Realisations and Alternations in German /r/-Realisation

Christiane Ulbrich [1], *Horst Ulbrich*

[1] School of Communication and Humanities Research Institute, University of Ulster
c.ulbrich@ulster.ac.uk, h.ulbrich@phonetik.net

Abstract

Rhotics, generally believed to be phonetically heterogeneous – are usually classified into one group of sounds due to their similar phonological behaviour and their diachronic and synchronic alternation [13, 12, 31, and 1]. Previous research has shown considerable segmental variation, especially in the realisation of /r/ in German which lead some authors to conclude that a positive description of the German phoneme /r/ does not make sense [11].

Index Terms: language variation, sound change, rhotics

1. Introduction

The realisation of /r/ produced by German speakers has previously been analysed in comprehensive corpora and /r/ was found to have undergone dramatic changes. An investigation carried out in the early 1970s showed that /r/ in the syllable rhyme was realised most frequently as a trill or a fricative [27]. Results of more recent studies showed that /r/ was found to be realised mainly as rhotacised vowels (or a vocalised /r/ (terms used synonymously throughout the paper). A relatively large amount of post vocalic /r/ realisations in coda position following long vowel [a:] has previously been characterised as elided or deleted. Nonetheless, more recent investigations in various languages describing the process of /r/ vocalization showed that instead of /r/-deletion [28] speakers are likely to retain the /r/ without a segmental realisation. Using cross-varietal data from German the paper will show that (i) the process of /r/ vocalisation is independent of regional variation and spreads from the north to the south in the German speaking countries in central Europe; (ii) vocalic r-realisations do not involve elision or deletion of the /r/sound and (iii) the allophonic alternation between trills and taps is not random but triggered by prosodic properties.

Rhotics are described as trills, fricatives, approximants, taps/flaps, and vocalised /r/, however, not without controversy: see for example Hall's discussion on fricatives [8, 30]. Rhotics are also produced in several different places throughout the vocal tract e.g. coronal and dorsal. However, fundamental questions regarding class membership of rhotics from a phonetic and/or phonological perspective remain unanswered and produce a dense body of studies concerned with /r/-sounds in many different languages. Hitherto, no common articulatory, acoustic or auditory phonetic property has been found to distinguish rhotics as a group from other sound classes. A relative large number of studies have shown a low F3 to be characteristic for many r-like sounds, however, not for the entire set of what we presently believe to be rhotics [12, 13]. In [12, pg 245] it was stated that the only true unity of rhotics "seems to rest mostly on the historical connections between these subgroups and on the choice of the letter 'r' to represent them all". A solution has been proposed by Wiese [31] consequently classifying rhotics on the basis of phonotactic properties and more specifically with respect to their location on the sonority scale. A definition of /r/-sounds on the base of prosody and/or phonotactics would resolve the problem of the large scale segmental variation.

2. German /r/-realisation

The realisation of /r/ in standard German has undergone dramatic changes within the 20th century, noticeable for many speakers of German in their own or public speech. In the beginning of the century /r/-sounds were predominantly realized (prescribed and described) as alveolar trills [r] [19]. In the second half of the century a transition took place towards the realisation of an uvular fricative or approximant [4, 26]. However, it does not need to be mentioned that almost the entire range of known /r/ variants can be found in the German regional varieties. In comprehensive investigations of the phonetics of /r/-sounds in German [e.g. 7] within regional varieties and within the standard variety [e.g. 26] a large number of variants was described. Previous descriptions of /r/-realisations in Austrian German (henceforth AG) and Swiss German (henceforth SG) mainly state untested hypotheses. Most authors agree that in Austrian German consonantal /r/-sounds are realized as trills [16]. In [23] both, apicoalveolar and uvular trills are described as the norm whereas in [24] only apicoalveolar articulation of /r/ was permitted. Vocalic realisations or deletions of phonetic content of /r/ were previously described for AG [e.g. 14, 17, 6], although these were generally without empirical verification. Previous studies in SG /r/ showed a large variability of possible realisations [9]. Using a distinction with respect to the phonotactics and the duration of the syllable nucleus preceding the /r/-sound the study showed that generally in SG trilled realisations of /r/-sounds prevail except in /r/ following long vowels where [ɹ] was produced most frequently. The apicoalveolar trill was still realized in 34% of the targets. SG and AG norms do not allow vocalized realisations. In contrast, German norms [e.g. 22] allow for rhoticised vowels in /r/-realisations following long vowels and in unstressed affixes. Their occurrence is documented in the literature since the beginning of the 20th century [29]. (Note that the discussion of prescriptive and descriptive norms and codifications is currently debated in sociolinguistic studies dealing with German standard variation [e.g. 5].) The present study aims to provide evidence that previously found changes in the pronunciation of /r/ are not limited to the standard variety spoken in Germany but can be found in the present-day SG and AG standard varieties. The hypotheses for the present investigation are the following: (i) crosslinguistic characteristics in the /r/-realisations in SG and AG standard varieties remain limited to the consonantal correlates of /r/. The realisation of rhoticised /r/-sounds is evident in SG and AG which in turn implies a demand for changes in the descriptive codification of the pronunciation of /r/ in the SG and AG standard varieties. The second part focuses on the alternation between trills and taps which is shown to be triggered by prosodic structure.

