# Speech rhythm and vowel raising in Bulgarian Judeo-Spanish

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## Abstract

The study investigates selected prosodic characteristics of (Sofian) Bulgarian Judeo-Spanish, a diaspora variety of Spanish spoken by descendants of the Jews expelled from Spain, all of them bilingual speakers with Bulgarian as their dominant language. While exhibiting some few relics from Old Spanish on the segmental level, Judeo-Spanish shows a puzzling similarity with Bulgarian with respect to speech rhythm and vowel raising. It is shown that the two languages spoken by the bilinguals, Bulgarian and Judeo-Spanish, pattern alike in displaying almost the same rhythmic values (except for %V) ([1], [2], [3], [4], [5]) and that raising of unstressed /a/ and /o/ as is typical of the variety of Bulgarian spoken in Sofia also regularly occurs in the Judeo-Spanish data. Our findings show that Judeo-Spanish is crucially influenced by Bulgarian, thus suggesting that it has largely converged toward the surrounding language on the phonological level.

**Index Terms**: Judeo-Spanish, Spanish, Bulgarian, language contact, speech rhythm, vowel raising

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## 1. Introduction

Judeo-Spanish (JUSPA) emerged in the Middle Ages in a socio-political context marked by the contact of several languages. The Sephardic Jews living in Spain formed an ethno-sociological group different in customs and beliefs from the non-Jewish population. Their main vernacular was (Medieval) Spanish, while they used Hebrew in ritual and educational contexts. After the expulsion from Spain in 1492, their vernacular developed independently of Iberian Spanish due to contact with the new surrounding languages, among them Bulgarian. The Bulgarian variety of JUSPA is spoken by a rather small group of about 250-300 (at least) bilingual speakers with Bulgarian (BULG) as their dominant language, the JUSPA community of Sofia being even much smaller. The oldest living native speakers were born around 1920, the youngest in the 1960ies ([6], [7]). The use of JUSPA is restricted to informal communication within the community; in 1998, *Club ladino*, a community center for Sephardic Jews, was founded in the city center of Sofia.

Apart from the remarks included in general presentations (e.g. [8]), the literature on JUSPA phonology is rather sparse. Both the segmental and the tonal properties of the variety of Judeo-Spanish spoken in İstanbul (Turkey) have recently been investigated ([9] and [10]; the only study explicitly dealing with the phonemic system of Bulgarian JUSPA stems from the mid 1970ies ([11]). The prosody, in particular speech rhythm and vowel raising, of the variety in focus has not been investigated until now.

## 2. Phonological properties of JUSPA

This section highlights selected properties of JUSPA in comparison with the surrounding language BULG on the one hand and (Castilian) SPA on the other.

SPA exhibits an unmarked vowel system with the five phonemes /i, e, u, o, a/; BULG., in addition, has a phonemic schwa /ə/ ([12]) that also forms part of the JUSPA vowel system, albeit restricted to word-medial stressed syllables in Bulgarian loan words ([11]). A striking feature that has a crucial impact on speech rhythm is the presence or absence of vowel reduction ([1]). While completely absent from SPA ([13]), Bulgarian presents reduction (or rather raising) of the vowels /o, e, a/ that are realized as [u, i, ə] in unstressed syllables, e.g. [ˈrabutə] *работа* 'work' vs. [rəˈbotnik] *работник* 'worker' ([12], [14], [15], [16]). However, in the variety of BULG spoken in Sofia the raising of vowels commonly only affects /a/ and /o/, which surface in unstressed position as [ə] and [u], respectively, while the front vowel /e/ is hardly ever reduced to [i] ([14]). Interestingly, (Sofian) JUSPA also presents the feature of vocalic reduction ([11]), presumably as a consequence of its long-lasting contact with Bulgarian. Note in this context that vowel reduction has not been attested in other varieties of Judeo-Spanish (see, e.g., [9] concerning the variety spoken in İstanbul). Figure 1 depicts the process of vowel raising as is attested in Sofian BULG and JUSPA.

