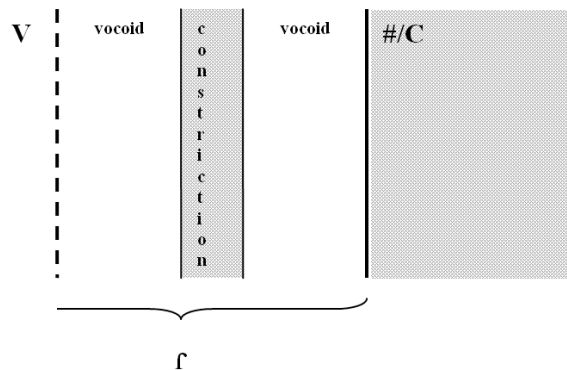
Figure 7. The tap in CrV or #rV

Figure 8. The tap in VrC or Vr#

Figures 7 and 8 illustrate how the tap would look with one full vowel in its vicinity. In both cases one of the tap's vocoids is delimited by the constriction on one side and the consonant or pause on the other side. The other vocoid blends into the full vowel. This is the reason why the tap appears to have only one vocoid in these contexts, which are easier to encounter than the Slavic CrC, Cr# and #rC.

Obviously, when [ɾ] is flanked by full vowels on both sides, both its vocoids are immediately continued by the full vowels and are not clearly delimited.[2] The tap would appear to be comprised only of a brief constriction. The general picture of this is shown in Figure 9.
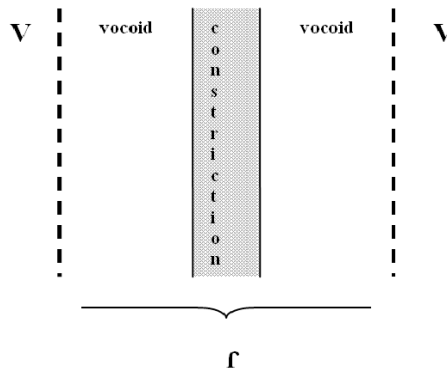
Figure 9. The tap in VrV

At this point, it is worth mentioning that the trill can, indeed, be regarded as a series of taps, as Lindau (1985) suggests. However, rather than viewing the trill as a succession of taps separated by vocoids, it would appear that the two sounds are even more alike, in that the only difference between them is the number of closures (constrictions).
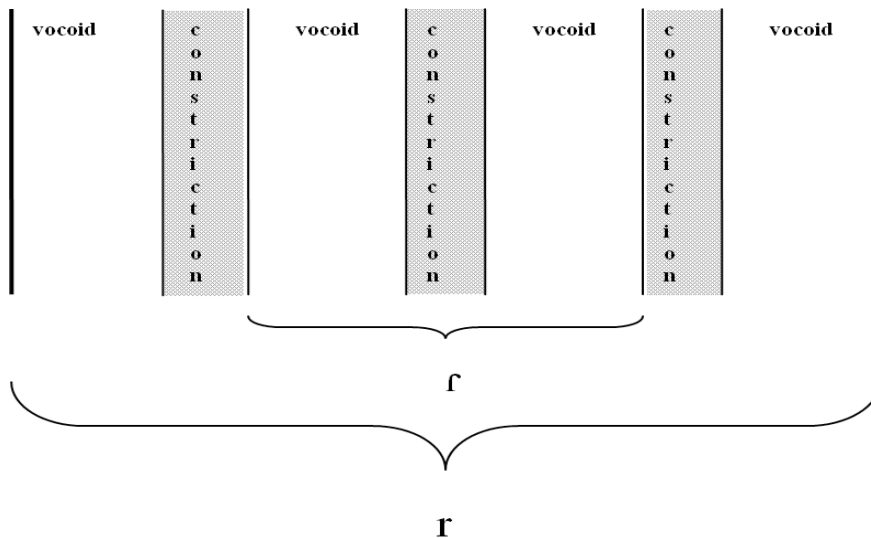
Figure 10. A trill is a series of taps

