The Acoustic Variation of Mid-to-Close Central Vowel Phonemes in Pindian and Farsherot Varieties of Aromanian

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1. Introduction

Among the most clearly distinguished dialect groups of the Aromanian language, one can find the Pindian varieties, predominantly spoken within the Pindus mountain range in Greece, and the Farsherot varieties, with a large portion of its speaker community being spread across Southern Albania. Here, an acoustic-phonetic analysis of spontaneous speech produced by native speakers from each dialect group is carried out. The assumed vowel types /ə/ and /ɨ/ are shown to be relatively distinct from each other acoustically, but only when carrying lexical stress and being produced by Pindian speakers, as also suggested by some theoretical accounts.

1. Background

1.1.1 Aromanian Vowel System

Since WEIGAND (1888: 3–5), there is a general consensus that Aromanian phonology features *at least* the five vowel phonemes /a/, /e/, /i/, /o/, and /u/. What is less clear is the status of sounds in the remaining, mid-to-close central portion of the Aromanian vowel space. WEIGAND (ibid.) differentiates between two further sounds that by modern conventions would be transcribed as /ə/ and /ɨ/, thus marking a distinction also present in the better-understood Daco-Romanian vowel system. Yet, interestingly, WEIGAND (1888: 4) also notes that in the speech of his informants from villages around Mount Olympus (Pindian-like varieties) the Aromanian 'â' (= /ɨ/) sound differed in quality both from its 'ă' (= /ə/) counterpart *and* its Daco-Romanian equivalent 'î' (= /ɨ/), according to his own auditive judgements.

The distinction between two broader dialectal types of Aromanian varieties, a Southern (including Pindian) and a Northern (including Farsherot) one, dates back to CAPIDAN (1932: 193–196). As far as mid-to-close central vowels are concerned, CAPIDAN (1932: 210–211) describes a general tendency for /ə/ and /ɨ/ to be interchangeable across dialects in cases where they evolved from an ancestral Vulgar Latin /a/ sound followed by a nasal consonant, with a general tendency of /ə/ being preferred in the North (regarded as diachronically more conservative), but /ɨ/ in the South (considered diachronically more progressed). SCHLÖSSER (1985: 28–29) also examines utterances of words, as produced by native speakers from Metsovo (Pindian), that show a mid-to-close central vowel which has evolved from a prenasal, stressed Latin /a/: He notes that some of these words can be heard to display an [ə] sound, whereas others show [ɨ] instead, with no clear systematicity regarding that binary choice. This leads him to believe that [ə] and [ɨ] are allophones of the same underlying vowel phoneme in the variety spoken in Metsovo, rather than contrastable phonemes /ə/ versus /ɨ/. With regard to the phonological status of these sounds, CARAGIU MARIOȚEANU (1968: 32; 1972: 109–110; 1975: 223) insists that there are two distinct phonemes /ə/ and /ɨ/ in Aromanian varieties of what she dubs 'type A' (roughly matching CAPIDAN's Southern varieties), but only a single phoneme /ə/ (let us write: $/ə/_{single}$) in varieties of 'type F' (Farsherot ones). However, CARAGIU MARIOȚEANU (ibid.) restricts the assumption of two separate, mid versus close central vowel phonemes in 'type A' *exclusively* to the *stressed* vowel system; she postulates that the *unstressed* vowel system of both dialectal types does not differentiate between /ə/ and /ɨ/ anyway. Partially to the contrary, ΚΑΤΣΑΝΗΣ/ΝΤΙΝΑΣ (1990: 30) maintain that separate phonemes /ə/ and /ɨ/ do, in fact, exist even in the unstressed Southern vowel system. Common orthographic conventions for writing (Southern) Aromanian that rely on the assumed existence of such a contrast (more details in Section 3.3.2) are actually a bit more consistent with this latter claim: One can both find graphemes corresponding to /ə/ as well as ones corresponding to /ɨ/ even in unstressed positions, although unstressed vowels are far more frequently transcribed using a grapheme that signals /ə/ (to acknowledge this in quantitative terms, see Table 3 in Section 4.1). In a rather recent publication that revolves around the proposal of a slightly novel such orthographic convention, ΜΠΕΗΣ/ΔΑΣΟΥΛΑΣ (2017: 60) mention the two word pairs /aˈrəu/–/aˈrɨu/ (= bad; river) and /aˈrədzɨ/–/aˈrɨd͡zɨ/ (= rows; you laugh) as potential evidence for the phonological relevance of a contrast /ə/ versus /ɨ/ in Southern varieties. These two minimal pairs are also listed by CARAGIU MARIOȚEANU (1968: 25) alongside three further examples.

On an additional note, CAPIDAN (1932: 206) and CARAGIU MARIOȚEANU (1968: 30) both describe a tendency for Farsherot speakers to pronounce $/ə/_{single}$ as a sound that comes close to a fronted quality around [e] or [ɛ]. In this regard, CARAGIU MARIOȚEANU (ibid.) goes on to specify that such fronted realisations of $/ə/_{single}$ would appear in both stressed and unstressed positions, but that they would be more commonly observed in *female* Farsherot speakers rather than male ones.