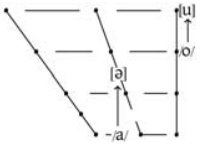


Figure 1: *Vowel raising in Sofian BULG and JUSPA.*

Regarding its consonantal system, JUSPA has preserved some features from Medieval Spanish, e.g. the sibilants /ʃ, ʒ/ (e.g., *bajo* [ˈbaʃo] vs. SPA [ˈbaxo], *mujer* [muˈʒeɾ] vs. SPA [muˈxeɾ], the [±]voiced contrast of the alveolar fricatives /s/ vs. /z/ ([11]), [17]). A reason for the maintenance of the rich sibilant system in JUSPA might be seen in the fact that the BULG consonant system also includes the phonemes /s z ʃ ʒ/ ([18]).

Concerning its rhythmic properties, (Castilian) SPA is traditionally classified as a typical syllable-timed language that strongly prefers regular sequences of CV syllables and completely lacks vowel reduction ([19]). Seen from the phonetic side, SPA is characterized by a high proportion of vocalic material (%V) and rather low values for the durational variability of both V and C intervals, as compared to stress-timed languages such as English ([1], [4], [20]). BULG, as opposed to SPA, exhibits complex syllable structures, allowing for up to three consonants in both the onset and the coda, i.e. (CCC)V(CCC), and presents vowel raising (see above), but usually no complete deletion of unstressed vowels as occurs, e.g., in English ([21], [22]). It is thus "less stress-timed" than English; its speech rhythm may thus be characterized as being of a mixed type ([23]). Until now, there is no work investigating the speech rhythm of JUSPA. For the current study, we hypothesize that the bilingual speakers (at least partially) transfer the rhythmic values from BULG to JUSPA, i.e. we assume that the rhythmic values shown in the

speech production of both of their languages are situated between the ones for SPA on the one hand and for Bulgarian, produced by monolingual speakers, on the other. Concerning the production of unstressed vowels, we expect the bilingual speakers to raise unstressed /a/ and /o/ in their production of JUSPA, due to transfer from BULG.

# 3. Methodology

## 3.1. Speakers

We collected data from five female bilingual JUSPA/BULG speakers, aged 80 to 88 (recordings Sofia, September 2012). Although they were born and raised in different places in Bulgaria (Kyustendil, Pazardzhik, Kazanlak, Samokov, and Karnobat), all of them have been living in Sofia for more than 60 years and speak the Sofian variety of BULG. The bilingual subjects were recorded in both of their languages (JUSPA and BULG_B(ilingual)). Five monolingual BULG speakers (1 ♂, 4 ♀, ages 26–34) and five monolingual speakers of (Castilian) SPA (3 ♂, 2 ♀, ages 24–34) serve as control groups. The Bulgarian subjects were born and raised in Sofia; the Spanish speakers were all born in the Castilian dialect area and raised in Madrid. The monolingual BULG speakers were recorded in Sofia in September 2012 (BULG_M(onolingual)); the (Castilian) SPA control data were gathered in Madrid in September 2011.

## 3.2. Material

The material gathered for the analysis of vowel raising and speech rhythm consisted of reading of the fable *The North Wind and the Sun*, recorded in BULG_M, BULG_B (*Северният вятър и слънцето*), JUSPA (*El ayre del norte i el sol*), and (Castilian) SPA (*El viento norte y el sol*), respectively. The data were recorded with a Marantz hard disk recorder (PMD671) and a Sennheiser microphone (ME64) and analyzed using *Praat* ([24]).

## 3.3. Analysis of vowel raising

In order to demonstrate that Judeo-Spanish also exhibits vowel raising like the contact language Bulgarian, both an auditory and an acoustic analysis were performed. First, all unstressed /a/ and /o/ occurring in the data recorded from the bilingual speakers (i.e. JUSPA and BULG_B) were transcribed by the second author (who is a native speaker of Bulgarian) according to their auditory properties as being reduced or unreduced. In a second step, two raters, both native speakers of Bulgarian, were asked to determine every single unstressed /a/ and /o/ as being realized as [a] or [ə] for /a/, and as [o] or [u] for /o/. For the final results of the auditory analysis, every vowel which was defined as being reduced by the second author and by at least one of the raters was counted as being reduced. The transcription agreement between the three raters amounts to 86 % for JUSPA and to 89% for BULG_B.