---

2   See Savu (2011, 2012) for the argument that the full structure of the tap is discernible in VrV as well, though obviously we cannot be sure where the tap's vocoids end and the full vowels begin.
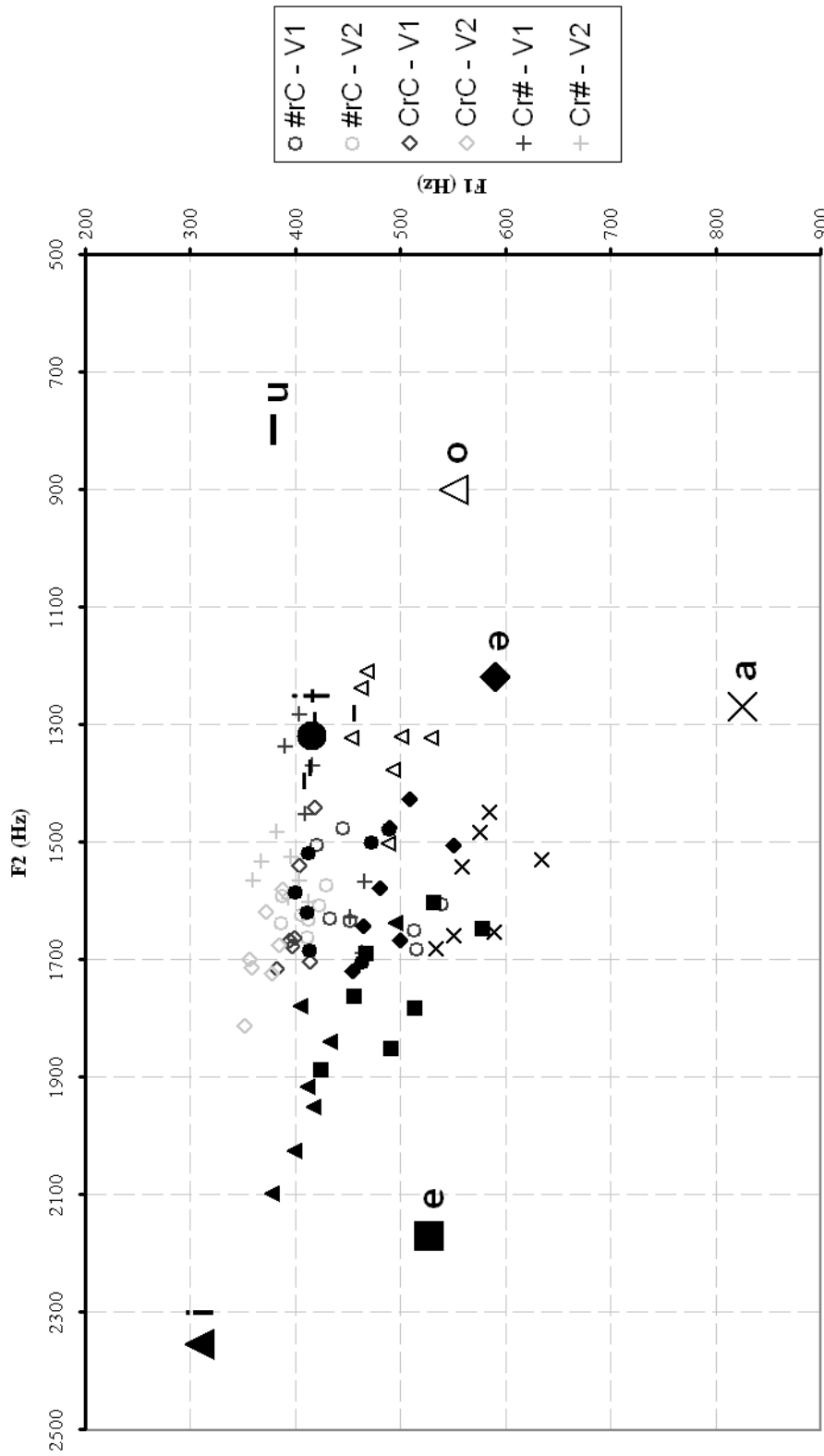
Figure 11. The quality of the tap's vocoids (Romanian data from Savu 2011, 2012; Polish data from Stolarski 2011)

2.3. On the quality of the vocoids

After having established that the rhotic tap has two vowel-like elements as part of its internal phonetic composition, let us now briefly look at the quality of these vocoids, as indicated by previous phonetic studies.

The vocalic elements of [ɾ] have been shown to have similar qualities to that of the central vowels [ə] and [ɨ] (Avram 1993; Ramírez 2006; Vago & Gósy 2007; Stolarski 2011). This would place them in the mid-high central area of the vowel space.