During discussions like the present one, which rely on binary dialect classification schemes (Northern/Southern, Farsherot/non-Farsherot, etc.), it needs to be kept in mind that most such schemes commonly used for describing Aromanian have certain shortcomings, either due to misleading geographic and cultural implications or because of their failure to account for salient local variation that cannot be captured by general, binary definitions of features alone, as convincingly laid out by KAHL (2005: 156–158). Therefore, when opting for such terminology anyway, its approximative nature should at least not be neglected.

1.1.2 Acoustic-Phonetic Methods

In his summary of the methodological repertoire of acoustic phonetics, HARRINGTON (2010: 83–87) mentions the well-established correlation between formant frequencies of vowels and aspects of their acoustic quality (in particular, concerning the first three formants: F1~openness; F2~frontedness; F3~<u>un</u>roundedness). Moreover, in their review of current best practices in measuring potential vowel mergers, NYCZ/HALL-LEW (2013: 5) discuss a useful metric that is referred to as the *Pillai score* (sometimes, alternatively, *Pillai-Barlett trace*) which is sensitive to the overlap between any two vowel distributions given as samples of points in two-, three-, or even higher-dimensional formant spaces. While originally a general test statistic for multivariate analysis of variance (MANOVA), in its phonetic context of application, a rather high Pillai score (maximum=1) can be interpreted as signifying that the examined vowel distributions are quite distinct from each other, whereas a rather low one (minimum=0) means that there is large overlap.

1.2 Objectives

Despite some differences in the claims they make, the theoretical models of the Aromanian vowel system discussed in Section 1.1.1 all have one thing in common: They are not supported by quantitative assessments of the kind that an acoustic-phonetic corpus study could provide. Instead, authors typically relied on their own, subjective auditive judgements in order to sketch out the phonological properties of particular varieties of Aromanian. Therefore, one main goal of the present study is to fill that gap by providing a quantitative account of the vowel system as found in a set of speakers from Pindian and Farsherot dialect regions. Further, as already suggested, most attention is dedicated, here, to variation in sounds assumed to be instances of mid-to-close central vowel phonemes, /ə/ and /ɨ/, and the potential circumstances under which it would be reasonable to assume a unified vowel phoneme $/ə/_{\text{single}}$ to be underlying instead.

2. Materials

2.1 Speech Corpus

Several field studies carried out by Thede Kahl and his colleagues over the years have, taken together, yielded a considerable output of recordings of Aromanian spontaneous speech from different dialect regions. In particular, the collected recordings cover both Pindian and Farsherot speakers, thus lending themselves quite conveniently for inter-dialectal comparisons. Here, the focus lies on a set of recordings acquired in two villages in the Pindus region (Greece), between 1999 and 2001, as well as in two villages and one major town, all located in Southern Albania, between 2003 and 2015. In Table 1, the assembled corpus is summarised, including the names of places of speaker origin and information on the overall length of each speaker-specific recording. Throughout this paper, speakers are referred to in an anonymised way by an ID reflecting their biological sex and place of origin, according to the scheme ⟨W for female, M for male⟩ ⟨initial letter of location⟩ $_{\text{⟨numerical index⟩}}$. For instance, the ID 'MT$_2$' stands for a particular male speaker from the Pindian village <u>T</u>uria.

Details on the context and main findings of the field studies from which the fragments of speech recorded in the villages Turia, Kutsufliani, and Andon Poçi originate are provided by BARA/KAHL/SOBOLEV (2005), DIETRICH/KAHL/SÁRROS (2001), and RĂDULESCU/KAHL (2006), respectively. The two remaining locations, Gjirokastër[1] and Stjar[2], are not covered by corresponding written publications. Nonetheless, the record-

1 Gjirokastër: https://www.youtube.com/watch?v=sW3O2W3qagM. *Dóji frats – The two brothers*; performer: Spiro Poçi; camera: Thede Kahl; interview: Hrisa Poçi; transcription: Maria Bara, Nicolae Bara, Thede Kahl, Spiro Poçi; translation: Thede Kahl, Andreea Pascaru; editor: Mehdi Aminian; retrieved from www.oeaw.ac.at/VLACH, ID number: rram1234 ALV0001a.

2 Stjar: https://www.youtube.com/watch?v=WeyfrcUqsag. *Noia şi noi – Noah and the Aromanians*; performer: Mita Xhavarra; camera/interview: Thede Kahl; Spiro Poçi; transcription/

ings made in these latter two can be accessed online, in the form of videos made available by the Commission Vanishing Languages and Cultural Heritage (VLACH).

Table 1: Summary of the examined speech corpus. The column 'Duration' lists overall audio length, potentially including pauses or speech produced by someone other than the examined speaker. Under 'Phones', the number of all segments corresponding to vowel or consonant realisations has been listed for each speaker.

