Sylwester Jaworski

Phonetic Realisations of the Polish Rhetoric Intervocalic Position : A Pilot Study

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SYLWESTER JAWORSKI[*]
Uniwersytet Szczeciński

PHONETIC REALISATIONS OF THE POLISH RHOTIC IN INTERVOCALIC POSITION: A PILOT STUDY[**]

1. Introduction

Rhotics are very common sounds in the languages of the world. A cross-linguistic analysis reveals that as many as 75% of all languages have a rhotic phoneme in their inventory (usually a trill), however, only 18% of those languages have two or more contrasting r phonemes[1]. Rhotics differ from other sound classes, e.g. plosives or fricatives, in that they constitute a heterogeneous group as their acoustic and articulatory characteristics differ from sound to sound. For instance, the retroflex approximant found in some accents of British English and the uvular trill characteristic of some French, German or Swedish accents constitute two elements of this category despite sharing very little in acoustic and articulatory terms. Some authors claim that the only reason for classifying rhotics as a distinct group of speech sounds is that they tend to be represented by the letter 'r' in those languages that use the Latin alphabet[2]. Naturally, there

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[*] Sylwester Jaworski – językoznawca, adiunkt w Katedrze Filologii Angielskiej Uniwersytetu Szczecińskiego. Tytuł doktora nauk humanistycznych uzyskał w 2008 r. w Instytucie Filologii Angielskiej Uniwersytetu im. Adama Mickiewicza w Poznaniu. Prowadzi zajęcia z fonetyki i fonologii oraz morfologii. Jego zainteresowania badawcze koncentrują się na procesach mowy szybkiej, zmianie językowej oraz patologii mowy. Autor kilku publikacji z zakresu fonetyki i fonologii.

[**] I would like to thank the reviewer of the paper for the insightful comments offered during the preparation of the final draft of this article.

[1] I. Maddieson, *Patterns of sounds*, Cambridge University Press, Cambridge 1984.

[2] P. Ladefoged, I. Maddieson, *The sounds of the world's languages*, Blackwell Publishers, Oxford 1996, p. 215.

are many different rhotics in the world's languages. The following eight symbols of the International Phonetic Alphabet: r, □, □, □, □, □, □, □ stand for the most common sounds of this class (see table 1 for articulatory details of the sounds).

Another characteristic feature that distinguishes rhotics from other sounds is that they constitute an articulatory difficulty. Cross-linguistically speaking, they are the last sounds mastered by children in the acquisition process[3]. This is definitely true of the languages that have a trill in their sound system, e.g. Polish. One reason for acquiring the trill so late is that it requires a considerable amount of articulatory effort and many young children find it very difficult to produce it properly. Due to the articulatory complexity of the trill, many speakers tend to replace it with articulatorily easier segments, e.g. taps, fricatives or approximants. Actually, tap realisations of the phoneme are by far the most common variants found in natural speech. Thus tapping, fricativisation and approximantisation of the rhotic can be regarded as a speaker-friendly, lenition process resulting in minimising the articulatory difficulties of speech. Since these three realisations differ in sonority, one can think of the allophones as different degrees of reduction of the rhotic with the tap constituting the first degree of reduction and the approximant being the 'weakest' form of a rhotic sound.

Table 1

Articulatory description of various rhotic sounds □

IPA symbol	Place and manner of articulation	Voicing
r	Dental or alveolar trill	+V
□	Dental or alveolar tap	+V
□	Dental or alveolar approximant	+V
□	Post-alveolar flap	+V
□	Post-alveolar approximant	+V
□	Uvular trill	+V
□	Uvular approximant	+V
□	Dental or alveolar lateral flap	+V

The present paper reports the results of a study that aimed at describing various physical realisations of the Polish phoneme /r/. The acoustic evidence presented here strongly suggests that in connected speech speakers of Polish articulate several variants of the rhotic, which include taps, fricatives, approximants and, hardly ever, trills. The major objective of this study is to describe the acou-

[3] M. Vihman, *Phonological development. The origins of language in the child*, Blackwell Publishers, Oxford 1996.

stic and articulatory characteristics of several different phonetic realisations of the Polish rhotic phoneme /r/. Also the author will make an attempt to prove that these variants are rate-dependent, which implies that in fast speech approximants are more frequent than taps.

2. The acoustic characteristics of rhotics

As it is rather impossible to provide an accurate description that would fit every rhotic, the articulatory and acoustic characteristics of the major variants of this sound category will be presented in the following sub-sections. It was mentioned in the introduction that in connected speech Poles produce taps, fricatives and approximants. In order to provide a comprehensive description of this class of sounds, examples of rhotics from different languages will be used.