Subsequently, all stressed and unstressed /a/ and /o/ occurring in the data collected from the bilinguals were analyzed acoustically. In order to compare the formant frequencies of the unstressed vowels with the ones of the stressed ones in both of their languages, we measured the formants of all stressed and unstressed /a/ and /o/ in the JUSPA and the BULG_B data. All /u/ and /ə/ (we refer here to the Bulgarian /ə/ that occurs in both stressed and unstressed position) were also taken into account in order to compare the formant frequencies of the unstressed /a/ and /o/ with the respective values of /u/ and /ə/. Material produced with creaky voice or disfluencies was excluded from the acoustic analysis.

The first two formants of the above mentioned vowels were extracted using the *Praat* function Formant Track and running a script that provides three scores for F1 and F2 of each vowel (measured at the 25%, 50%, and 75% temporal points of the vocalic duration). Since the two data sets (BULG_B and JUSPA) differ with respect to the occurrences of syllable structures (CV, CVC, CCV, etc.) and regarding the segments that precede the vowels as syllabic onsets (plosives, nasals, liquids, etc.), we used only the values obtained from the measurements in the middle of the vowel in order to avoid co-articulation effects.

The values obtained from the formant tracker were checked randomly by the second author; incorrect values were respectively changed in the overall results, following [25]. We calculated the mean F1 and F2 values for stressed and unstressed /a, o/ occurring in both JUSPA and BULG_B. The occurrences of stressed and unstressed /u/ were grouped together for both languages, since /u/, as opposed to /a/ and /o/, is not expected to exhibit stress-dependent qualitative differences in Bulgarian. The same holds for stressed and unstressed /ə/.

## 3.4. Analysis of speech rhythm

For the rhythmic analysis, the whole data recorded in BULG_M, BULG_B, JUSPA, and SPA were segmented into vocalic and consonantal intervals.

Following [2, 26], the boundaries between V and C intervals were determined on the basis of formant structure and pitch period and set at the point of zero crossing of the waveform. Pre-pausal and phrase-final intervals were considered for the analysis since possible effects of final lengthening were likely to be reflected in the measures ([2], [4]). According to [4], we treated glides as belonging to the V intervals if there was no friction attested in the data. For plosives and affricates following a stretch of silence (pause) the beginning was placed at 0.05s prior to the burst, given that their boundaries can hardly be determined on the basis of the aforementioned criteria ([27]). Silent pauses and material affected by any kind of speech disfluency were excluded from the analysis.

Using the software *Correlatore* ([28]), we calculated both the proportion of vocalic material in the speech signal (V%) and the durational variability of vocalic and consonantal intervals as expressed by the variation coefficient VarcoV/C and the Pair-wise Variability Index (VnPVI, CnPVI, CrPVI). VarcoV/C is a speech rate normalized version of ΔV/C, which expresses the standard deviation of vocalic and consonantal intervals; the PVIs differ from both ΔV/C and VarcoV/C in computing the durational variability in successive V/C intervals instead of calculating the variability of V/C intervals over the whole acoustic signal; see [1], [2], [3], [4], and [5].

# 4. Results

The analysis of vowel raising and speech rhythm showed that the two languages spoken by the bilingual speakers, i.e. JUSPA and BULG_B, pattern alike with respect to both vowel raising (similar formant frequencies) and speech rhythm (comparable values for the rhythm metrics).

### 4.1. Vowel raising

Table 1 represents the results of the auditory analysis and shows the occurrences of reduced /a/ and /o/ in JUSPA and BULG_B.

