

# L2 Stressed Vowel Production by Bulgarian Learners of German

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## ABSTRACT

This study investigates the production of German vowels by three groups of Bulgarian speakers. Two groups have been living in Germany for approx. 5 and 10 years, respectively. The third group has not lived in Germany but has received on average 8.6 years of German tuition in Bulgaria. The acoustic analyses of quality (F1, F2) and quantity (duration in ms.) compare the Bulgarian L2 vowels both with the L1 vowels of a German control group and with the Bulgarian speakers' own L1 vowels. The results show that Bulgarian L2 speakers have difficulties in realizing several German-vowel quality contrasts and that they differ from native speakers in the degree to which they employ duration to realize these contrasts.

**Keywords:** L2, interference, Bulgarian, German, SLM

## 1. INTRODUCTION

Since Trubetzkoy first postulated the idea of a “phonological raster” in [19] as a native-language filter through which learners of a foreign-language perceive L2 sounds, widespread agreement has existed that the L1 has considerable influence on L2 pronunciation. The concept of an L1 filter is still accepted, even though opinions on its nature and how it functions differ considerably [11, 7, 3, 5].

The present study considers the pronunciation of German vowels by Bulgarian learners within Flege's Speech Learning Model (SLM), which predicts different learning behaviour for L2 vowels, depending on whether they are perceived as a) ‘identical’, b) ‘similar’ to one, or c) ‘different from’ all of their L1 vowels [6, 7, 8]. In the case of type a), it is predicted that the L1 category will be used and will remain permanently as part of the L2 system. For type b) the immediate use of the similar L1 vowel is also predicted, with the possibility of developing a new L2 category over time, if awareness of the (relatively small) L1-L2 difference remains. In type c), initial difficulties and the gradual development of a new category are predicted.

These predictions, however, offer no criteria for weighting dimensions of vowel difference, a step which might make the difference between hearing a particular vowel as ‘identical’ vs. ‘similar’ or as ‘similar’ vs. ‘different’. The Bulgarian vowel system differs from the German in the lack of two dimensions which German uses, namely the vowel length distinction and the front-vowel rounding dimension [13, 14]. Equal weighting would mean that long vowels and

front rounded vowels would behave in the same way, as either type b) or type c). Different weighting would mean different behaviour, with one as type b) and the other as type c).

Bulgarian (BG) has 6 vowel phonemes: /i/, /ɛ/, /a/, /ɔ/, /u/ und /ɜ/, with partial or complete neutralization of some oppositions when unstressed [15, 16, 17, 18, 2]. Apart from three diphthongs (/ai/, /aʊ/, /ɔɪ/) and – depending on analysis – one or two unstressed vowels (/ə/, /ɐ/), German (DE) has 14 monophthongs, usually grouped as 7 short-long pairs: /i: ɪ/, /y: ʏ/, /e: ɛ/, /ø: œ/, /u: ʊ/, /o: ɔ/, /a: a/ [9, 10, 12]. The vowel /ɛ:/, common in southern German states, will not be considered since it is not established in all regional varieties. Comparison of the two vowel systems shows that the areas of gross timbre differentiation in the two languages are similar. The difference in inventory size is due to the use of the two dimensions mentioned above which are missing in Bulgarian [13, 14].

Expected vowel equivalences for Bulgarian learners

are:

/i/ <sub>BG</sub>	for /i:/ <sub>DE</sub> and/or /ɪ/ <sub>DE</sub>
/ɛ/ <sub>BG</sub>	for /e:/ <sub>DE</sub> and/or /ɛ/ <sub>DE</sub>
/a/ <sub>BG</sub>	for /a:/ <sub>DE</sub> and/or /a/ <sub>DE</sub>
/ɔ/ <sub>BG</sub>	for /o:/ <sub>DE</sub> and/or /ɔ/ <sub>DE</sub>
/u/ <sub>BG</sub>	for /u:/ <sub>DE</sub> and/or /ʊ/ <sub>DE</sub>

The front rounded vowel pairs /y: ʏ/<sub>DE</sub> and /ø: œ/<sub>DE</sub> differ from all Bulgarian vowels along both new dimensions and clearly belong to type c) in terms of learning behaviour. And since our subjects are all grammatically and lexically fluent in German, an approximation to the German front-rounded qualities is expected.

Whether the finer differences in timbre as a function of phonemic length or the difference in duration between the short and long member of the German vowel pairs influences the Bulgarian perception of difference or equivalence to a greater extent (i.e. has greater weight) cannot be predicted *a priori*. Nor is the relative perceptual weight of lip-rounding vs. tongue position theoretically predictable. However, Bohn maintains in [4] that length differences are easier to learn than vowel quality differences, independent of whether the speaker has specific linguistic experience with vowel-length distinctions or not.