2.1. Trills

In order for a speech sound to be referred to as a trill, one speech organ has to vibrate against another. Statistically speaking, the alveolar segment can be regarded as a 'prototypical' trill as it is found in a greater number of languages than the other trills, i.e. the uvular and bilabial ones[4]. The alveolar trill is articulated with the apex producing a series of closing and opening gestures. Figure 1 shows a spectrogram and an oscillogram of the word *morro* 'snout' produced by a native speaker of Peninsular Spanish. There are three noticeable occlusions that last about 25 ms, separated by vocalic sounds whose duration is, on average, 5–10 ms shorter than that of the occlusions. Interestingly enough, the F1, F2 and F3 values of the vocalic elements tend to be high when the flanking vowels are low, whereas high vowels result in decreasing the formant frequencies[5].

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[4] R. Wiese, *The unity and variation of German /r/*, in: R.Van Hout and H. van de Velde (eds.), *r-atics, Sociolinguistisc, Phonetic and Phonological Characteristics of /r/*, Etudes de Travaux, 4, p. 11–26.

[5] B.B. Falgueraz, *Las vibrantes del Español: manifestaciones acústicas y procesos fonéticos*, An unpublished PhD dissertation, Barcelona 2001, p. 273.

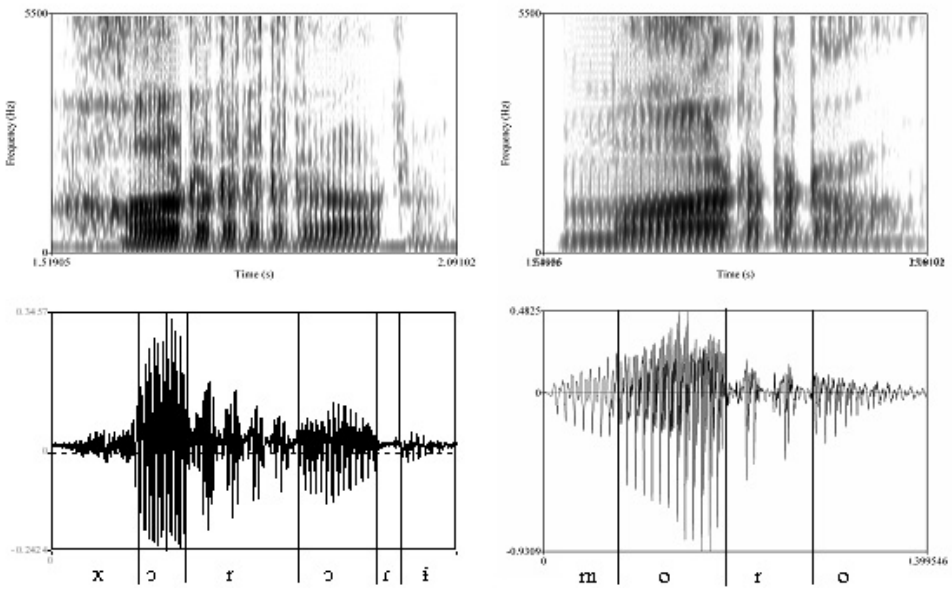

Fig. 1. The spectrograms and oscillograms of the Polish word *horrory* 'horrors' (left panels) and the Spanish word *morro* 'snout' produced in isolation

Figure 1 shows spectrograms and oscillograms of two apical trills produced by a native speaker of Polish (left panels) and a native speaker of Iberian Spanish (right panels). As the spectrograms show, in both realisations the apex produced a series of closing and opening gestures (five in the Polish word and three in the Spanish word) which were made possible by an airflow passing through a narrow aperture formed by the tongue. Importantly, in trills the movements of the tongue are not controlled by any muscular action. Rather they result from the aerodynamic conditions produced by an airstream passing through the aperture, which makes trills very similar to vocal fold vibration in voicing. After the active articulator has formed a total closure with the passive organ, a sufficiently strong airflow separates them and a certain volume of air flows through the aperture. As a consequence, the pressure behind the closure drops dramatically and the active articulator springs back to its former position producing another closure[6]. On average, trilled articulations consist of two or three such cycles[7]. As trilling crucially depends on the size and shape of the aperture as well as on the airflow,

[6] Aerodynamic changes of this type are referred to as the Bernoulli effect.

[7] J.I. Hualde, *The Sounds of Spanish*, Cambridge University Press, Cambridge 2005, p. 181.

minimal changes to one of the factors can result in a non-trilled realisation of a given sound.