Dialect	Location	Year	Sex	Speaker ID	Duration	Phones
Pindian	Turia	2000/2001	female	WT_1	04:34	2,469
				WT_2	03:12	1,481
			male	MT_1	05:11	2,801
				MT_2	01:58	906
	Kutsufliani	1999	female	WK_1	01:23	595
				WK_2	00:34	315
				WK_3	01:04	582
Farsherot	Andon Poçi	2004/2005	female	WA_1	04:36	2,287
				WA_2	04:13	2,034
				WA_3	00:26	242
			male	MA_1	02:08	1,256
				MA_2	01:30	702
	Gjirokastër	2003	male	MG_1	14:46	6,513
	Stjar	2015	male	MS_1	04:35	2,282

It can be noted that the speech corpus of interest is heavily imbalanced in terms of the sizes of its speaker-specific subcorpora: These range from a number of analysable phone segments of just 315 (for speaker WK_3) up to the other extreme of 6,513 (for speaker MG_1). Further, categories of sex are unequally distributed across the considered geographical locations, with merely two male, but five female speakers being included as representatives of Pindian varieties. In addition, except for Turia and Andon Poçi, any location features speakers of a single sex only. Accounting for these imbalances is a key challenge for the present analysis. Another thing to note is that precise information on the age of speakers is, unfortunately, not available and thus also cannot be reported here. Judging by (subjective) auditory impressions, they all seem to be somewhere between 45 and 75 years old.

The raw recordings of speakers WT_1, MT_2, and MA_2 are characterised by a clearly audible steady noise in the background. In order to ensure that this would not compromise the quality of the acoustic-phonetic analysis, a noise-reduction effect was applied using the open-source audio editing software Audacity [3] with the parameter settings dB=12, sensitivity=6, and bands=3. Moreover, the raw recording of MA_1 was

translation: Thede Kahl; editor: Antonio Fichera; retrieved from www.oeaw.ac.at/VLACH, ID number: rram1234ALV0003a.

3 Audacity® software is copyright © 1999–2021 Audacity Team. Website: https://audacityteam.org/. The name Audacity® is a registered trademark.

affected in a different, quite particular manner, in that it contained sounds of bird chirping within the higher frequency bands. The salience of these sounds was mitigated through a high-pass filter, again in Audacity, relying on the parameter settings Hz=3,400 and (roll-off) dB=48. All remaining speakers' recordings were left unchanged.

2.2 Transcriptions

For all considered Aromanian speech recordings, transcriptions were kindly provided by the authors of the field studies they stem from. The convention of how to denote any particular sound varies slightly across transcriptions. Most importantly, the mid-to-close central vowel phonemes of interest were denoted as either ⟨ă⟩, ⟨ā⟩, ⟨î⟩, ⟨є⟩, or ⟨ε⟩. Notably, a phonemic distinction between /ə/ and /ɨ/ was not reflected orthographically in the vast majority of transcriptions. In just one transcription, featuring speaker WT_2, was such a contrast signalled through the distinctive use of ⟨ă⟩ for /ə/ versus ⟨î⟩ for /ɨ/.

The transcriptions were manually converted into a unified convention, the SAMPA script – a computer-readable alternative to the International Phonetic Alphabet based only on ASCII characters. While doing that, some dialect-specific features were accounted for, e.g., by using different symbols for the phoneme /r/ depending on whether it was pronounced as [r] (more typical in the Pindus region) or rather as somewhere between [ʁ] and [χ] (a distinctive trait of some Farsherot speakers). All instances of mid-to-close central vowels, i.e., of both /ə/ and /ɨ/, were represented by SAMPA's schwa symbol ⟨@⟩ during this initial step.

3. Methods

3.1 Speech Segmentation

WebMAUS, developed by KISLER/REICHEL/SCHIEL (2017), is a tool for automatic temporal alignment of speech recordings with corresponding phonetic transcriptions. It was used, here, in order to acquire preliminary phone-level segmentations of the Aromanian speech recordings of interest based on their SAMPA transcriptions. These preliminary segmentations turned out to be at least somewhat satisfactory, despite WebMAUS not being particularly accommodating of a low-resource language like Aromanian. Yet, it was still necessary to go over each and every resulting segmentation by hand and to correct any encountered mismatching segment boundaries. This process of manual adjustment was performed using the software Praat by BOERSMA (2001), an application specifically designed for purposes of acoustic-phonetic analysis.

3.2 Formant Tracking

Again using Praat, formant frequencies of F1, F2, and F3 were calculated for every vowel segment. Here, this was done by only considering the middle 60 % of each segment interval, thus reducing the potential coarticulatory impact of adjacent segments on the measurement. The parameters *Number of formants*, *Window length*, *Dynamic range*, and *Dot size* were set to 5, 0.025 s, 30 dB, and 1.0 mm, respectively. In line with a recommendation by HEERINGA/JOHNSON/GOOSKENS (2009: 173) for cases when speech of speakers of varying sexes is analysed, the *Maximum formant* parameter was set to a value of 5,250 Hz. All resulting measurements of formant frequency were then converted from Hertz (Hz) to Bark scale, the latter being an established psychoacoustical scale introduced by ZWICKER (1961: 248).

3.3 Properties of Vowels of Interest

Based on the approach outlined above, a dataset of vowel tokens with their corresponding formant frequencies could be obtained. A subdataset containing only realisations of mid-to-close central vowel types, i.e., those of interest here, was then augmented by adding further information on two key properties of the recorded vowels, which were determined by their linguistic context.