## 2. MATERIAL AND METHODS

### 2.1. Participants

In total, 40 adults aged between 19 and 54 were recorded: 10 German native speakers as control group (5F, 5M, aged between 20 and 34) and 30 Bulgarian

native speakers in the test group (15F, 15M). All the Bulgarian speakers were born and educated in Sofia, Bulgaria. The 30 speakers in the test group were selected and then placed in different sub-groups (5F, 5M each) according to the length of time they had spent in Germany: BG0 were 10 German language students of Sofia University, who had never been to Germany but has received on average 8.6 years of German tuition in Bulgaria; BG5 were students at Saarland University who had been living in Germany (where they started to learn German) for a maximum of 5 years but with very little formal teaching; BG10 were Bulgarians who had been living in Germany for at least 10 years, started learning German in Bulgaria and completed their studies in Germany, where they are employed at present. None of the test-group had started to learn German till after puberty.

## 2.2. Speech material

All the German vowels were produced in stressed position in disyllabic words (or occasional non-words) of the form /'b\_tən/ embedded in the carrier sentence "Ich werde \_\_\_ sagen" (I will say \_\_\_); the Bulgarian words, produced by the Bulgarian speakers only, were structured /'b\_ta/, and the equivalent carrier sentence in Bulgarian was used. All vowels were produced twice by each speaker, giving 1480 utterances for analysis (280 by 10 German speakers: 10 x 14 vowels x 2 repetitions; 1200 by 30 Bulgarian speakers: 30 x 14 German and 6 Bulgarian vowels x 2 repetitions).

## 2.3. Procedure

All vowels were manually segmented on the basis of the synchronized microphone signal and spectrogram. Using PRAAT scripts, the duration and mid-point Hz. values for F1-2 of each vowel realization were measured. All measurements were manually checked and, if necessary, corrected. To compensate for physiological differences between speakers (cf. [1]), Lobanov z-score transformations were calculated for each formant value per speaker. The vowel duration was normalized in relation to word duration. The z-scores and the normalized duration values were used in the statistical analyses (multivariate analyses of variance and Scheffé post hoc tests) to test for differences between vowels as a function of speaker group.

# 3. RESULT AND DISCUSSIONS

## 3.1. Bulgarian vs. German L1 vowels

Before we consider the Bulgarian learners' L2 vowel performance, it is useful to see what the quality relationship between their native Bulgarian vowels and the German target vowels is (see table 1).

In terms of the 'corner vowels' (/i, a, u/), which define the groups vowel space, we see that the average F1 and F2 for Bulgarian /i/ and /u/ lie between the more extreme values for long German /i:/ and /u:/ and the more central short /i/ and /u/. For Bulgarian /a/ the F1 and F2 values are not statistically separable from short German /a/. The long German /a:/ vowel is more "open" (F1 is higher) than the Bulgarian and German short /a/.

The mid Bulgarian vowels (/ɛ/ and /ɔ/) also lie between the mid-open German short /ɛ/ and /ɔ/ and the mid-close German long /e:/ and /o:/, although in terms of F2 the /ɛ/\_{BG} does not differ significantly from /ɛ/\_{DE}.

It appears, therefore, that Bulgarian learners cannot really adopt the timbre of their L1 vowels for *either* of the nearest target vowels of the L2 system, and for the long member of each pair they have to modify both duration and quality. The following section will show what modifications in L1 production were observed.

**Table 1:** Vowel differences (BG vs. DE) for the zF1/zF2 measures (Scheffé post-hoc comparisons).

zF1	zF2
/i:/_{DE} < /i/_{BG} < /i/_{DE} [F(2,97)=89.454, p<.001]	/i/_{DE} < /i/_{BG} < /i:/_{DE} [F(2,97)=113.717, p<.001]
/e:/_{DE} < /ɛ/_{BG} < /ɛ/_{DE} [F(2,97)=140.392, p<.001]	/ɛ/_{DE}, /ɛ/_{BG} < /e:/_{DE} [F(2,97)=239.797, p<.001]
/a/_{BG}, /a/_{DE} < /a:/_{DE} [F(2,97)=8.162, p<.001]	n.s.
/o:/_{DE} < /ɔ/_{BG} < /ɔ/_{DE} [F(2,97)=58.071, p<.001]	/o:/_{DE} < /ɔ/_{BG} < /ɔ/_{DE} [F(2,97)=83.066, p<.001]
/u:/_{DE}, /u/_{BG} < /u/_{DE} [F(2,97)=32.392, p<.001]	/u:/_{DE} < /u/_{BG} < /u/_{DE} [F(2,97)=26.075, p<.001]

## 3.2. L2 German vowels vs. L1 Bulgarian vowels

In a first step we consider how the Bulgarian speaker groups were able to modify their German-vowel production relative to their L1 vowels in order to achieve a vowel-pair distinction (see table 2).