Table 1. *Occurrences of reduced and unreduced /a, o/ in unstressed positions in JUSPA and BULG_B.*

| | JUSPA | | BULG_B | |
|---|---|---|---|---|
| | № of /a/ and /o/ | % | № of /a/ and /o/ | % |
| reduced /a/ | 135 /a/ | 75.5% | 108 /a/ | 84.5% |
| unreduced /a/ | | 24.5% | | 15.5% |
| reduced /o/ | 107 /o/ | 36% | 70 /o/ | 71% |
| unreduced /o/ | | 64% | | 29% |

According to the outcomes of our auditory analysis, the bilingual speakers realized /a/ as [ə] in 75.5% of the cases in JUSPA and in 84.5% in BULG_B. The realization of /o/ as [u] amounts to 36% in the JUSPA data and to 71% for BULG_B. Summarizing, raising of /a/ and /o/ occurs more frequently in BULG_B than in JUSPA.

Tables 2 and 3, below, present the formant frequencies for the data gathered from the bilingual informants. The results of the acoustic analysis clearly show that the bilingual speakers exhibit vowel raising in both JUSPA and BULG_B.

Table 2. *Mean formant frequencies for JUSPA (Hz).*

| | stressed /a/ | unstressed /a/ | stressed /o/ | unstressed /o/ | /u/ |
|---|---|---|---|---|---|
| № | 51 | 135 | 77 | 107 | 48 |
| F1 | 877 | 633 | 602 | 413 | 348 |
| F2 | 1491 | 1635 | 1067 | 1067 | 904 |

Table 3. *Mean formant frequencies for BULG_B (Hz).*

| | stressed /a/ | unstressed /a/ | stressed /o/ | unstressed /o/ | /u/ | /ə/ |
|---|---|---|---|---|---|---|
| № | 29 | 108 | 70 | 70 | 28 | 84 |
| F1 | 847 | 520 | 578 | 385 | 330 | 490 |
| F2 | 1650 | 1721 | 1094 | 1066 | 1032 | 1617 |

As can be seen in Tables 2 and 3, the material recorded comprises different numbers of stressed and unstressed vowels (i.e. 51 stressed /a/ and 135 unstressed /a/ for JUSPA, but 29 stressed /a/ and 108 unstressed /a/ for BULG_B, etc.). As for the formant frequencies, while the mean F1 values for stressed /a/ are almost the same in both the JUSPA and the BULG_B productions (877 Hz for JUSPA and 847 Hz for BULG), this is not the case for the mean F2 values which are 1491 Hz for JUSPA and 1650 Hz for BULG_B. Regarding /a/, it can be said that unstressed /a/ is frequently produced as [ə] in both bilingual languages (mean F1 value 633 Hz for JUSPA and 520 Hz for BULG_B). Thus, we observe a statistically significant difference between the F1 scores for stressed and unstressed /a/ in both JUSPA and BULG_B (dependent t-test: D=244.8±20.5, t(4)=26.709, p<0.001 for JUSPA; D=347.7±34.2, t(4)=22.745, p<0.001 for BULG_B).

Nevertheless, unstressed /a/ is more likely to be reduced (or rather: raised) in BULG_B (F1=520 Hz and F2=1721 Hz) than in JUSPA (F1=633 Hz and F2=1635 Hz), since the values for BULG_B are closer to those of stressed or unstressed /ə/ (see Table 3: F1=490 Hz and F2=1617 Hz). These findings confirm the outcomes of the auditory analysis in which the raters defined /a/ as [ə] in 84.5% of the cases for BULG_B and in 75.5% of the cases for JUSPA. The picture doesn't change when the realization of unstressed and stressed /o/ is taken into account: The mean F1 and F2 values for the stressed /o/ are quite similar in JUSPA (F1=602 Hz and F2=1067 Hz) and in BULG_B (F1=578 Hz and F2=1094 Hz). Although, according to the auditory analysis, unstressed /o/ seems to be realized as [u] twice more in the BULG_B speech than in the JUSPA material, the mean F1 and F2 scores for both bilingual varieties are nearly equal (F1=413 Hz and F2=1067 Hz for JUSPA; F1=385 Hz and F2=1066 Hz for BULG_B). The mean formant frequencies for unstressed /o/ pattern with the F1 and F2 values for /u/ rather than with the F1 and F2 scores for stressed /o/ in both varieties. However, the differences between the mean F1 and F2 scores for unstressed /o/ and for /u/ are higher in the JUSPA productions than the same ones in the BULG_B data. Nevertheless, the difference between the F1 scores for stressed and unstressed /o/ in both varieties is statistically significant (D=189.3±30.9, t(4)=13.697, p<0.001 for JUSPA; D=196.4±25.1, t(4)=17.482, p<0.001 for BULG_B).