Other studies report that the vocoids are similar to the nuclear vowels in their vicinity (for the languages in which /r/ in such contexts were studied), albeit more central (Quilis 1993 cited in Schmeiser 2009; Baltazani 2009, among others). For example, the vocoid appearing in a Cʸre context would be higher and more front than the vocoid in Cʸra.

Savu (2011, 2012) presents a detailed experiment on /r/ in Romanian, in contexts $(V_1)CrV_1$, $V_1rC(V_1)$ and #rV, designed to measure the quality of the vocoids of [ɾ], in order to see how much it can vary. The results showed 86% of all /r/ tokens to be taps, while other realizations of /r/ were not taken into consideration, since the focus of the experiment was the one vocoid appearing in each of the words.

Unfortunately, Romanian does not have contexts CrC, Cr# and #rC. To cover this gap, the Polish data from Stolarski (2011) were used for comparison. Figure 11 plots the vocoids in Romanian and Polish as compared to the average quality of the Romanian full vowels. Participants were asked to utter tokens of the seven Romanian vowels as part of the experiment described above.

The graph in Figure 11 shows the vowel space of the average quality for the Romanian vowels (the larger symbols). The smaller symbols represent the vocoids and match the shape of the full vowel(s) that /r/ had in its vicinity. For example, the small filled triangles represent the vocoids in contexts (i)Cri, irC(i) and #ri, the small squares are the vocoids in words containing the sequences (e)Cre, erC(e) and #re, *etc*. The graph also contains the vocoids in Polish words (two vocoids per each word), for CrC, Cr# and #rC. They are represented by the empty circles and diamonds, and plusses.

As the graph clearly shows, the tap's vocalic elements consistently stay mid-high and central. The Romanian vocoids also exhibit a tendency to go towards the front area of the vowel space and more generally towards the quality of the full vowel /r/ borders with, while Polish vocoids, which are influenced only by consonants, stay central and relatively high. All the vocoids, for all contexts, stay away from [o], [u] and [a], meaning they are never low or back.

The vocalic elements in both Polish and Romanian appear to be very similar to the Romanian [ɨ] and fairly similar to [ə]. These two are, then, the vowels that mostly resemble the vowel-like parts of [ɾ].

To conclude this section, it would appear that the structure of [ɾ] is that of a small constricted interval flanked by two mid-high, central vocoids. As already stated, the following section focuses on some of the implications this structure might have.

3. Implications of the tap's structure

Section 2 discussed the details of the structure of [ɾ], showing this sound to have the internal structure mid-high central vocoid – constricted interval – mid-high central vocoid. In section 3 I would like to argue that the structure of the tap may lead to a phonetic explanation for certain phenomena.

3.1. /Cr̩C/ vs. /CɨrC/

The first topic that would be interesting to approach having in mind the vocoid – constriction – vocoid structure of [ɾ] is the perception of (Slavic) words in the Romanian vocabulary that contain, for the Romanian speaker, /CɨrC/ sequences. Take, for example, the Romanian word *tîrg* 'bazaar.' This word is perceived as /tɨrg/ in Romanian, (/CɨrC/), but a speaker of Serbian or Macedonian would say there is no vowel there, and the word is /trg/ (/Cr̩C/). /r/ can do the job of a vowel and be the syllable nucleus.[3] In other words, for a Romanian speaker it seems that the speaker of Slavic does not perceive the vowel that is definitely there, while the Slavic speaker would say Romanians perceive an extra vowel.

