VARIATION IN SCHWA + /r/ IN GERMAN

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ABSTRACT

The possible psychological reality of an analysis of the German vowel [ɐ] as /ə/+/r/ is examined. Firstly, the sensitivity of [ɐ] to contextual factors is compared to [ə]. Secondly, the vowelised realisation of assumed /ə/+/r/ sequences is examined for a dialect with an apical /r/ variant. The plausibility of interpreting [ɐ] as a vocalic variant of /r/ in terms of reduced articulatory gestures is considered in the light of the results.

INTRODUCTION

The German vowel [ɐ] can be understood as the phonetic realisation of an underlying phonological segmental sequence /ə/+/r/. Examination of the acoustic structure of uvular variants of /r/ point to an articulatory continuum ranging from a uvular fricative [ʁ] to a half-open, central-to-back vocoid. Thus [ɐ] in consonant+[ɐ] sequences (e.g. Kupfer - [kʊpfɐ], bitter - [bɪtɐ], Bäcker - [bɛkɐ]) may be analysed as the syllabic equivalent to the nonsyllabic off-glide [ɐ] found in vowel + vowelised /r/ variants (e.g. Bier - [bi:ɐ], Kur - [ku:ɐ]). In terms of the phonological representation, the same modifications in the production processes may be evoked as for [ə]+nasal or [ə]+lateral realised as syllabic nasal (e.g. bitten - [bɪtn̩], Schuppen - [ʃʊpm̩], backen - [bakŋ̍]) and syllabic lateral (Mittel - [mɪtl̩]) respectively. That is, in terms of segmental structure, the schwa is elided, and the sonorant takes over the syllabic function. The vocalic nature of the resulting sonorant in the case of /r/ parallels the vowelised /l/ in some varieties of British English (e.g. bottle - [bɔtʊ], milk - [mɪʊk]) cf. [1].

While, articulatorily, the alternation between a contoid and a vocoid realisation of the underlying liquid consonant is easily explained as a case of target undershoot, a feature-based phonological representation is stuck with an unmotivated alternation of the general class feature [consonant]. A gestural phonological account, on the other hand [2, 3], captures the variation as a phonetic continuum from fricative (or trill) to vocoid depending on the degree of overlap between the vowel- and /r/-gesture (both being tongue-body gestures). If a part of the task of phonological theory is to capture the sound structure of linguistic signs in a manner which can be plausibly related to their production, i.e. to the underlying articulatory plan *for*, the articulatory patterns involved *in*, and the acoustic forms resulting *from* their use in speech, then a gestural approach would appear more adequate in this case at least.

If we exploit the presence of two free and articulatorily radically different variants of German /r/ (uvular and apical), a gestural phonological account allows a number of predictions to be made relating to the general interpretation of German [ɐ] as a vowelised realisation of a phonologically real /r/ (in the above sense) rather than a second unstressed vowel derived historically from post-vocalic /r/[1]:

1. In a speaker with an apical rather than a uvular /r/, the quality of the vocalic realisation of the assumed /ər/ sequence should relate differently to /ə/, since the retraction gesture of the tongue body towards the uvular target is replaced by a tongue-tip gesture which has much less effect on the tongue body.

2. As the phonetic reflex of a constant consonantal target overlapping a preceding schwa, the [ɐ] should vary less in equivalent flanking vowel conditions than schwa alone in that position. However, this expected difference in variance should be much more marked with uvular /r/ than apical /r/ speakers since the constant tongue-tip gesture constrains the tongue body less in its move from the preceding full vowel via (underlying) schwa to the following full vowel.

3. In a /ə/#/r/ sequence, the quality of /ə/ should approach that of [ɐ], presumably lying between /ə/ and [ɐ] as a result of reduced articulatory overlap between the final /ə/ and the initial /r/. In [ɐ]#/r/ sequences, the effect of the following initial /r/ should be less.

The following data analysis aims to address these predicitons.

[1] Of course, morphophonological alternations such as *unser - unsere*: [ʊnzɐ] - [ʊnzərə] argue at a different level for the underlying /r/ interpretation.

EXPERIMENT

Two native speakers (1M. 1F) of standard German, one (GF, M) with a uvular /r/ and a slight North German accent, the other (JB, F) with an apical /r/ and a mild West Bavarian accent, recorded the following corpus under quiet studio conditions:

1. Short sentences in the form of article + trochaic noun + trochaic verb-form, or pronoun + verb + noun. The first lexical form contained /i:/, /u:/ or /a:/ and ended with /tə/ or /tər/ (realised as [tɐ]); the second lexical form had either an initial bilabial stop or an initial /r/ followed by /i:/, /u:/ or /a/. e.g.:

Ich biete Pasta Der Dieter pustet
Ich biete Ruten Der Dieter ruhte

The 36 items (2 unstressed vowels x 2 initial consonant classes x 3 vowels x 3 vowels) were read 5 times in quasi-randomized order (180 tokens per speaker) with both lexical items accented. These are referred to as "context" items.