Interestingly enough, in languages in which trills do not contrast with other rhotics, trilled realisations are hardly ever produced. For instance, in Scottish English they are heard only in declamatory styles[8], the same as in Polish and Russian where they are normally realised as taps. This is definitely a strategy aimed at minimising articulatory cost which is very unlikely to be applied in languages such as Spanish where the alveolar tap and the post-alveolar trill constitute two different phonemes.

2.2. Taps (and flaps)

Unlike trills, taps have only one short closure. It is worth mentioning that many phoneticians, e.g. Ladefoged, distinguish between taps and flaps. In the former "a brief contact between the articulators is made by moving the active articulator directly towards the roof of the mouth", whereas in the latter the active articulator moves tangentially towards the site of the contact and touches it passing[9].

A tap can be regarded as a period of silence, usually with a voice bar, as illustrated in Figure 2. In contrast to trills, the acoustic characteristics of taps, whose closure phase is on average 40 ms long, do not appear to be significantly dependent on the quality of the flanking elements. The panels on the left show the alveolar tap produced by a native speaker of American English in the word *water*, whereas the panels on the right depict the tap realised by a native speaker of Igbo in the word *nmiri* 'water'.

[8] J.C. Wells, *Accents of English*, Cambridge University Press, Cambridge 1983, p. 411.

[9] P. Ladefoged, I. Madiesson, op.cit., p. 231.

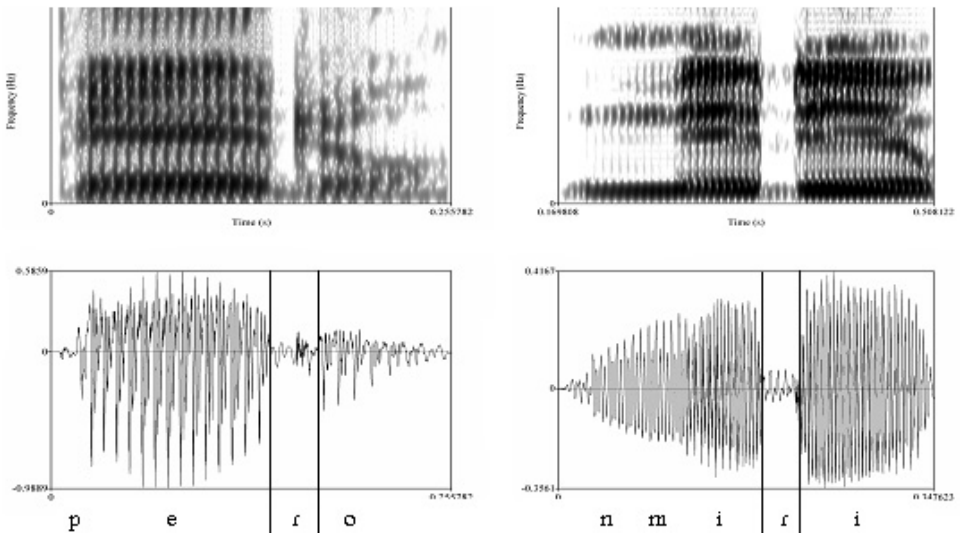

Fig. 2. A tap in the Spanish word *pero* 'but' and in the Igbo word *nmiri* 'water'

The articulatory description of various rhotic sounds presented in Table 1 implies that every sound belonging to this category is inherently voiced. Even though the spectrograms in Figures 1 and 2 seem to substantiate that claim as during the closure phases of the trills as well as those of the taps the vocal folds were vibrating, one can frequently come across voiceless realizations of rhotics, especially as far as taps are concerned. Speakers of Polish, for example, manifest a very strong tendency to produce voiceless taps (see section 4) and so do speakers of Russian[10]. Figure 3 below presents two spectrograms of a tap realisation of the alveolar rhotic in Polish and Russian which show typical articulations of intervocalic [r] sounds in the two languages. Importantly, in both cases the taps are voiceless as there seems to be no vocal fold activity during the closure phase of the tap.

[10] The acoustic properties of the Russian rhotic will be discussed in detail in Jaworski (forthcoming).