10.21437/Interspeech.2007-711

3. Material and Method

The first part of the analysis is based on directly comparable speech data produced by newsreaders. Generally, in the German speaking areas, newsreaders are expected to speak a variety which does not feature characteristics to allow for a regional allocation. This has been validated in a number of perception tests [25]. The material consists of read speech produced by an equal number of five male newsreaders per variety. In sum ten SG and AG speakers read the same text: eleven news messages. The second part of the analysis is based on read speech produced by an equal number of 4 female and 4 male age-matched speakers per variety. They were all university students aged between 21 and 23. Initially the speakers read the same text as the newsreaders to ensure that the process of /r/ vocalisations was found in all speakers to the same extent, since their dialectal background differed (however, the participants were matched regarding the following criteria: age, living in a city, parents with university degree and native speakers of German). In the SG group four speakers were from Zurich and four speakers from Bern. In the AG group six speakers were from Vienna and two from Innsbruck. After making sure that all speakers produced vocalised /r/ in coda positions a word list was read by each of the speakers containing 15 word and 15 non-word minimal pairs: [a:] vs. [a:r] (word: ja vs. Jahr; non.word: ma vs mar.
The recordings were carried out on DAT in sound proof cabins of the SG and AG public broadcasting agencies DRS, SFDRS, and ORF. The material was subsequently digitised at a sampling rate of 16kHz, 16 bit, mono format. The /r/-realisations were divided into three groups each consisting of three subgroups (see table 1) with respect to their phonetic environment, phonotactic positioning within the target words and the number of tokens produced by each speaker.

Table 1: Grouping and number of /r/ realisation

group	description
1	Word onset (7), syllable onset (13), onset in consonant cluster (19)
2a	Coda following short vowels (9)
2b	Coda in unstressed prefixes (8)
2c	Coda in unstressed suffixes (12)
3a	Coda in pluri-syllabic words following long vowels except [a] (9)
3b	Coda in mono-syllabic words following long vowels except [a] (11)
3c	Coda following [a] (9)

The following realisations were found in the present data: [r] apicoalveolar trill; [ʀ] uvula trill; [ɾ] apicoalveolar flap (or tap); [ʀ^{1}] uvula tap; [ɹ] apicoalveolar approximant; [ʁ] voiced uvular fricative; [χ] voiceless uvular fricative; [x] voiceless velar fricative; [ɣ] voiced velar fricative; [e̯] diphthongal realisation of Vr; [ɐ] monophthongal realisation of Vr; [ɻ] voiced uvular approximant; [0] /r/-elision (no auditory or acoustic cues). The /r/ realisations were organized using an adaptation of Ulbrich's categories [23].

4. Results

The present analysis revealed cross-varietal differences in the /r/- realisation in onset position. In both, SG and the AG consonantal /r/-patterns were found to prevail. In coda position however, a similar tendency towards vocalized /r/-realisations was found.

4.1. /r/- Realisation in SG and AG

The results of the analysis of /r/-realisations in onset position (word, syllable and consonant cluster) did not show different realisation patterns in either the SG or the AG variety. Therefore, in Fig. 1 the results for all /r/-realisations in onset position are summarised. It is evident from the graph in Figure 1 that there are cross-varietal differences in the place of articulation. Whilst both groups of speakers realised the majority of onset /r/ as trill (and taps); the place of articulation differed significantly ($F_{(1;9)}$ = 4,32; p<.05). SG speakers preferred the apicoalveolar place of articulation whereas AG speakers mainly realised onset /r/ in the uvular place of articulation. Also, AG speakers produced significantly more fricatives than Swiss speakers.