The interesting observation to make is that Slavic languages with syllabic consonants do not have /ə/ or /ɨ/ (mid or high central vowels) in their inventories (according to the inventories in Sussex & Cubberley 2006: 154).[4] Therefore, it is only to be expected that they should not be able to distinguish these vowels. If [ɾ] itself has vocalic elements, then the difference between how Romanians perceive *tîrg* and how speakers of Slavic do is a difference in parsing what is between the two consonants at the edges, /t/ and /g/ in this case. Whatever mid-high central vocalic material exists between the two consonants will be parsed by a speaker of Macedonian or Serbian as part of the vocoids of [ɾ] (see Figure 12).
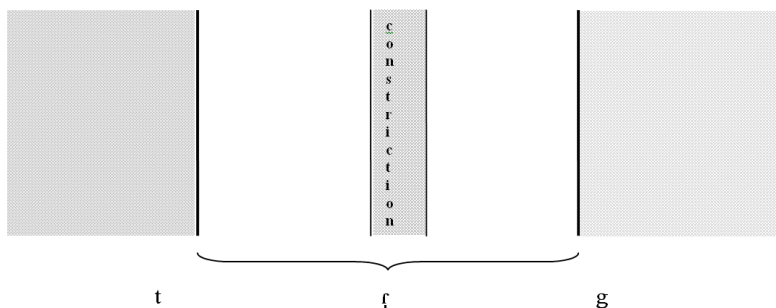

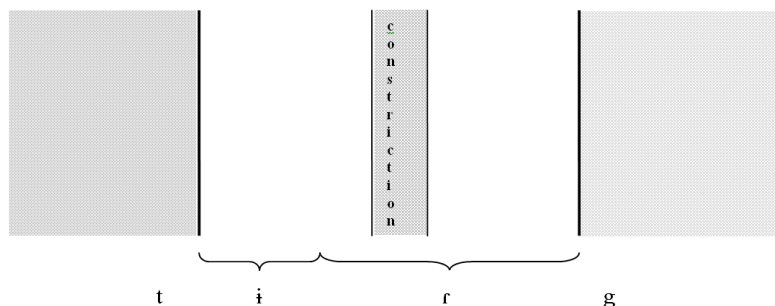Figure 12. The entire vocalic parts between /t/ and /g/ are part of [ɾ] for the Slavic speaker

Figure 13. Romanian speakers cut a portion of the first vocalic element

---

3   In Savu (2011, 2012), it is suggested that it is precisely the tap's strong vocalic component that enables it to function as a syllable nucleus.

4   An exception might be Slovenian, but the existence of syllabic /r/ in Slovenian is debatable (Sussex & Cubberley 2006). Bulgarian clearly has /ə/ as part of its vowel inventory and this language does not have syllabic /r/.

Romanian, however, does distinguish both /ə/ and /ɨ/ and does not have syllabic consonants. Thus, speakers of Romanian cut a portion of what for the Slavic speaker is the first vocoid of [ɾ] and this becomes the /ɨ/, the syllable nucleus, in /tɨrg/. This is shown in Figure 13.

In conclusion, the structure of [ɾ] helps us understand why speakers of Serbian or Macedonian and speakers of Romanian differ in their judgments with regard to such sequences. The difference rests in the phonologies of these languages, to which their respective speakers have access when processing the same acoustic input.

3.2. /r̩/ vs. /ər/ in Macedonian

A similar rationale to that in section 3.1 can be used to argue that the Macedonian language does indeed have syllabic /r/.

Sussex and Cubberley (2006: 156–157) mention that the status of syllabic /r/ in Macedonian is debatable because /ər/ can be frequently heard. However, the lack of /ə/ in other contexts in Macedonian suggests that /ər/ would not be the best analysis.

The structure of the tap, if the realization of /r/ in Macedonian turns out to be [ɾ], provides further support for the syllabic /r/ analysis. Since [ɾ] itself partly consists of mid-high central vocalic elements, any short [ə] interfering between the constriction and the consonants in CrC would be considered a part of [ɾ], though non-native speakers may parse it separately, just like Romanians perceive the Slavic Cr̩C sequences as CɨrC. Arguably, Macedonian speakers do not distinguish /ə/, since it is not part of the vowel inventory of the language.

It may be argued, therefore, that the occurrence of a mid central vowel should not raise difficulties for syllabic /r/ in Macedonian. The vocoids are there because they are part of [ɾ], and the way they are perceived and parsed depends on the vowel inventory of each person's native language.

The line of thought outlined in sections 3.1 and 3.2 suggests a possible diachronic development. A language which loses mid or high central vowels may develop syllabic /r/ instead. This is because if /ɨ/ and /ə/ are lost in other contexts, native speakers lose the ability to distinguish them. When they are in the immediate vicinity of [ɾ] they may become part of the vocoids of the rhotic. A way to visualize this is the structure in Figure 13 turning to the one in Figure 12.