3.3.1 Lexical Stress

For each realisation of a vowel of interest, it was determined manually whether it appeared in a stressed or unstressed position within the word containing it. Among unstressed positions, a further distinction was made between syllables that were *pretonic* (immediately preceding the stressed syllable), *posttonic* (immediately succeeding it, or *atonic* (neither). Note that some words in Aromanian, most prominently short forms of pronouns, are clitics. Phonologically, any such word behaves as if it were part of the adjacent host word. Thus, for the present purpose of annotating lexical stress, clitics were also not treated as independent words, but rather as extensions to their host words.

3.3.2 Ideal /ə/–/ɨ/ Distinction

It should be noted that with regard to the postulated vowel types of interest, /ə/ and /ɨ/, the available transcriptions did not convey any distinction between these two orthographically, but rather represented both using the same grapheme (except in the case of speaker WT_2). Yet, in order to be able to meaningfully examine if a hypothetical contrast between these two vowel types also manifests itself in real speech data or not, some *a priori* information on which vowel tokens are assumed to correspond to /ə/ and which, instead, to /ɨ/, is necessary. Therefore, the goal here was to retrieve a reliable mapping of any vowel-of-interest occurrence to either /ə/ or /ɨ/, based on what might be referred to as *ideal Southern Aromanian phonology*: As laid out earlier in Section 1.1.1, common theoretical accounts suggest that only Southern varieties of Aromanian (including Pindian) maintain a phonemic distinction between a mid central and a close central vowel. This motivates applying that underlying theoretical mapping to the speech data at hand. If theory is right about this, then one should expect to be able to confirm such a distinction in spontaneous speech produced by Pindian, but not Farsherot native speakers.

Note that this is why, in the present context, /ə/ and /ɨ/ are not referred to as *vowel phonemes*, at least for now, but instead more generically as *vowel types*, given that their phonemic status is not yet verified, but rather something to be tested. For example, whenever a wording like 'the /ɨ/ realisations by Farsherot speakers' is used hereinafter, it will neither entail that a distinct phoneme /ɨ/ exists for the concerned varieties, nor that the realisations referred to are acoustically resembling a close front unrounded one, i.e., [ɨ]. Such a wording shall only hint at which vowel type those realisations *would* correspond to if classified along the lines of an ideally assumed phonology of the *Southern* varieties.

In order to acquire a theoretical mapping of the kind just described, several scientific as well as literary sources were consulted as potential evidence. Previous work on Aromanian morphophonology provides useful insights into general patterns that allow recognising the presence of either one of the two vowel types of interest: For instance, Κατσανης/Ντινας (1990: 82) show how verb forms with a monosyllabic stem and a nucleus /a/, like /ˈskapə/ (= he/she finishes) consistently reduce this /a/ to /ə/ (and not /ɨ/!) in other inflected forms where the stem is not stressed, e.g., /skəˈpə/ (= he/she finished). To give another example, Schlösser (1985: 39) describes how Aromanian words in which a mid-to-close vowel succeeds a /d͡z/ sound, like /ˈd͡zɨku/ (= I say) sometimes evolved from an ancestral Latin word, e.g., DĪCŌ, via the pattern /di/ > /d͡zɨ/ due to the palatalising effect of the ancestral /i/ sound; in such cases, the Pindian variety of Metsovo that he examined reportedly displayed an /ɨ/ (and not /ə/!) sound.

Reports of synchronic or diachronic morphophonological patterns like these served as valuable hints during the manual classification of vowel-of-interest occurrences in the speech corpus as either /ə/ or /ɨ/. Yet, a substantial number of occurrences could still not be explained through such high-level patterns alone and thus had to be further examined on a lexical basis. For these remaining cases, a sparse collection of glossaries and Aromanian literary texts that employed an orthographic convention reflecting a distinction between /ə/ and /ɨ/ was thoroughly searched for entries and occurrences of word forms associated with the same lexical lemma as any word token from the speech corpus which contained an as yet unspecified vowel of interest. Sources included in this process, in addition to the linguistic works mentioned above, were a comprehensive glossary appended to an anthology of Aromanian folk tales and songs that was compiled by Papahagi (1922: 379–506), a somewhat smaller glossary provided together with a collection of texts of traditional Aromanian songs from Metsovo that was put together by Παδιωτης (1988: 119–153), and a booklet accompanying a rather recently published album of musicalised Aromanian poetry by Νιτσιακος/Λιακος/Σεβιλογλου (2019).

It became evident that one would often find ambiguous or contradicting information within a single source or when comparing multiple sources to each other. To give a few examples: The interrogative adverb /k(ə|ɨ)ˈt͡se/ (= why) is transcribed with a grapheme corresponding to /ɨ/ by Papahagi (1922: 419), but with one corresponding to /ə/ in the remaining sources. Κατσανης/Ντινας (1990: 122) explicitly mention the existence of variants with either vowel type for the prepositions /ˈf(ə|ɨ)rə/ (= without) and /ˈp(ə|ɨ)nə/ (= until). Papahagi (1922) lists the noun /aˈr(ə|ɨ)u/ (= river) with a grapheme for /ɨ/, in line with what was discussed back in Section 1.1.1 about the minimal pairs brought up by Μπεης/Δασουλας (2017: 60). However, Παδιωτης (1988: 143) transcribes the same noun with a grapheme corresponding to /ə/ instead. In all such unclear cases, a classification decision had to be made eventually, sometimes motivated by which variant was used in the majority of sources (e.g., motivating /kəˈt͡se/ and /aˈrɨu/), sometimes by analogies to equivalent or similar words in the related language Daco-Romanian (e.g., motivating /ˈfərə/ and /ˈpɨnə/) or a contact language of Aromanian like Albanian or Greek. But even after careful consideration of the available sources, some of the collected vowels of interest could still not be confidently associated with either of the two types /ə/ and /ɨ/, often because they appeared in words that were quite rare or presumably regionalisms. This was the case for 65 of the total 1,603 vowel-of-interest observations, and they were excluded from the dataset.