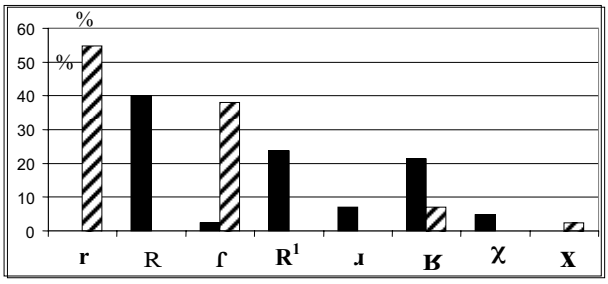

Figure 1: */r/-realisations in onset position.*

Following short vowel in the syllable coda, /r/ was realised by SG and AG in the majority as [e̯] (Fig. 2. No significant differences were found between the two groups of speakers. However, the speakers produced a relatively large number of targets in this position with a consonantal variant of /r/. More than 25% were realised as an apicoalveolar tap by SG speakers. An apicoalveolar trill was realised in 12%. Monophthongal vocalised variants were produced in 15%. In the AG data, more than 10% of the targets were transcribed as deleted. Also, AG speakers realised a relatively large variety of consonantal variants in that position showing a preference for the realisation of uvular variants. The realisation in unstressed prefixes and suffixes was found to be nearly identical in both groups of speakers. In unstressed affixes both groups of speakers realized the majority of the target /r/ as a rhoticised monophthongal vowel (60% AG; 80% SG). Similarly, the realisation patterns of /r/ following long vowels were found to be independent of the syllable number of the target word (3a and 3b, see Figure 3). The AG data, however, showed a relatively large proportion (20%) of diphthongal /r/-realisations and consonantal /r/ variants (20%). Amongst those a large intra-speaker variation was found. The realisation patterns in coda position following long vowels (Fig. 3 and Fig 4) are not as conclusive as the results reported for the previous categories. A preference was found in both groups of speakers for a vocalized realisation of /r/. Nonetheless, SG as well as AG groups showed a large intra-speaker variation in the realisation of consonantal variants. Manners and places of articulation varied strongly within and across subjects. This is even more visible in the SG data compared to the AG data, especially in the /r/-realisation following long vowel [a:]. In both groups only 20% of the analysed targets were produced with a monophthongal vocalized [ɐ]. In 20% of the AG and 30% of the SG data /r/ was described as deleted. Comparing /r/ in coda position, following long [a:] the largest amount (<50%) of consonantal /r/ variants was produced by both, SG and AG data.