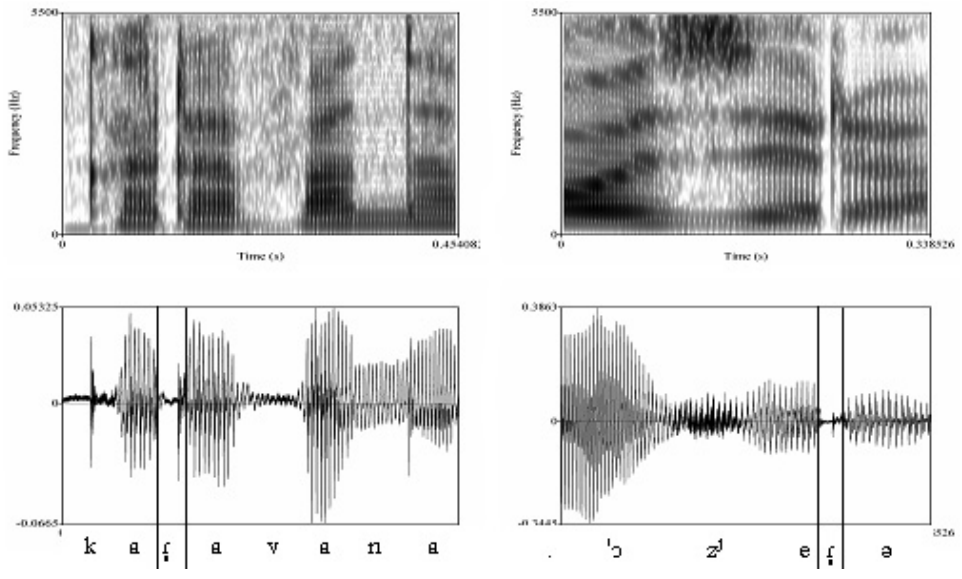

Fig. 3. Voiceless taps produced in the Polish word *karawana* 'caravan' and the Russian word *озеро* [□□z□e□ə] 'lake'

2.3. Fricatives

The category of rhotics also includes fricatives in the realisation of which the airstream passing through an approximation between two organs produces audible friction, usually in the region of F3 and F4. Even though some languages do not have a fricative rhotic in their sound inventory, it is very likely that speakers of those languages produce such sounds by applying a lenition process in fast or casual speech. It must be emphasised at this point that the term lenition is used here to underline the fact that this type of fricativisation appears to be a speaker-friendly process, applied to minimise articulatory effort. Since the articulatory target is not reached and a total closure is not produced, the resultant sound can be regarded as more sonorous than the target sound, but by no means is it claimed that fricatives are more sonorous than rhotics. After all, reduction does not have to be realised as an increase of sonority. Low vowels, for instance, are often more central, that is less sonorous, in fast speech.

Figure 3 below shows two fast speech realisations of the Polish word *kawalera* 'bachelor' (gen.sing) and the Spanish word *contrarrevolucionaria* 'counterrevo-

lutionary'. Neither of the languages has a rhotic fricative in its inventory, yet in both cases the rotic sound in the Polish word, which should have been produced as a tap, and the second 'r' sound in the Spanish word, which the speaker definitely wanted to articulate as a trill, were realised as fricatives. Particularly in the case of the Polish rhotic the friction is very clear and, in fact, audible.

As the spectrogram and oscillogram of the Spanish word in Figure 4 show, sometimes it can be problematic to determine whether a given sound should be classified as a fricative or an approximant. On the one hand, there is relatively strong formant structure in the region of F1 and F2, but on the other hand, friction is found in the high frequency region. Thus there is a good reason to classify the sound as a fricative, and there is an equally good reason to classify it as an approximant. Therefore, the researcher's decision as to which class the sound belongs to is often arbitrary.