3.4 Outlier Removal

Since automatic formant tracking, performed as described in Section 3.2, is prone to some error which can lead to outlier observations, it is advisable to detect and remove such observations in order to acquire a distribution that is more normal and a more accurate estimate of any particular vowel category's acoustic space. Vowel quality is multidimensional in that it is described by the values of at least two formants; in this case, the three formants F1, F2, and F3. By computing the squared Mahalanobis distance (D^2) for each vowel realisation with respect to the distribution of all realisations of the same vowel type produced by the same speaker, a quantitative measure of the degree to which any observation can be considered an outlier was obtained. The decision threshold was set at $D^2 = 7.82$, approximately corresponding to excluding extreme observations that are less than 5 % likely to have been drawn from the true distribution.

3.5 Evaluation Metrics

Overlap between vowel distributions can be measured by computing Pillai scores, as mentioned in Section 1.1.2. Here, this is done for each speaker with respect to the contrast /ə/ versus /ɨ/, relying on three-dimensional formant-frequency distributions (F1, F2, F3). For purposes of comparison, Pillai scores are also calculated for five other vowel contrasts that do not involve vowel types of interest. Based on subdistributions of /ə/ and /ɨ/ only encompassing occurrences in stressed positions, analogous scores are computed, this time either relying on all three formants together or solely depending on a single formant's variation. A potential association between lexical stress and the respective occurrence frequencies of /ə/ and /ɨ/ is assessed using a chi-squared test. In order to acquire an estimate of the broader Aromanian vowel space, samples of vowel realisations pertaining to a specific type were first averaged within and then across speakers, grouped by their categories of dialect and sex.

4. Results

4.1 Overlap Between /ə/ and /ɨ/

Pillai scores for the contrasts between speaker-specific distributions of /ə/ and /ɨ/ are reported in Table 2 in the second rightmost column, alongside averaged values for all four combinations of dialect group and speaker's sex. The very rightmost column 'Rel. (%)' contains the same scores, but given as percentages relative to the average of Pillai scores for the five further vowel contrasts /a/–/e/, /e/–/i/, /i/–/u/, /u/–/o/, and /o/–/a/. Such averages are given in the column labelled 'Mean', and the five preceding columns show Pillai scores for the just mentioned individual contrasts. It is interesting to observe that Farsherot speaker WA3, among all speakers, seemingly displays by far the least overlap between /ə/ and /ɨ/, reflected by the considerably high Pillai score of .730. At the same time, none of the Pindian speakers scored above .258, and the average scores for Farsherot speakers of either sex (.353 for females, .213 for males) are also higher than those for their Pindian counterparts (.205 for females, .135 for males). However, caution is advised before prematurely interpreting this as indicating that, entirely in contradiction to common theoretical classifications, a phonemic contrast /ə/ versus /ɨ/ was actually slightly more relevant in Farsherot rather than Pindian varieties. First, the potentially confounding factor of lexical stress has to be accounted for.

Table 2: Pillai scores, computed for several vowel contrasts in the F1×F2×F3 space. The 'Mean' column contains averages over the five preceding columns. In the 'Rel. (%)' column, any Pillai score for the contrast /ə/ versus /ɨ/ in terms relative to the corresponding 'Mean' value is listed.

Dialect	Speaker	/a/–/e/	/e/–/i/	/i/–/u/	/u/–/o/	/o/–/a/	**Mean**	/ə/–/ɨ/	**Rel. (%)**
Pindian	WT_1	.370	.358	.561	.099	.315	**.341**	.150	**44.1**
	WT_2	.538	.121	.791	.373	.736	**.512**	.252	**49.2**
	WK_1	.329	.234	.771	.151	.414	**.380**	.108	**28.5**
	WK_2	.556	.527	.621	.216	.670	**.518**	.258	**49.9**
	WK_3	.355	.206	.473	.316	.469	**.364**	.258	**71.1**
	MT_1	.281	.116	.396	.199	.350	**.268**	.199	**74.2**
	MT_2	.459	.251	.654	.035	.334	**.347**	.071	**20.5**
Avg. Pindian female		.430	.289	.643	.231	.521	**.423**	.205	**48.5**
Avg. Pindian male		.370	.184	.525	.117	.342	**.307**	.135	**47.4**
Farsherot	WA_1	.720	.137	.678	.281	.548	**.473**	.193	**40.8**
	WA_2	.524	.169	.568	.135	.775	**.434**	.137	**31.6**
	WA_3	.455	.287	.748	.275	.673	**.488**	.730	**149.7**
	MA_1	.489	.146	.739	.145	.298	**.363**	.186	**51.1**
	MA_2	.717	.077	.490	.376	.639	**.460**	.422	**91.7**
	MG_1	.564	.105	.617	.161	.428	**.375**	.059	**15.8**
	MS_1	.516	.207	.744	.193	.564	**.445**	.184	**41.3**
Avg. Farsherot female		.566	.197	.664	.230	.666	**.465**	.353	**74.0**
Avg. Farsherot male		.572	.134	.647	.219	.482	**.411**	.213	**50.0**