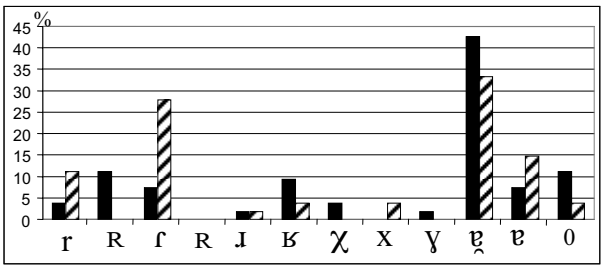

Figure 2: */r/ in syllable coda following short vowels*

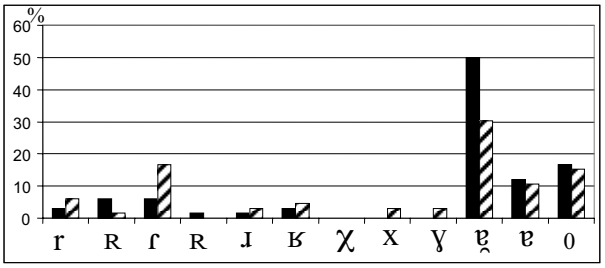

Figure 3: *in coda following long vowel (except [a])*

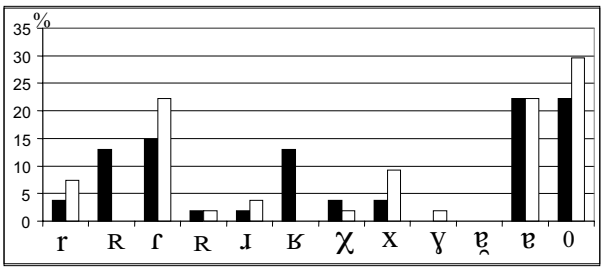

Figure 4: *in coda following long vowel [a]*

4.2. Durational differences in [a:r] vs. [a:]

The study showed that /r/ following long vowel [a:] is perceived as deleted or assimilated in the SG and the AG varieties. Previous investigations on the /r/ realisation in the Northern German variety also showed that /r/ in the sequence [a:r] appears to be deleted [26]. However, there is evidence that speakers employ strategies to retain the contrastive potential of /r/ without its segmental realisation [18, 28]. Also, the observation that there is no total assimilation of /r/ towards any other preceding vowel than [a:] suggests that speakers should develop strategies to maintain the contrast between [a:r] and [a:]. These strategies could be either qualitative or quantitative in nature. Qualitative differences would be observable in the formant structure, which has been found and described in an early investigation [15]. He showed that while F3 shows no transitional effects, F1 and F2 did. Quantitative differences would be found in the duration of the monosyllabic words. A list of stimuli containing minimal pairs of monosyllabic words and nonwords was developed. The list included 15 [a:r]-sequence words and 15 [a:]
sequence words:
- minimal pair words: <sah> (“saw”) vs. <Saar> (place name).
- minimal pair non-words: <flar> vs. <fla>
They were mixed with 30 distracter items (monosyllabic words and nonwords containing long vowels) which did not bear any relevance for the present study. The test items were presented in a randomised order. This list was read twice in a sound proof booth by eight SG and eight AG speakers. The speakers were advised to produce non-words with long vowel. Following a perception test an auditory and acoustic analysis was carried out. The stimuli were extracted from the list and reorganised in a way that the minimal pairs produced by each speaker could be presented to naïve listeners. Ten participants were asked to rate whether or not there were durational differences in the minimal pairs. Table 2 shows that all speakers perceived the word or non-word containing the [a:r] sequence were perceived to be longer.

Table 2: *rating of durational differences by 10 participants (P1 – P10) in 15 word (grey) and non-words minimal pairs*

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
12	10	8	12	11	14	12	14	12	9
10	9	8	11	13	12	12	13	9	13

The auditory analysis was carried out by two trained phoneticians involving a narrow phonetic transcription of the words and non-words and the same rating of durational difference between the two items in the minimal pairs. Both transcribers perceived /r/ containing words to be longer (transcriber 1: 14 in words, 12 in non-words; transcriber 2: 11 in words, 12 in non-words). There was no overlap in the minimal pairs which were rated to involve durational differences amongst participants and transcribers.

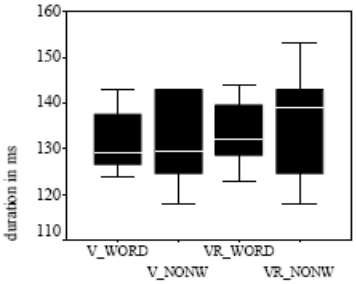

Figure 5: *Duration in word and non-word minimal pairs*

The acoustic measurements were carried out using Praat [3]. Markers were set at word onset and offset of each of the stimuli for the durational measurements. Figure 5 shows the averaged durations of [a:] and [a:r] of SG and AG speakers separately. The analysis showed that in both, word and non-word minimal pairs the stimuli containing the [a:r] sequence were realized longer than those without. However, an ANOVA revealed that the differences were only significant in non-word minimal pairs ($F_{(1;15)}= 1.58$, $p>.05$).