/i: ɪ/ - None of the groups achieved any differentiation in the F1 dimension, but BG5 and BG10 achieved a distinction in the F2 dimension. BG5 and BG10 identified the quality of the short vowel /ɪ/ with their L1 /i/.

/e: ɛ/ - Only BG10 modified their production in the F1 dimension, again identifying the German short /ɛ/ with their L1 /ɛ/\_{BG}. All the groups achieved F2 differentiation, but only BG10 had a significant /e: - ɛ/ distinction.

/a: a/ - BG0 modified their production in the F1 dimension but did not achieve a distinction (which is arguably only a product of vowel duration). Both BG5 and BG10 modified their F2 production but also failed to achieve a significant distinction between the two German vowels.

/o: ɔ/ - All the groups modified their production of F1, but BG5 failed to distinguish /o:/ and /ɔ/ significantly. BG0 differentiated both German target vowels from

their /ɔ/<sub>BG</sub> whereas BG10 identified the short vowel quality with their Bulgarian vowel. In the F2 dimension BG0 differentiated /o:/ and /ɔ/, separating both German targets from their /ɔ/<sub>BG</sub> while BG5 and BG10 identified /ɔ/ with /ɔ/<sub>BG</sub>.

/u: ʊ/ – BG10 achieved a distinction in F1, identifying the long German vowel with their /u/<sub>BG</sub>. In the F2 dimension, only BG0 differentiated their production, but there was no significant /u: - ʊ/ distinction.

**Table 2:** Vowel differences (BG\_DE vs. BG) for the zF1/zF2 measures (Scheffé post-hoc comparisons).

zF1	zF2
<i>a) BG0 vs. BG</i>	
n.s.	/i/ <sub>BG</sub> = /i/ <sub>BG0</sub> < /i/ <sub>BG0</sub> = /i:/ <sub>BG0</sub> [F(2,97)=11.791, p<.001]
n.s.	/ɛ/ <sub>BG</sub> , /ɛ:/ <sub>BG0</sub> < /ɛ/ <sub>BG0</sub> , /e:/ <sub>BG0</sub> [F(2,97)=4.588, p<.01]
/a/ <sub>BG</sub> , /a:/ <sub>BG0</sub> < /a:/ <sub>BG0</sub> , /a/ <sub>BG0</sub> [F(2,97)=4.775, p<.01]	n.s.
/o:/ <sub>BG0</sub> < /ɔ/ <sub>BG0</sub> < /ɔ/ <sub>BG</sub> [F(2,97)=15.854, p<.001]	/o:/ <sub>BG0</sub> < /ɔ/ <sub>BG</sub> , /ɔ/ <sub>BG0</sub> [F(2,97)=13.107, p<.000]
n.s.	/u:/ <sub>BG0</sub> , /u/ <sub>BG</sub> < /u/ <sub>BG</sub> , /ʊ/ <sub>BG0</sub> [F(2,97)=3.979, p<.05]
<i>b) BG5 vs. BG</i>	
n.s.	/i/ <sub>BG</sub> , /i/ <sub>BG5</sub> < /i:/ <sub>BG5</sub> [F(2,97)=14.145, p<.001]
n.s.	/ɛ/ <sub>BG</sub> , /ɛ/ <sub>BG5</sub> < /ɛ/ <sub>BG5</sub> , /e:/ <sub>BG5</sub> [F(2,97)=6.315, p<.01]
— [F(2,97)= 4.974, p<.01]	/a/ <sub>BG</sub> , /a:/ <sub>BG5</sub> < /a:/ <sub>BG5</sub> , /a/ <sub>BG5</sub> [F(2,97)=5.665, p<.01]
/o:/ <sub>BG5</sub> , /ɔ/ <sub>BG5</sub> < /ɔ/ <sub>BG5</sub> , /ɔ/ <sub>BG</sub> [F(2,97)=6.444, p<.01]	n.s.
n.s.	n.s.
<i>c) BG10 vs. BG</i>	
n.s.	/i/ <sub>BG</sub> , /i/ <sub>BG10</sub> < /i:/ <sub>BG10</sub> [F(2,97)=8.576, p<.001]
/e:/ <sub>BG10</sub> < /ɛ/ <sub>BG10</sub> , /ɛ/ <sub>BG</sub> [F(2,97)=12.344, p<.001]	/ɛ/ <sub>BG</sub> , /ɛ/ <sub>BG10</sub> < /e:/ <sub>BG10</sub> [F(2,97)=14.573, p<.001]
n.s.	/a/ <sub>BG</sub> < /a/ <sub>BG10</sub> , /a:/ <sub>BG10</sub> [F(2,97)=6.308, p<.01]
/o:/ <sub>BG10</sub> < /ɔ/ <sub>BG</sub> , /ɔ/ <sub>BG10</sub> [F(2,97)=4.149, p<.05]	n.s.
/u/ <sub>BG</sub> , /u:/ <sub>BG10</sub> < /ʊ/ <sub>BG10</sub> [F(2,97)=7.082, p<.001]	n.s.