A closer look at the distributions of /ə/ and /ɨ/ types in the (notably very short) recording of speech produced by WA_3 is quite instructive: Of the overall only 15 observations of a vowel of interest in her speech, 8 correspond to /ə/ and 7 to /ɨ/. All of the /ɨ/ observations appear in a stressed position and are relatively open and fronted, resembling an [ɛ] sound (F1 between 5.1 and 6.3 Bark; F2 between 12.2 and 14.6 Bark), whereas the /ə/ observations all appear in pre-, post-, or atonic positions and are acoustically rather centred at roughly an [ə] quality (F1 between 4.1 and 5.3 Bark; F2 between 10.5 and 13.8 Bark). This complete association of vowel type and lexical stress in the recording of WA_3, coupled with the apparent inclination towards more open and fronted qualities for stressed realisations explains the unusually high Pillai score of .730

(and even 149.7 % on the relative scale). As is going to be examined more closely below in Section 4.2, speaker WA_3 is just an extreme case (likely caused by the very low number of observations) of a general tendency of Farsherot speakers to opt for an [ɛ] allophone when producing a vowel of interest in a stressed position.

Table 3: Contingency table of vowel type and lexical stress, after outlier removal.

	Atonic	**Pretonic**	**Posttonic**	**Stressed**	Total
Ideally /ə/	101	302	434	203	**1,040**
Ideally /ɨ/	16	40	17	334	**407**

How occurrences of categories of vowel type and lexical stress are not independent of each other across the whole dataset of included observations of vowels of interest is demonstrated by a chi-squared test ($\chi^2 = 498.5$, df = 3, $p < 2.2 \times 10^{-16}$) and can also intuitively be acknowledged by inspecting the corresponding contingency table given as Table 3. Therefore, restricting the computation of Pillai scores exclusively to stressed observations may yield measures that are not influenced by this confounding effect and thus more straightforwardly interpretable. Unfortunately, of the 14 speakers featured in the examined speech corpus, only 9 fulfil the condition of providing at least four stressed observations of each vowel type, which is the minimum required to be able to reliably calculate a Pillai score, here. The speakers who thus cannot be considered during this next analysis step are WK_1, WK_2, WK_3, WA_3, and MA_2. For the remaining speakers, the degree of distinctness between stressed /ə/ and /ɨ/ distributions is quantified by the Pillai scores given in Table 4. Note that, here, the main scores computed based on overlap within the full three-dimensional space spanned by F1, F2, and F3 are reported in the rightmost column. The three preceding columns, instead, show secondary scores resulting from computations where just the one-dimensional space spanned by a single one of the three formants is considered.

Here, the results look very different. Three of the four Pindian speakers, WT_1, WT_2, and MT_1, who were displaying low Pillai scores of .150, .252 and .199 in the prior, stress-agnostic analysis, are now associated with much higher (main) scores of .525, .523, and .593, respectively. Only for Pindian speaker MT_2, the score stayed more or less in place at a very low value, even decreasing slightly from .071 to .039. Among Farsherot speakers, the score noticeably increased only for MA_1 from prior .186 to now .376. It stayed in place for speakers WA_1 (.193 to .198) and MG_1 (.059 to .050), but showed a decrease for speakers WA_2 (.137 to .077) and MS_1 (.184 to .053). On average, the relationship observed previously has been reversed: When only considering stressed vowel tokens, it is not the Farsherot, but the Pindian speakers who display higher Pillai scores, i.e., less overlap between their /ə/ and /ɨ/ distributions, more in line with theoretical expectations. For every included Pindian speaker, the secondary score specific to the F1 formant was maximal compared to its counterparts for F2 and F3. This, again, is consistent with the theoretical assumption of a Pindian contrast between /ə/ and /ɨ/ that acoustically corresponds to [ə] and [ɨ], i.e., two vowel qualities that primarily differ from each other in terms of their openness (F1), but not their frontedness (F2) or unroundedness (F3). Conversely, the already quite low main scores recorded for Farsherot speakers, here, cannot be decomposed into secondary, formant-specific scores that show a general, speaker-independent preference for a single formant as the maximal contributor to distinctness between stressed /ə/ and /ɨ/ distributions.

Table 4: Pillai scores for the contrast /ə/ versus /ɨ/, but only among occurrences in stressed positions. Column names indicate which formants dimensions were considered. In each row, the maximum value among scores for 'F1', 'F2', and 'F3' is underlined.