4.3. Tap and trill alternation

The following section deals with the analysis of the alternation between trill and tap variants. The speakers of the two varieties alternated between a trill and its weakened (or hypoarticulated) variant: a tap. The alternation appears consistent across the two varieties except that the place of articulation varies. In the literature similar alternations have been described and found to be triggered by prosodic structure [20]. This part of the study focuses on the /r/-realisations in onset since only in this position it was consistently produced as a consonantal variant. 40 tokens per speaker were analysed. Two hypotheses were formulated:

1. [r] is realised in accented syllables; [ɾ] is realised in unaccented syllables
2. [r] is realised before strong prosodic boundaries; [ɾ] is realised before weak prosodic boundaries

For the analysis all syllables containing /r/ in onset position were prosodically annotated using the autosegmental

framework [2]. Thereby accented syllables, their tonal patterns, their degree of prominence, and their position regarding prosodic boundaries were annotated. The annotation of prosodic boundaries follows the ToBI system allowing for a differentiation of boundary strength [21]. Two correlation analyses were carried out. The results of the first correlation analysis showed that the choice of the consonantal /r/ variant is positively correlated to the accentuation of the target word ($r=0.856$, $p<.05$). The second correlation analysis showed that hierarchically higher (stronger) prosodic boundaries trigger the realisation of hyperarticulated trilled /r/-sounds ($r=0.692$, $p<.05$). In clitic groups (BI 0), phrase medial word boundaries (BI 1) tapped /r/-realisations prevailed. At intermediate or full Intonational Phrase boundaries trilled /r/-realisations were produced in the majority. These results were found across varieties and the intra-speaker variation was insignificant. For BI 2 boundaries (disjuncture marked by a pause or virtual pause *OR* tonally marked) a less clear cut result was obtained; trilled and tapped variants overlapped.

5. Summary and Discussion

SG and AG speakers realised consonantal variants only in word, syllable and onset consonant cluster position. The manner of articulation was comparable to a certain extent. Mainly trills were produced but also a relatively high proportion of taps which can be interpreted as their weakened variants. However, while SG speakers produced apicoalveolar trills and taps, AG speakers produced uvular trills and taps. A relatively large proportion of fricatives were also found in the AG data. In coda position both groups of speakers produced mainly vocalized variants of /r/ with the exception of /r/ following long vowel. Here, a relatively large number of realisations was found to be consonantal but showed large intra- and inter-speaker variation. The relatively large number of fricative realisations in AG involves a process of posteriorisation of trills towards fricatives which has been reported for a number of other languages [10] and the German variety [27]. The quantitative analysis in word and non-word minimal pairs showed significant differences only for the non-word stimuli. This could be due to the fact that in non-words the perception and processing cannot be aided by any other linguistic information. So a speaker is limited to the sound sequence to transfer the stimuli. Previous investigations of /r/ have taken into consideration that the great range of possible pronunciations of /r/ documented for different languages might be conditioned by the syntax-prosody interface rather than being purely allophonic variation as traditionally assumed. The tap/trill alternation in both groups of speakers was found to be the result of the influence of prosodic boundary strength and accent realisation, however, this needs to be followed up using a more carefully designed corpus which allows for more controlled data also regarding the interaction with other prosodic factors such as phrase final lengthening. Additionally, the question of acoustic, auditory and articulatory correlates of /r/ needs to be addressed.

6. References

[1] Barry, W. J., „Schwa vs. Schwa + /r/“, Phonetica 52, 228-35, 1995.

[2] Beckman, M.E. and Pierrehumbert, J.B., “Intonational structure in Japanese and English”, *Phonology Yearbook 3*, 255-309, 1986.

[3] Boersma, P. & Weenik, D. *Praat: doing phonetics by computer*. URL: http://www.fon.hum.uva.nl/praat/.

[4] Boor, H. de, Moser, H. and Winkler, C. (eds.), Siebs Deutsche Aussprache. Reine und gemäßigte Hochlautung mit Aussprachewörterbuch, Berlin, 1969.

[5] Clyne, M., The German Language in a Changing Europe, Cambridge, CUP, 1995.

[6] Ebener, J., “Österreichisches Deutsch – ein Thema für die Didaktik“, In: ide. Informationen zur Deutschdidaktik. Vol. 2. Wien, 88-98, 1989.

[7] Göschel, J., „Artikulation und Distribution der sogenannten Liquida r in den europäischen Sprachen“, In: Indogermanische Forschungen 76, 84-126, 1971.

[8] Hall, T. A., *The Phonology of Coronals,* Amsterdam, 1997.

[9] Hove, I., Die Aussprache der Standardsprache in der deutschen Schweiz, PhDDiss. University Freiburg, 1999.