This condition was selected to reveal the degree of spectral variation in schwa and schwa+/r/ as a product of the flanking extreme vowels /i:, a(:), u:/.

2. Three-syllable phonological words (lexical words or minimal syntagms) stressed on the second syllable with either first-syllable /ə/ or /ər/ or third-syllable /ə/ or /ər/. These are referred to as "pretonic" and "post-tonic" schwa items, respectively. E.g:

Ich picke, Der Dieter
Gebieter, Verbieten

For the pretonic items 15 words were selected for each category to cover the stressable monophthong phonemes of German; each item was read three times in quasi-random order (2 schwas x 3 repetitions x 15 vowels = 90 tokens per speaker). For the post-tonic items, 90 words were selected to give each stressed vowel a bilabial, an alveolar and a velar stop as postvocalic context (2 schwas x 3 consonants x 15 vowels = 90 items per speaker).

These data were collected to provide a stressed-vowel frame of reference for the two speakers, within which to locate the quality of the schwa and schwa+/r/ realisations. They also provide further data towards a definition of the unstressed vowel qualities under two different positional and segmental context conditions.

The recordings were digitised at 10 kHz using the PC-based Kay Computer Speech Lab (CSL) facilities. Duration measures were made on the sound-pressure waveform linked to a broad-band (293 Hz) digital spetrogram. Formants were measured on a 12-pole LPC spectrum calculated over a 25ms window (reduced to 15 ms for very short schwa realisations) located in the middle of the segment.

RESULTS

Figures 1a and 1b show the relative positions of the unstressed and stressed

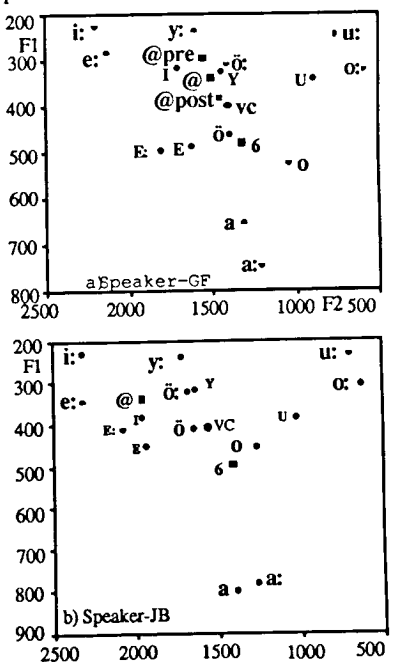

Fig. 1 Schwa values in relation to stressed vowels and centroid

vowels on an F1/F2 vowel chart for the combined pre- and post-tonic condition.

Let us consider the first prediction derived from a gestural phonological approach. The North German speaker (GF), with uvular /ʀ/, has an average /ə/ value which is considerably closer and slightly more "fronted" than the centroid of the stressed vowels (mean F1, mean F2). This is almost completely the product of the very short (therefore less open) pre-tonic /ə/ realisations. Post-tonically, the /ə/ is very close to the centroid value, conforming to the assumption that the schwa is phonologically targetless and therefore tends towards the relaxation position of the vowel articulators (tongue body, jaw and lips) [4, 5]. The average [ɐ] value conforms to the pattern found in a previous analysis of a standard German speaker with uvular /ʀ/ [5], lying centrally between /ɛ/ and /ɔ/ and could be plausibly attributed to merging the neutral vocalic element with a retraction gesture of the tongue body in the direction of a uvular target.

The Bavarian speaker (JB), on the other hand, has an extremely fronted /ə/, very close to /ɪ/ and well separated from the stressed vowel centroid. Her average value for [ɐ], however, is in a very similar position to that of the North German speaker, relative to her other stressed vowels, namely midway between (and slightly more open than) /ɛ/ and /ɔ/. In both cases, these data call for a different explanation from the one offered for standard German. On the one hand they suggest a definite target for /ə/ rather than a phonologically unspecified relaxation target. Auditorily, this is acceptable, since the unstressed <e> in Bavarian German in no way evokes the impression of a neutral central vowel.

On the other hand, the [ɐ] cannot be explained as an articulatory merger of schwa and /ʀ/, since there is nothing in the apical /ʀ/ gesture which would drag the tongue body away from the fronted, closer position. Here again, it would seem that JB's [ɐ] vowel, in contrast to GF, has a definite vocalic target.

If this interpretation is correct, there should also be a clear difference in the pattern of variability between the two speakers. According to prediction 2, the flanking vowels should exercise maximum influence on the phonologically undefined /ə/ tokens, but should be inhibited by the underlying /ʀ/ element in [ɐ] in the case of GF. Speaker JB, on the other hand, should have equal variability for /ə/ and [ɐ], since, according to the above data, they both appear to have a phonologically defined target.