### 3.3. L2 German vowels vs. L1 German vowels

The second step, after considering the (lack of) differentiation of their Bulgarian vowel production is to see how close the groups come to approximating the German vowel qualities.

#### 3.3.1. Vowel Quality

Separate MANOVAS per vowel with *speaker group* (DE, BG0, BG5, BG10) as fixed factor and F1 and F2 normalized values as dependent variable show that in their production of 9 of the 14 German vowels *all three* BG speaker groups deviated significantly in F1 or F2, or in both F1 and F2 from the target values.

Deviation in both F1 and F2: /e:/ was too open ([F(3,76)=17.803, p<.001]) and too retracted ([F(3,76)=42.453, p<.001]); /i/ and /y/ were too raised ([F(3,76)=28.904, p<.001] and [F(3,76)=7.669, p<.001] respectively) and too fronted ([F(3,76)=37.432, p<.001] and [F(3,76)=10.652, p<.001]).

Deviation only in F1: /ɛ/ and /æ/ was too raised ([F(3,76)=5.193, p<.01], [F(3,76)=12.712, p<.001]), /o:/, /y:/ too open ([F(3,76)=8.792, p<.001], [F(3,76)=12.191, p<.001]).

Deviation only in F2: /u:/ was too central ([F(3,76)=7.264, p<.001]), /ɔ/ too retracted ([F(3,76)=6.778, p<.001]).

Only /i:/ was approximated successfully in F1 and F2 by all three Bulgarian speaker groups. They were all successful in F1 approximation for /a:/ and in F2 approximation for /y:/. There were no significant deviations in F1 and F2 from the target values for /a/, but the Bulgarian speaker groups differed significantly in both dimensions among themselves, BG0 having a higher F1 than BG10 ([F(3,76)=4.163, p<.01]) and a lower F2 than BG5 ([F(3,76)=3.044, p<.05]). For the target vowel /u:/ the MANOVA reached marginal significance in F1 ([F(3,76)=3.009, p<.05]) but no single speaker group deviated significantly from the target value. In the 9 remaining cases of F1 or F2 comparison with the target values, successful approximation was found 4 times for BG0, 3 times for BG5 and 5 times for BG10.

In summary then, over all 28 comparisons (14 vowels x 2 formants) the three groups deviated in the same manner in 12 cases, approximated in the same manner in 5 cases, and were only significantly different from one another in 8 cases.

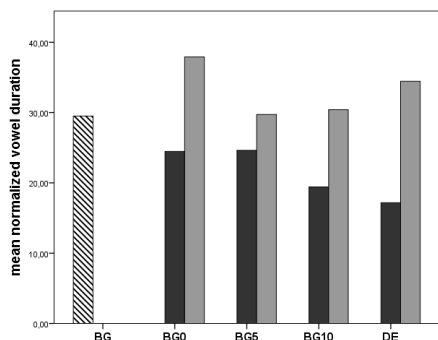
#### 3.3.2. Vowel Duration

So far we have only considered the timbre-determining formant values. The German length contrasts, however, were also identified above as a new contrast dimension to be learned. Separate ANOVAS per vowel length (short, long) with *speaker group* (DE, BG0, BG5, BG10) as fixed factor and normalized vowel duration as dependent variable show that the German speakers differ significantly from the other three groups (compare figure 1, where Bulgarian vowel durations are given as reference). The short vowels of the BG10 group were closest in duration to the German values, while the values of the other two groups (BG0 and BG5) formed another homogenous sub-group ([F(3,556)= 64.519, p<.001], i.e., DE < BG10 < BG0, BG5). For the long vowels the German values are intermediate; longer than those of BG5 and BG10 and shorter than those of BG0. ([F(3,556)=36.872, p<.001], i.e., BG5, BG10 < DE < BG0).