3.3. Vowel-rhotic metathesis

Another issue that is interesting to consider at this point is vowel-rhotic metathesis between consonants (CɾVC turning into CVɾC or vice-versa). The tap's structure suggests a phonetic explanation for this phenomenon.

Let us consider that between the two consonants at the edges there is a "vocalic continuum" formed by the full vowel plus the vocoids of the tap, interrupted by the constriction. Since the constriction is needed for there to be [ɾ], the difference between CɾVC and CVɾC lies in where the constriction is placed on this vocalic continuum. CɾVC would have a constriction near the first consonant, to the left of the vocalic continuum, while in CVɾC the constricted interval is near the second consonant, meaning more to the right. This is illustrated in Figures 14 and 15.
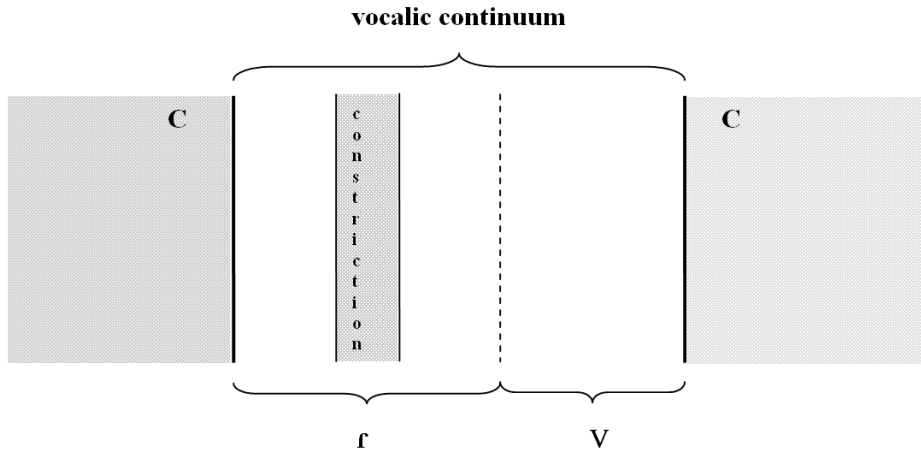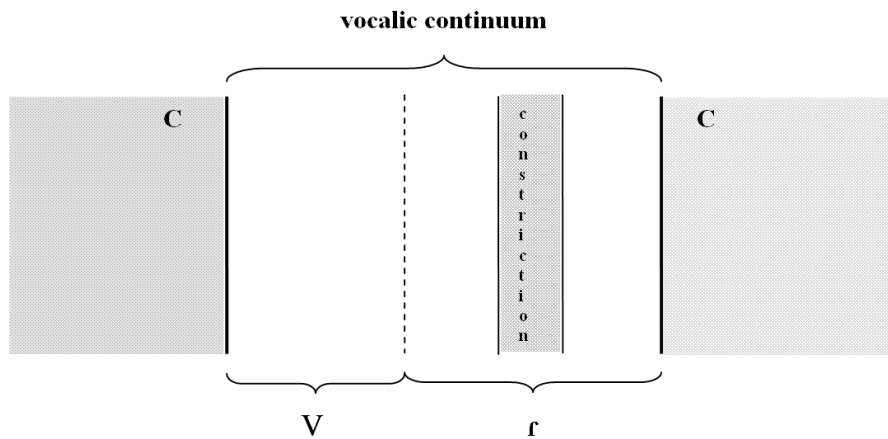
Figure 14. CɾVC

Figure 15. CVɾC

Since the tap is perceived where the constriction is, methathesis could be taken as the movement of the constricted interval to the left or to the right of the vocalic continuum. Thus, moving the constriction to the right in CɾVC would turn it into CVɾC, just like moving the constriction to the left in CVɾC would turn it into CɾVC.

4. Conclusion

This paper outlines the details of the phonetic structure of the rhotic tap, [ɾ], and considers some of the implications thereof. The sound in question is argued to have the following structure: mid-high central vocoid – constricted interval – mid-high central vocoid. These vocoids that enter the composition of the tap are shown to shed light on certain phenomena. The perception of the same acoustic input as /CɨrC/ and /CŗC/ by speakers of Romanian and Macedonian or Serbian respectively may be seen as

a difference in parsing what is between the consonants at the edges, according to the vowels each language distinguishes. Similarly, the tap's containing vocalic parts supports the syllabic /r/ analysis in Macedonian. Another problem that the structure of [ɾ] provides insights into is the vowel-rhotic metathesis between consonants, which can be seen as the movement of the constricted interval along the vocalic continuum formed by the vocoids of the rhotic and the full vowel.