### 4.2. Speech rhythm

Table 4 summarizes the values obtained from the analysis of the fable *The North Wind and the Sun* for SPA, JUSPA, BULG_B, and BULG_M. The scores for the two varieties spoken by the bilingual speakers are quite similar (except for %V), the values for VarcoV und VnPVI largely being situated between those obtained from the analysis performed on the SPA and the BULG_M data.

Table 4. *Mean values of six rhythm metrics for SPA, JUSPA, BULG_B, and BULG_M.*

| | %V | VarcoV | VarcoC | VnPVI | CrPVI | CnPVI |
|---|---|---|---|---|---|---|
| SPA | 40.4 | 43.3 | 39.8 | 36.6 | 40.6 | 46.3 |
| JUSPA | 45.6 | 45.3 | 42.3 | 43.6 | 60.3 | 45.7 |
| BULG_B | 38.6 | 44.1 | 41.1 | 44.3 | 58.1 | 47.5 |
| BULG_M | 33.7 | 49.7 | 38.1 | 49.8 | 50.9 | 45.1 |

While BULG_M displays the lowest proportion of vocalic material, BULG_B, SPA, and JUPSA show higher values for %V. As for the variability of vocalic intervals, the VarcoV and VnPVI scores for JUSPA and BULG_B are almost the same: More precisely, they are situated between those obtained from the analysis performed on the data produced by the two control groups (i.e. BULG_M and SPA). The differences between SPA on the one hand and JUSPA, BULG_B, and BULG_M on the other for the VnPVI values are statistically significant (SPA vs. JUSPA p=0.036, SPA vs. BULG_B p=0.018, and SPA vs. BULG_M p<0.001). Regarding the variability of consonantal intervals, both bilingual varieties exhibit quite similar values for VarcoC, CrPVI, and CnPVI. Considering the normalized metrics (VarcoC and CnPVI), it can be said that all four varieties pattern together showing similar variability of consonantal intervals; however, taking into account the values for the non-normalized or raw Pair-wise Variability Index for consonantal intervals (CrPVI), BULG_M and SPA display a lower variability of consonantal intervals. Figure 2 represents the distribution of the four varieties under discussion over the %V/VnPVI plane.

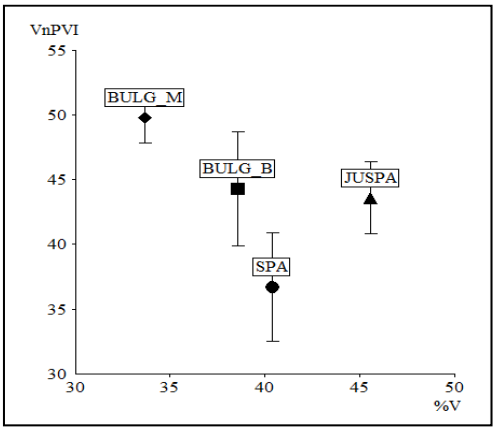


Figure 2: *Distribution of BULG_M, BULG_B, JUSPA, and SPA over the %V/VnPVI plane.*

## 5. Discussion

We interpret the results of our rhythmic analyses as follows: Regarding the proportion of vocalic material (%V) and the variability of V intervals (VarcoV and VnPVI) for BULG_M and SPA, it is expected that BULG_M displays a greater variability of vocalic intervals, but lower percentages for vocalic material (%V) than SPA, due to the presence of vowel reduction in Bulgarian. These expectations are confirmed by the results shown in Table 4 (see also Figure 2). Regarding the variability of C intervals (as is expressed by VarcoC, CrPVI, and CnPVI, respectively), the results confirm previous findings reported in, e.g., [21], who showed that Bulgarian (a language that presents complex consonant clusters and thus long C intervals almost throughout the whole speech signal) exhibits a variability of consonantal intervals similar to those of syllable-timed languages such as Spanish (a language with simple structures and thus presenting continuously short C intervals). This similarity becomes obvious when the values for the speech-rate normalized PVI (CnPVI) are taken into account (46.3 for SPA and 45.1 for BULG_B).