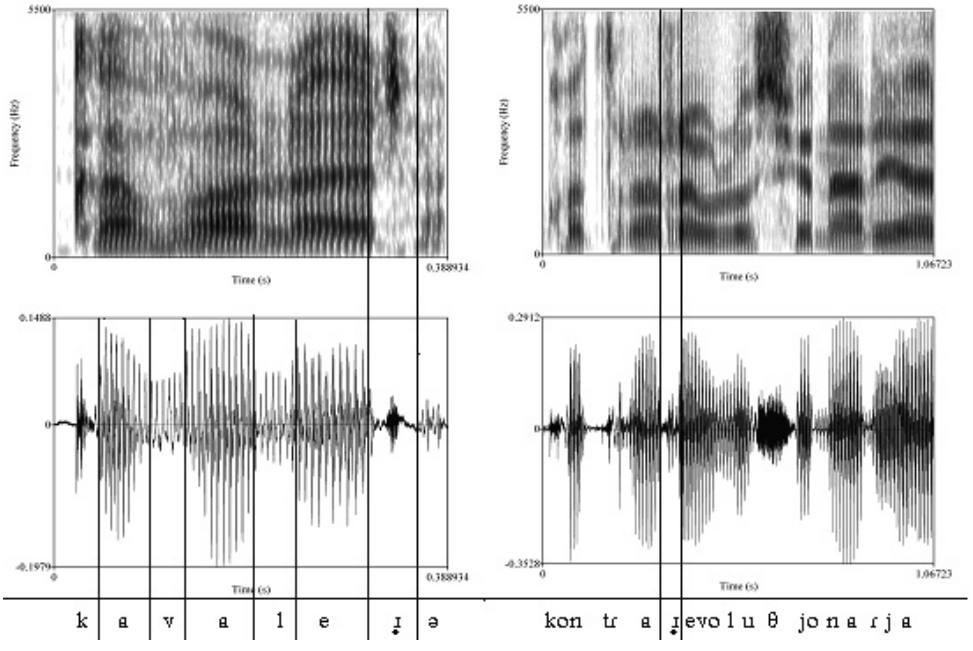

Fig. 4. Fricativisation of [r] in fast speech in the Polish word *kawalera* 'bachelor' (gensing) and the Spanish word *contrarrevoucionaria* 'counterrevolutionary[11]

[11] Since IPA does not provide a symbol for the alveolar fricative rhotic, the sound will be represented here by the symbol □□ as in Ladefoged-Madiesson 1996.

2.4. Approximants

An approximant sound is articulated when "one articulator is close to another, but without the vocal tract being narrowed to such an extent that a turbulent airstream is produced"[12]. Approximants are thus vowel-like sounds, which sometimes makes them hardly distinguishable from the flanking vowels. Figure 4 shows two spectrograms and oscillograms of two rhotic approximants produced by native speaker of American English in the word *surrounding* and by a native speaker of Polish in the word *Karol* (the Polish 'equivalent' of Charles). In the former, the trajectories of F2, F3 and F4 show that there is an approximant between the vowels. Obviously, the lesser intensity of the formants also helps to determine the phonetic category of the intervocalic segment. In the latter, in which the approximant results from a lenition process, the formants (except for F4) do not change. In fact, one might argue the rhotic has been deleted. The drop in F4 as well as the lesser intensity of this section of the spectrogram are the only phonetic cues as to the presence of the rhotic.

Being similar to vowels makes approximants susceptible to deletion, and in fact intervocalic approximants tend to be dropped quite regularly as well as ones that either precede or follow a vowel that has similar acoustic characteristics. For instance, in English [□] is regularly deleted in words such as *always*, *although* or *already* when it immediately follows [□□]. In *February*, *literary* and *library*, on the other hand, a whole syllable containing the rhotic approximant is elided. As a result, these words are normally pronounced [□feb□i], [□l□t□i] and [□la□b□i], respectively[13].

In the Polish language, it is the bilabial velar [w] that is regularly dropped if placed between two vowels, e.g. in *powiedziała* [p□vjed□□awa] 'she said' normally realised as [p□vjed□□a□]. By the same token, the rhotic [r] is also deleted in the same environment, particularly in the speech of individuals who have a speech impediment and replace the trill with an approximant. As a matter of fact, in fast speech when rhotic undergoes reduction, many 'healthy' speakers of Polish also delete the segment (see the right panel of Figure 5).

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[12] P. Ladefoged, *A course in phonetics*, Blackwell Publishers, Boston 2006, p. 15.

[13] A. Cruttenden, *Gimson's pronunciation of English*, Arnold, London 1994, p. 215.