References

Avram, Andrei (1993) "Cercetări experimentale asupra consoanelor lichide din limba română." [In:] *Fonetică şi dialectologie* 12; 8–20.

Baltazani, Mary (2009) "Acoustic Characterization of the Greek Rhotic in Clusters." [In:] *Proceedings of the 18th International Symposium on Theoretical and Applied Linguistics*. Vol. 1; 87–95.

Baltazani, Mary, Katerina Nicolaidis (2011) "Production of the Greek Rhotic in Initial and Intervocalic Position: An Acoustic and Electropalatographic Study". Paper presented at the 10th International Conference on Greek Linguistics, Komotini, Greece, September 01–04, 2011.

Bradley, Travis G., Benjamin S. Schmeiser (2003) "On the Phonetic Reality of /ɾ/ in Spanish Complex Onsets." [In:] Paula M. Kempchinsky, Carlos-Eduardo Piñeros (eds.) *Theory, Practice and Acquisition: Papers from the 6th Hispanic Linguistics Symposium and the 5th Conference on the Acquisition of Spanish and Portugese*. Somerville, MA: Cascadilla Press; 1–20.

Gudurić, Snežana, Dragoljub Petrović (2005) "O prirodi glasa [r] u srpskom jeziku." [In:] *Zbornik Matice za Filologiju i Lingvistiku* 48; 135–150.

Ladefoged, Peter, Ian Maddieson (1996) *The Sounds of the World's Languages*. Oxford: Blackwell Publishers.

Lindau, Mona (1985) "The Story of /r/." [In:] Victoria A. Fromkin (ed.) *Phonetic Linguistics: Essays in Honor of Peter Ladefoged*. Orlando: Academic Press; 157–168.

Pavlìk, Radoslav (2008) "K niektorým otázkam kvalitatívnych a kvantitatívnych vlastností slovenských vibránt." [In:] *Jazykovedný časopis* 52 (12); 65–97.

Quilis, Antonio (1993) *Tratado de fonología y fonética españolas*. Madrid: Editorial Gredos.

Ramírez, Carlos J. (2006) "Acoustic and Perceptual Characterization of the Epenthetic Vowel between the Clusters Formed by Consonant + Liquid in Spanish." [In:] Manuel Díaz-Campos (ed.) *Selected Proceedings of the Second Conference on Laboratory Approaches to Spanish Phonetics and Phonology*. Somerville, MA: Cascadilla Proceedings Project; 48–61.

Recasens, Daniel, Aina Espinosa (2007) "Phonetic Typology and Positional Allophones for Alveolar Rhotics in Catalan." [In:] *Phonetica* 63; 1–28.

Savu, Carmen F. (2011) "Another Look at the Structure of the Rhotic Tap: Constricted Intervals and Vocalic Elements." Paper presented at the *R-atics 3 Workshop*, Free University of Bozen-Bolzano, Italy, December 2–3, 2011.

Savu, Carmen F. (2012) "An Acoustic Phonetic Perspective on the Phonological Behavior of the Rhotic Tap." Paper presented at *ConSOLE XX*, University of Leipzig, Germany, January 4–8, 2012.

Schmeiser, Bradley (2009) "An Acoustic Analysis of Intrusive Vowels in Guatemalan Spanish /ɾC/ Clusters." [In:] *The University of Pennsylvania Working Papers in Linguistics* 15 (1); 193–202.

Stolarski, Łukasz (2011) "Vocalic Elements in the Articulation of the Polish and English /r/." Paper presented at *Languages in Contact 2011*, University of Wrocław, Poland, June 11–12, 2011.

Sussex, Roland, Paul Cubberley (2006) *The Slavic Languages*. Cambridge: Cambridge University Press.

Online sources

Vago, Robert M., Mária Gósy (2007) "Schwa Vocalization in the Realization of /r/." [In:] *Proceedings of the 16th International Congress of Phonetic Sciences*; 505–509. Available at: http://www.icphs2007.de/conference/Papers/1080/1080.pdf