Dialect	Speaker	F1	F2	F3	**F1×F2×F3**
Pindian	WT_1	<u>.505</u>	.152	.031	**.525**
	WT_2	<u>.411</u>	.146	.081	**.523**
	MT_1	<u>.594</u>	.221	.104	**.593**
	MT_2	<u>.089</u>	.085	.084	**.039**
Avg. Pindian female		<u>.458</u>	.149	.056	**.524**
Avg. Pindian male		<u>.342</u>	.153	.094	**.316**
Farsherot	WA_1	<u>.180</u>	.060	.166	**.198**
	WA_2	.060	.041	<u>.081</u>	**.077**
	MA_1	.087	.041	<u>.129</u>	**.376**
	MG_1	.019	<u>.025</u>	.015	**.050**
	MS_1	.014	<u>.063</u>	.014	**.053**
Avg. Farsherot female		.120	.051	<u>.123</u>	**.138**
Avg. Farsherot male		.040	.043	<u>.053</u>	**.159**

4.2 Estimated Vowel Space

Until now, the focus has been on determining the degree of overlap between distributions of /ə/ and /ɨ/. It would also be insightful to get an impression of where their means are located within the broader Aromanian vowel space, including the remaining five vowel types. The plots in Figure 1 aim at visualising this. They were acquired by first averaging over vowel samples of individual speakers, and then further averaging the obtained speaker-specific means. This process was repeated four times, each time with regard to a different group of speakers sharing the same dialect and sex. Motivated by what was discussed in the previous Section 4.1 about the special characteristics of stressed distributions of the vowels of interest, locations of stressed-only /ə/ and /ɨ/ types were also estimated and plotted. This is the reason why, here, not all 14 speakers, but again only the 9 speakers displaying enough stressed observations of either vowel type of interest (listed in Table 4) are included.

One can observe a clear pattern that differentiates the Pindian from the Farsherot vowel spaces: For Pindian speakers, the average location of vowel tokens classified as /ɨ/ lies visually somewhat above (i.e., lower F1) the one of /ə/. In contrast to that, for Farsherot speakers, the vowel tokens labelled /ɨ/ appear to be typically distributed a bit below and to the left of (i.e., slightly higher F1 and higher F2) their /ə/ counterparts. This seems to be related what has been observed regarding speaker WA_3 back in Section 4.1: Tokens of /ɨ/ are substantially more likely to appear in stressed positions; such positions are, in turn, often associated with higher F1 and F2 frequencies, among

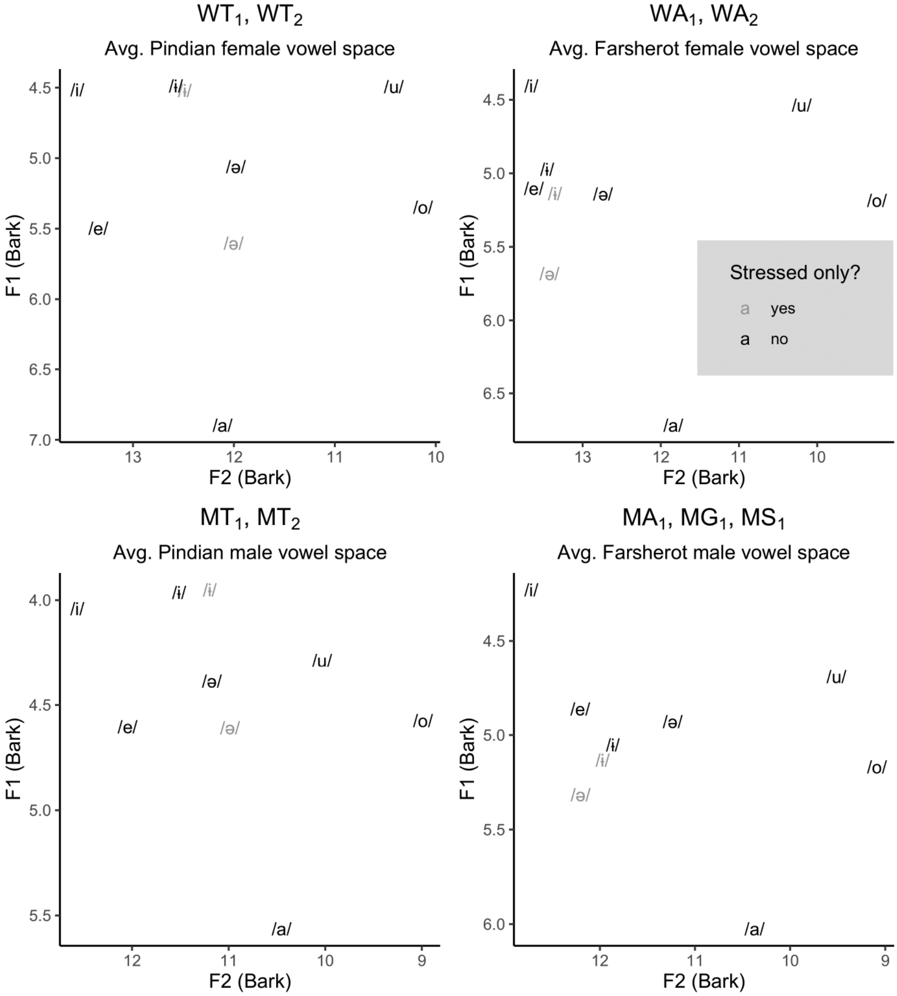

Figure 1: Plots displaying average locations of each vowel type on the F1×F2 plane, grouped by speakers' dialect and sex. Labels above each plot indicate which speakers were considered. Averages have been computed over the means of speaker-specific vowel distributions, so each speaker is given equal weight within any particular plot. Exclusively for the vowel types /ə/ and /ɨ/, mean points of distributions only encompassing occurrences in stressed positions have additionally been plotted in green.