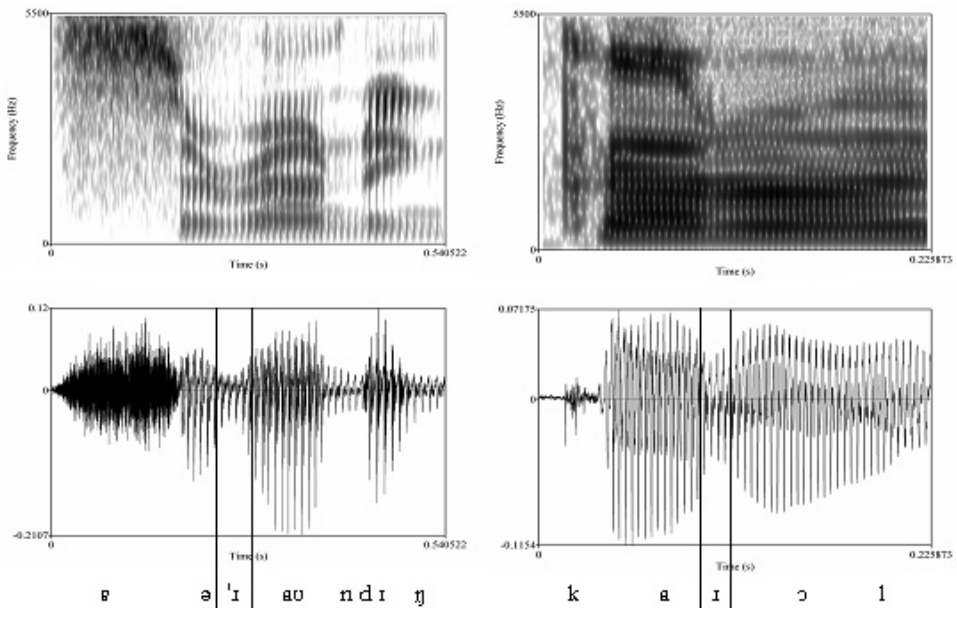

Fig. 5. Approximant rhotics in the English word *surrounding* and the Polish word *Karol* produced in fast speech

3. Experiment

As the different allophones of the /r/ sound shown in the four figures above differ in sonority, one can argue they result from different degrees of undershoot, which is likely to increase proportionally to speaking rate up to the point of deletion. As a consequence, approximant allophones of the rhotic are expected to be more frequent in fast speech than in natural speech. The primary objective of the present study is to show which variants of the rhotic sound of Polish placed in intervocalic position are found in natural speech of the subjects as well as the influence an increased speech rate has on the physical realisation of the sound. In order to achieve these goals, four female native speakers of Polish were asked to read 20 meaningful sentences containing words in which the rhotic sound was

placed between two vowels. The participants read each sentence twice at different self-determined speech rates, namely natural and fast[14].

Since the position of a given sound in relation to the main stress usually has an impact on how it is produced, the target words were divided into two sets. Set I consisted of words in which the rhotic constituted the only onset element of the stressed syllable and set II was made up of words in which the [r] sound was placed in the onset of an unaccented syllable. All the target words are listed in Tables 2 and 3. As it is a pilot study, only intervocalic position is taken into consideration.

4. Results and discussion

Every participant produced 40 intervocalic rhotic sounds: twenty in natural and twenty in fast speech. Half of the sounds were placed in stressed syllables, the other half in pre-stress and post-stress positions. In this study, the quality of the flanking vowels was not taken into consideration.

Quite predictably, in natural speech most of the rhotics were realised as taps (59.5%). Fricative rhotics constitute 23.4%, approximants 15.8% and trills only 1.3% as there are only two trills in the data. Tapping was more frequent in those words in which the rhotic sound was the only onset element of the stressed syllable (72.5%) than in those in which it was placed in unaccented syllables (52.5%). There are, however, significant differences between the participants (cf. Figures 6 and 7). For example, in MG's speech taps constitute 82.5% of all realisations, while MJ, who seems to reduce speech to a much greater extent, produced only 16 taps, that is 40%. The data also imply that the rhotic undergoes lenition as in fast speech there are fewer instances of taps (60%) than in natural speech (77.5%). Thus fricativisation and approximantisation of the rhotic can be thought of as a phonetically conditioned processes which means that the sound is subject to the same mechanical constraints as any other intervocalic stop[15]. This explains why the number of approximant rhotics is greater in fast speech than in natural

[14] The recordings were made in February 2007 in the computer room of Collegium Balticum (Szczecin). The Praat software (version 4.5.1) was used to digitise the data and carry out the acoustic analyses.

[15] See S. Jaworski, *Inertial and non-inertial phonological processes*, Poznań Studies in Contemporary Linguistics 45 (1), p. 103–129.

speech as well as why taps placed in unaccented syllables undergo the process much more frequently (27.5%) than in accented ones (3.75%).