Comparison of GF's /ə/ and [ɐ] in the context condition with following labial consonant (see fig 2a, each point represents 5 values for a given context condition) shows that under an identical set of context conditions, /ə/ varies considerably more than [ɐ] (F1: F = 2.51; F2: F = 3.17, in both cases df 89/89, and $p < 0.001$). JB does have different variability in F1 (F = 3.36, df 89/89, $p < 0.001$, see fig 2b), but it is [ɐ] which varies more; F2 variance does not appear to differ (F = 1.53, df 89/89, $p > 0.05$).

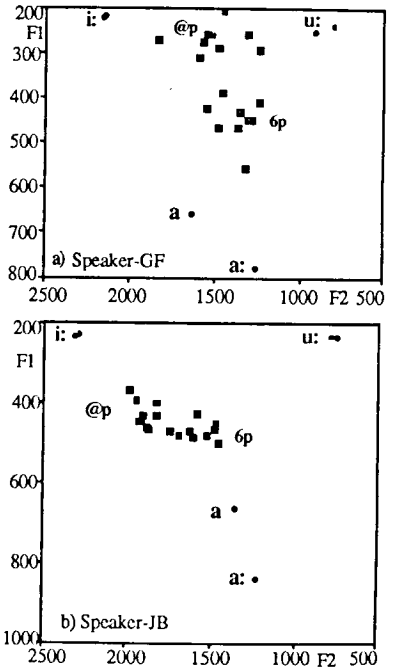

Fig 2 Vowel-context sensitivity of /ə/ and[ɐ] before bilabial consonant

Finally, a comparison of the influence of the two post-schwa(+/ʀ/) consonants (bilabial plosive and /ʀ/) on the unstressed vowel quality in the context condition

provides additional evidence in the question of a regional difference in the phonological status of /ə/ and [ɐ]. Figures 3a and 3b show the corner-vowel values and the pre-labial vs. pre-/ʀ/ values for /ə/ and [ɐ] in the context condition.

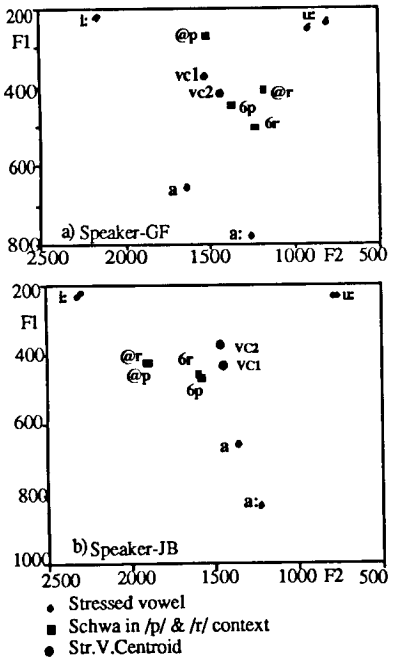

Fig. 3 Sensitivity of /ə/ and [ɐ] to labial and /ʀ/ post-context

Speaker GF shows a massive effect of the post-schwa /ʀ/-context; F1 increases and F2 decreases in comparison to /ə/ followed by /b/ or /p/ (one-way ANOVA, F1: F = 91.9; F2: F = 83.4; in both cases df 89, $p < 0.0001$). In other words, the same shift is observed in /ə/ before /ʀ/ as is found between /ə/ and [ɐ] in non-/ʀ/ contexts. A similar though smaller shift (but still highly significant F1: F = 18.1; F2: F = 31.8, df 89, $p < 0.001$) is observed for [ɐ] between the labial- and in the /ʀ/-context. This may be seen as an augmentation of the shift resulting from the effect of the assumed /ʀ/ behind the [ɐ] vowel.

Speaker JB, on the other hand, shows no contextual effects whatsoever for either /ə/ or [ɐ], indicating further that the difference between /ə/ and the [ɐ] vowel has nothing to do with an underlying /ʀ/ element (/ə/-F1: F = 0.00008, [ɐ]-F1: F = 0.52; /ə/-F2: F = 0.41, [ɐ]-F2: F = 0.41; df 89, $p > 0.1$ in all cases).

CONCLUSION

In the light of the results of the present analysis, we find support in the production patterns of speaker GF for the assumption that [ɐ] is represented as /əʀ/ in his articulatory plans. Firstly, variance for [ɐ] is less than for /ə/, indicating the "constraining" effect of an overlapping consonantal element; secondly, a surface /ʀ/ following /ə/ changes its quality massively in the direction of [ɐ].

For speaker JB, on the other hand, it would appear that [ɐ] is a separately encoded vocalic element, since it has a quality, relative to the stressed vowel system which is similar to the [ɐ] of a speaker with a uvular /ʀ/ and can therefore not be considered a merger of overlapping /ə/ and /ʀ/. It is seen that a following surface /ʀ/ (apical) has no appreciable effect on the quality of either /ə/ or [ɐ].

Finally, there is clear evidence that speaker JB has an established target quality for /ə/, whereas, at least for the durationally unconstrained post-tonic schwa, GF reveals a quality very close to the centroid of the stressed vowels, supporting the theory that the quality of /ə/ is phonologically undefined

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