Interestingly, BULG_B patterns with JUSPA rather than with BULG_M in displaying almost the same rhythmic values (except for %V), which can be explained by the influence from Judeo-Spanish, the other language used by the bilingual speakers. The (unexpectedly) high %V values for JUSPA can be explained by the fact that the speakers read the fable in Judeo-Spanish slower as compared to their reading of the Bulgarian version of the text (regarding the influence of speech rate on rhythm see [21], [29], [30]). The reason for this might be the fact that their predominant language is Bulgarian and they are not accustomed to the use of Judeo-Spanish in its written form. Regarding the variability of V intervals, expressed by VarcoV and VnPVI (see Figure 2 for the latter), both BULG_B and JUSPA display intermediate scores situated in between those of SPA and BULG_M. The lower variability of V intervals in the BULG_B as compared to BULG_M once again might be interpreted as an effect of 'syllable-timed influence' from JUSPA in the bilingual speakers. The higher VnPVI value for JUSPA as compared to the one for SPA, in turn, suggests 'stress-timed influence' from Bulgarian and may be interpreted as an effect of vowel reduction (or rather: vowel raising), a phonological feature that is completely absent from (Castilian) SPA and has presumably been transferred to JUSPA from the dominant language Bulgarian in the bilingual speakers. Regarding the variability of C intervals, the differences between the languages investigated are less clear (see Table 4). However, the two varieties spoken by the bilingual speakers, JUSPA and BULG_B, once again display similar values.

To sum up, the phonological shape of the diaspora variety JUSPA patterns with its contact language Bulgarian in several respects: It presents vowel reduction (or rather: vowel raising) in the same way as the Sofian variety of Bulgarian does (raising of /a/ and /o/ to [ə] and [u] in unstressed position). Regarding the variability of vocalic intervals, it exhibits intermediate values, located in between those of the variety of Bulgarian spoken by monolingual speakers in the capital of Sofia (BULG_M) and Castilian Spanish (SPA). These findings can be attributed to the long-standing contact with Bulgarian and to convergence of two phonological systems (Bulgarian and Spanish) in the bilingual speakers.

## 6. Conclusion

Sofian Judeo-Spanish phonology is characterized by two opposite aspects: Some segments, e.g., the sibilants /ʃ/ and /ʒ/ mentioned in section 2, above, are maintained from Medieval Spanish, thus, at least partly, attributing a conservative character to the variety investigated here. The innovative features, though, are more striking, since both the feature of vowel reduction (or rather: vowel rasing) and the rhythmic properties are (at least partially) transferred from the surrounding language Bulgarian to Judeo-Spanish. To put it bluntly, it may be stated that the bilingual JUSPA/BULG_B speakers practically use the same phonology for both of their languages − at least regarding the aspects investigated in the present study. This might be due to the fact that the first Sephardic Jews who arrived in the Ottoman Empire (today: Bulgaria) and started acquiring Bulgarian as an L2 drew on the resemblances between the two phonological systems in order to avoid high cognitive costs in language processing (see [31]). During the initial period, they might have had two distinct phonologies, while the segments that belong to both of the systems, such as the sibilant phonemes, increasingly converged with respect to their concrete phonetic realization. In a further step, the two systems might have completely converged, insofar that phonological features not belonging to the Judeo-Spanish system (such as vowel raising) were integrated as well. It is even conceivable that the contemporary bilingual JUSPA/BULG_B speakers dispose of one phonological system only, i.e. the Bulgarian one, as a result of an entire convergence on the phonological level.

All things considered, we argue that the variety of Judeo-Spanish nowadays spoken in Sofia (JUPSA) is a typical contact variety that exhibits features of the languages involved in the situation of linguistic contact. Our results by and large confirm the view that the sound shape of a given language is more likely to adopt features from other languages in contact situations than is the case for core-syntactic properties such as, e.g., the ordering of verb and object (OV vs. VO) [32].

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