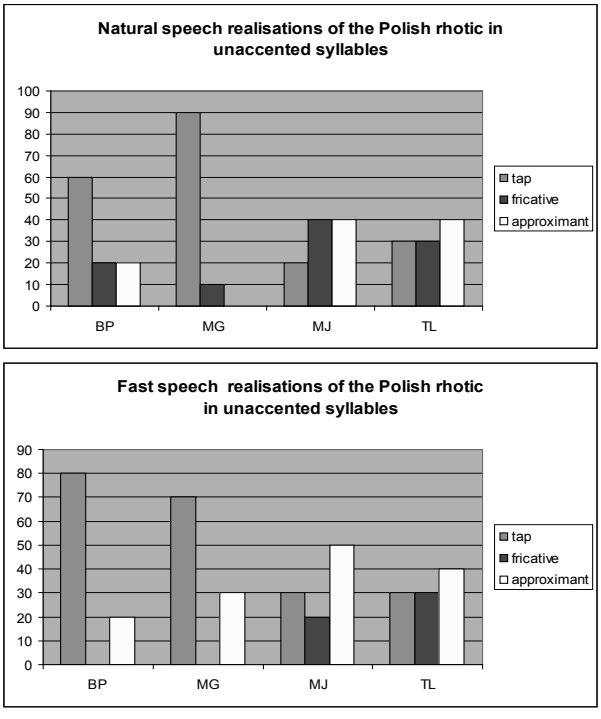

Fig. 6. Natural and fast speech realisations of the Polish rhotics in unaccented syllables

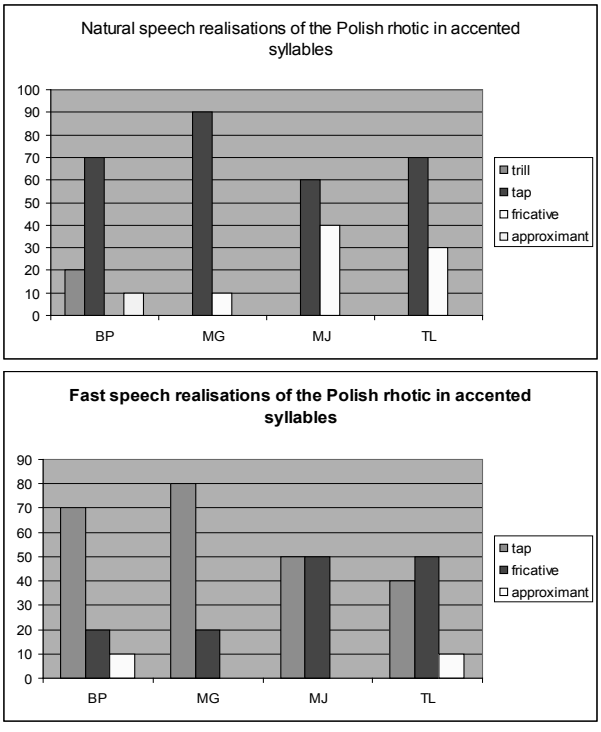

Fig. 7. Natural and fast speech realisations of the Polish rhotics in unaccented syllables

5. Conclusion

It was mentioned in the introduction that many researchers regard the Polish rhotic sound as a trill despite the acoustic evidence indicating that it could be classified otherwise. One can account for this rather intriguing fact by claiming that trilled realisations better represent the mental representation of the phoneme. That would explain why Poles always produce a trill when they are asked to make the sound in isolation. However, in connected speech speakers normally replace the difficult segment with an 'easier' counterpart. It is worth emphasising that substitutions of this kind should by no means be regarded as a characteristic feature of the Polish language. For instance, Wells[16] maintains that a trilled realisation

[16] J.C. Wells, *Accents of English*, Cambridge University Press, Cambridge 1982, p. 411.

of /r/ in Scottish English is "virtually restricted to formal or declamatory-styles". Looked at from this perspective, the vast majority of the realisations observed in this study, i.e. taps, fricatives and approximants, should be thought of as various degrees of articulatory undershoot.

Interestingly, these different realisations of the trill resemble, to some extent, the consonant strength hierarchy presented by Hyman[17] shown in (1):

(1) tappu > tapu > tabu > taBu > tawu > tau > to:

The processes presented in (1) are, respectively, intervocalic degemination, intervocalic voicing, intervocalic spirantisation, intervocalic sonorisation, intervocalic sonorant deletion and vowel coalescence. The hierarchy in (1) is definitely based on two articulatory criteria, namely the type of closure and voicing. If the same criteria are used, one can propose a similar rhotic strength hierarchy, which might look like the one presented in (2):

(2) trill > voiceless tap > voiced tap > voiceless fricative > voiced fricative > approximant.

"From an acoustic point of view, a trill can be regarded as a series of taps"[18]. Looking at the first degree of trill reduction from this perspective, one is inclined to say that it resembles degemination and the following steps resemble those presented in (1) in the sense that one finds instances of corresponding stages of reduction. However, although intervocalic stops and rhotics manifest certain similarities, one should not consider rhotics to be equivalent to stops on a strength hierarchy. The former sounds are generally regarded as more sonorous due to other articulatory characteristics, e.g. the duration of the close phase, which is considerably longer in the case of plosives.