Farsherot speakers like her. Further, this dialect group displays general means of both /ə/ and /ɨ/ (which are likely not phonologically distinct in that group anyway, according to theory) that lie in quite close proximity to the one of the further vowel type /e/, around an acoustic quality approaching [e] or [ɛ]. Finally, as far as the included Pindian speakers from Turia are concerned, for both females and males, the visualisation of group-specific average locations of vowel types displays a general mean of /ə/ above (i.e., lower F1) the corresponding mean for stressed-only /ə/, while the mean of /ɨ/ stays more or less in place regardless of whether all or just stressed tokens are considered. This is consistent with the conclusions drawn from the Pillai measurements collected in Section 4.1, which showed that a Pindian contrast /ə/ versus /ɨ/ becomes more pronounced (and actually relevant at all) only once comparing stressed-only distributions.

5. Discussion

These results indicate that the assumption of a typical /ə/–/ɨ/ distinction can acoustically be confirmed only for distributions of vowels that occur exclusively in stressed positions and were produced by an average Pindian speaker (from Turia). When including unstressed vowels in the analysis as well, all examined distribution pairs show considerable overlap. This finding is consistent with the CARAGIU MARIOȚEANU's (1968: 32) view that the unstressed Aromanian vowel system of both Farsherot and non-Farsherot (e.g., Pindian) speakers would not distinguish between /ə/ and /ɨ/, but incompatible with ΚΑΤΣΑΝΗΣ/ΝΤΙΝΑΣ's (1990: 30) assertion that Southern varieties would distinguish two such phonemes even in the unstressed vowel system. It still remains unclear, though, if the acoustically detected contrast [ə] versus [ɨ], among stressed vowel distributions produced by Pindian speakers, also translates into a phonemic one, /ə/ versus /ɨ/, or is just marking allophonic variation of a single phoneme as SCHLÖSSER (1985: 28–29) would suggest. To come to a firm conclusion, it would make sense to examine the minimal pairs proposed by CARAGIU MARIOȚEANU (1968: 25) and ΜΠΕΗΣ/ΔΑΣΟΥΛΑΣ (2017: 60) more closely. Ideally, good minimal pairs should be consistently valid throughout a large number of Southern varieties and also reflect this through common orthographic conventions (which was not the case for /aˈrəu/–/aˈrɨu/; see Section 3.3.2).

Regarding the examined Farsherot speakers, their occasional tendency to produce rather fronted allophonic variants of a unitary phoneme /ə/$_{\text{single}}$ can be confirmed, in line with what is suggested by CAPIDAN (1932: 206) and CARAGIU MARIOȚEANU (1968: 30). However, in contrast to CARAGIU MARIOȚEANU's (ibid.) claim that such variants occur equally among stressed and unstressed positions, yet more often in female speakers, the present results indicate that actually stressed positions in particular are more inclined towards fronting /ə/$_{\text{single}}$ into a quality around [ɛ], while this concerns speakers of either sex to roughly the same extent.

In any case, claims drawn from the present findings should initially be restricted to the specific places of origins of the speaker groups examined (Turia, Kutsufliani, Andon Poçi, Gjirokastër, Stjar) and not readily generalised to broader dialectal types and regions. The high degree of local variation across the often geographically isolated fragments of the Aromanian dialect spectrum is made evident by the comprehensive Aromanian language atlases published by SARAMANDU (2014) and SARAMANDU/NEVACI (2020). Even concerning three of the locations examined here, it is recorded, for instance, that (Farsherot) Andon Poçi's [ˈlimbə] corresponds to (Pindian) Turia's [ˈlimbɨ], yet to (also Pindian) Kutsufliani's [ˈlimbə] (all meaning 'language/tongue'; SARAMANDU 2014: 195). For other words, though, Turia and Kutsufliani seem to be more consistent with respect to each other (e.g., Andon Poçi: [ˈmɛnə], [kəˈlivə] versus Turia/Kutsufliani: [ˈmɨnɨ], [kɨˈlivɨ]; respectively meaning ‘hand’ and ‘hut’; SARAMANDU 2014: 275, SARAMANDU/NEVACI 2020: 294).

A methodological challenge that the present study faced was the heavy imbalance of the examined corpus of spontaneous speech. Due to the sparsity of data, five speakers were included only in the general, stress-agnostic comparisons of vowel distributions, but not in the subsequent analyses that were exclusively targeting stressed distributions. Unfortunately, among those five speakers one can find all three available speakers from Kutsufliani, thus rendering it impossible (or speculative at best) to apply the same conclusions to them regarding the impact of lexical stress which were drawn based on speech from Turia. Future work may attempt to replicate a similar acoustic-phonetic corpus study based on a dataset that is more balanced and preferably also more homogeneous in terms of properties like year of recording, speaker age, interview modality, and audio quality.

Data Availability Statement

The obtained dataset containing formant frequencies and additional information on vowel realisations produced by Aromanian native speakers from Kutsufliani, Turia, Andon Poçi, Gjirokastër, and Stjar can be accessed here: https://github.com/MixalhsB/aromanian-vowels.

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