In summary: the short vowels were consistently longer relative to the German L1 values (but shorter than the BG L1 values) whereas for two of the three groups (BG0 was the exception), the long vowels were shorter

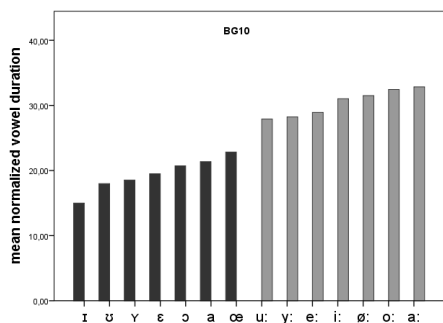
than L1 DE. This resulted in a consistently lower long/short vowel ratio for the BG groups (1:2.3 for DE, 1:1.8 for BG0, 1:1.2 for BG5 and 1:1.7 for BG10).

**Figure 1:** Mean normalized vowel durations for the short and long vowel realizations per speaker group.



Behind this simple picture of average values lies a more complex picture of durational uncertainty. Figure 2 shows a disruption of the ‘universal’ pattern of intrinsic vowel duration as a function of the close-open dimension in the BG10 L2 vowel production, despite normal patterning in their native L1 vowels.

**Figure 2:** Mean normalized vowel durations for the short and long vowel realizations per vowel category.



### 3.3.3. Vowel Contrasts

Table 3 shows how well (or badly) the different Bulgarian speaker groups succeeded in maintaining the necessary German vowel-quality contrasts. It can be clearly seen that none of the learner groups are close to establishing a reliable system of intra-pair contrasts. BG10, with the longest learning period and the longest direct exposure to native-speaker German, achieve a contrast in 5 of the seven pairs, 4 in the open-close dimension, 2 in the back-front dimension (but only one in both dimensions). BG5, with up to 5 years direct experience in Germany but very little formal teaching, only achieve one contrast – in the front-back dimension. BG0, with no direct exposure to native German but considerable formal teaching in Bulgaria, achieve 3 vowel contrasts (1 F1, 2 F2, with one in both dimensions). However, as seen in section 3.3.2., the Bulgarian speakers can still differentiate within the vowel pairs by using relative duration instead of vowel

quality, though with reduced contrast compare to German speakers.

**Table 3:** Vowel-quality contrasts as realized by Bulgarian L2 and German L1 speakers.

	BG0		BG5		BG10		DE	
	zF1	zF2	zF1	zF2	zF1	zF2	zF1	zF2
î : ɪ				**		*	***	***
e: ε					**	**	***	***
a: a							***	*
o: ɔ	**	***			*		***	***
u: ʊ		**			*		***	***
ø: œ							***	
y: ʏ					*		***	***

## 4. CONCLUSION

In general the Bulgarian vowels are located in vowel space between the tense (long) and lax (short) German vowels. It is apparent that the L2 categories are attracted by the L1 vowel qualities. The findings in section 3.3.1. show, that at least some of the German vowels are identified with Bulgarian vowel categories. Although the Bulgarian speakers in the three groups have difficulties realizing the qualitative (tense-lax) contrasts of the German vowel pairs, they differentiate the intra-pair vowels by means of vowel length. The results offer evidence to support the claim in [4] that duration takes over the differentiating function when learners have problems acquiring the contrasting quality features. However, their production differs from native speakers in the *degree* to which they employ duration to realize these contrasts. Speakers of the BG5 group almost always produced the vowels they could not differentiate qualitatively with clearly different durations, and all groups produced shorter ‘short’ vowels than the L1 vowel durations, which allowed a short-long contrast to emerge even for those who did not produce ‘long’ vowels of sufficient length. At the same time, it is clear that the L2 learners *had* established new phonetic quality categories for some vowels, i.e. the front rounded vowels. This bears out the SLM prognosis that it is the lack of a phonetically similar sound in the L1 inventory which allows the learners to develop a new category in the course of time. However, the L2 speakers merge each *pair* of tense/lax front rounded German vowels in one phonetic quality. This confirms their under-developed sensitivity for the spectral differences within the pairs, though the speaker groups differ considerably in the degree to which some sensitivity is present. The results indicate that the degree of foreign accent is not primarily a function of the time spent in the L2 country (compare the BG0 and BG5 performance). An earlier start of L2 teaching and a longer teaching phase appear to be more important for the post-puberty learners investigated here.

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