Another conclusion that can be drawn from the data is that the rhotic phoneme of Polish is undergoing a dramatic change and is likely to become an approximant very similar, in acoustic terms, to the 'r-sound' of English. Although the change is not going to take place within a decade, two arguments indicate that it is, in fact, quite likely to occur in the future. It is estimated that about 50% of all children between the ages of 5 and 10 years have a speech impediment and

[17] L. Hyman, *Phonology: Theory and Analysis*, Holt Rinehart and Winston, New York 1975, p. 164.

[18] M. Lindau, *The story of /r/*, in: V. Fromkin (ed.), *Phonetic Linguistics. Essays in Honour of Peter Ladefoged*, Academic Press, Orlando 1985, p. 166.

as many as 7.5% of those children cannot produce the trill. On the other hand, as this study shows, even individuals who do not have any impairment, regularly replace the trill with one of its weaker variants because it allows them to minimise articulatory cost. Given that the principle of least effort, as the tendency to reduce articulatory cost is sometimes referred to, is known to be the primary cause of sound change, replacing the strong rhotics with their weaker counterparts appears to be a question of time.

Appendix

Table 2

Realisation of [r] sounds in unaccented syllables[19]

Target word	BP		MG		MJ		TL	
Tempo	natural	fast	natural	fast	natural	fast	natural	fast
kawalera	□	□	□	□	□̣	□̣	□	□̣
karawana	□	□	□	□	□	□	□̣	□
Saharę	□	□	□	□	□	□	□̣	□
Canberra	□	□	□	□	□̣	□	□	□̣
narodowego	□	□	□	□	□	□	□	□̣
Urugwaju	□	□	□	□	□̣	□	□	□
aresztowała	□	□	□	□	□̣	□	□̣	□̣
interesującą	□̣	□	□̣	□	□̣	□̣	□	□̣
Karol	□	□	□	□	□̣	□̣	□̣	□
uzbiera	□̣	□̣	□̣	□̣	□̣	□̣	□̣	□̣

Table 3

Realisation of [r] sounds in accented syllables

Target word	BP		MG		MJ		TL	
Tempo	natural	fast	natural	fast	natural	fast	natural	fast
warunki	r	□	□	□	□̣	□	□̣	□̣
turystyka	r	□	□	□	□̣	□	□	□̣
telekonfe-rencji	□	□	□	□	□̣	□̣	□	□̣
poranków	□	□	□̣	□̣	□̣	□̣	□̣	□
staruszek	□	□	□	□	□̣	□	□̣	□
surówkę	□	□ □	□	□	□	□̣	□	□
galaretkę	□	□	□	□	□̣	□	□̣	□̣
turystów	□	□	□	□	□	□	□	□
wyraźne	□	□ □	□	□̣	□	□	□	□̣
karane	□	□	□	□	□̣	□̣	□̣	□

[19] Following Ladefoged and Maddieson (1996), the symbol □ □ is used in the paper to represent such a sound.

Keywords: *rhotics*, *lenition processes*, *fast speech*

PHONETIC REALISATIONS OF THE POLISH RHOTIC IN INTERVOCALIC POSITION: A PILOT STUDY

Summary

Even though rhotics, be it taps, trills or approximants, are very common sounds in the world's langauges, there is a consensus in the literature that they constitute an articulatory difficulty. Not only are they acquired at the last stages of the acquisition period, but also their distribution is usually constrained. Since speakers find them difficult to produce, rhotics are particularly susceptible to lenition. The present paper reports the results of an experiment that aimed at describing various physical realisations of the Polish phoneme /r/ placed in intervocalic position. The data presented in the article show that in this position speakers do not articulate a tap, but in most cases they produce either a fricative or an approximant.

Translated by Sylwester Jaworski

FONETYCZNE REALIZACJE POLSKIEGO /R/ W POZYCJI INTERWOKALICZNEJ: BADANIA PILOTAŻOWE

Streszczenie

W literaturze fonetycznej polska głoska /r/ opisywana jest jako drżąca, tzn. taka, która jest artykułowana poprzez wykonanie serii gestów, na ogół czubkiem języka, powodujących na przemian otwieranie i zamykanie aparatu mowy. Jednakże w mowie dźwięk ten ma kilka różnych artykulacji, np. frykatyw, aproksymant lub [r] jednouderzeniowe 'tap'. Artykuł ten opisuje cechy artykulacyjne i akustyczne różnych fizycznych realizacji tego dźwięku w pozycji interwokalicznej.