[10] Kavitskaya, D., “Aerodynamic constraints on the production of palatalized trills: the case of the slavic trilled [r]”, *Proceedings of Esca. Eurospeech97. Rhodes, Greece:* 751-754, 1997.

[11] Kohler, K. J.. Einführung in die Phonetik des Deutschen. Berlin. 1995[2].

[12] Ladefoged, P. and Maddieson, I., Sounds of the World’s Languages. Oxford. Blackwell, 1996.

[13] Lindau, M., “The story of /r/”, In: Victoria A. Fromkin, (ed.). Phonetic Ling. Academic Press: 157-168, 1985.

[14] Lipold, G., „Die österreichische Variante der deutschen Standardaussprache“, In: P. Wiesinger (Ed.): Das österreichische Deutsch. Wien, Schriften zur deutschen Sprache in Österreich, Vol. 12, 31-54, 1988.

[15] Meyer-Eppler, W., Zur Spektralstruktur der /r/-Allophone des Deutschen. Acustica, 9, pp. 247-250, 1959.

[16] Moosmüller, S., „Der Stellenwert der phonologischen und phonetischen Variation in der Sprechererkennung“. In: A. Braun; H.R. Masthoff: Phonetics and its Applications.ZDL, Vol. 121, Stuttgart, 97- 109, 2002.

[17] Muhr, R., Österreichisches Sprachdiplom Deutsch. Materialien und Handbücher zum österr. Deutsch. Vol. 4. 27-53, 2002.

[18] Plug, L. and R. Ogden, “A Parametric Approach to the Phonetics of Postvocalic /r/ in Dutch”. Phonetica 60: 159-186, 2003.

[19] Siebs, T., Grundzüge der Bühnenaussprache. Berlin etc. 1900

[20] Silva, A. H. P. and Albano, E., Brazilian Portuguese rhotics and the phonetics/phonology boundary. Proceedings of XIVth ICPhS 99, San Francisco. 2211-2214, 1999.

[21] Silverman, K., Beckman, M., Pitrelli, J., Ostendorf, M., Wightman, C., Price, P., Pierrehumbert, J., & Hirschberg, J. ToBI: a standard for labeling English prosody. Proceedings of ICSLP (pp. 867–870). Banff, 1992.

[22] Stötzer, E. (Ed.), GwdA (Großes Wörterbuch der deutschen Aussprache), Leipzig: Bibl. Institute, 1982.

[23] Takahashi, H., „Die richtige Aussprache des Deutschen in Deutschland, Österreich und der Schweiz nach Maßgabe der kodifizierten Normen“. Frankfurt a. M. etc., Duisburger Arbeiten zur Sprach- und Kulturwissenschaft. Vol. 27, 1996.

[24] Trojan, F., Österreichisches Beiblatt zu Siebs Deutsche Hochsprache -Bühnensprache. Wien, 1957.

[25] Ulbrich, C., Phonetische Untersuchungen zur Prosodie der Standardvarietäten des Deutschen. Hallesche Schriften zur Sprechwiss und Phonetik 16, Frankfurt/M. Peter Lang, 2005.

[26] Ulbrich, H., „Zur Kodifizierung der Raussprache im Siebs“, Zeitschrift für Phonetik, Sprachwissenschaft und Kommunikationsforschung 26, 120-133, 1973.

[27] Ulbrich, H., „R-Aussprache 1966 und 1996 – stabile und instabile Realisierungsmodi“. In: Jonach, I. (Ed.): Sprache und Sprechen, Vol. 34. München, Basel, 143-152, 2002.

[28] Van den Heuvel, H. and C. Cucchiarini, “/r/-deletion in Dutch: rumours or reality?”. In: H. Van de Velde & R. van Hout (eds.), ‘r-atics. Sociolinguistic, phonetic and phonological characteristics of /r/. Etudes & Travaux – ILVP/ULB, Brussels, 185-198, 2001.

[29] Viëtor, W., Kleine Phonetik des Deutschen, Englischen, und Französischen. Leipzig: O. R. Reisland, 1901.

[30] Walsh Dickey, L., The Phonology of Liquids. Ph.D. dissertation, Department of Linguistics, University of Massachusetts, 1997.

[31] Wiese, R., „The unity and variation of (German) /r/“, In: Zeitschrift für Dialektologie und Linguistik, 25-43, 2003.