ON THE SINGER'S FORMANT IN LITHUANIAN TRADITIONAL SINGING

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ABSTRACT

While the singer's formant is in fact obligatory for the unamplified male operatic voice – to be heard in the context of the whole orchestra, the question of this voice quality in other vocal techniques remains open. The present pilot study aims to analyze possible manifestations of the singer's formant in Lithuanian traditional singing and to review techniques of evaluation of the singer's formant.

Two examples of traditional singing (recordings of vocal performances) are chosen for the analysis; a male hay making song and a female rye harvesting song. Both examples represent so-called 'field' genres performed outdoors and characterized by of esonant and loud voices; thus appearance of the singer's formant is more likely compared to 'indoor' genres. A set of parameters proposed in previous studies and indicating presence of the singer's formant is applied; singing power ratio (SPR), energy ratio (ER), L3–L1, and level of the singer's formant (L_{SF}). Although reliability of the parameters is to some extent disputable, the intense spectral bands characteristic for the singer's formant are detected. The singer's formant in both examined performances (especially in the female example) is less prominent compared to the case of the male operatic voice.

1. INTRODUCTION

The singer's formant, a specific formant occurring at approximately 2 kHz – 4 kHz frequencies, is widely discussed, starting from the seminal studies published several decades ago (cf. Sundberg, 1970; 1972; 1973; 1974; Dmitriev & Kiselev 1979; Shutte & Miller, 1985) and continuing up to the present (cf. Sundberg, 1995; Millhouse, Clermont & Davis, 2002; Ferguson et al., 2006; Reid et al., 2007). Presence of the singer's formant is considered in fact an obligatory requirement for operatic male voices. In addition, more recent studies found possible manifestations of the singer's formant in operatic female or castrato voices as well, though to a lesser extent (cf. Sundberg, 2007; Lee et al., 2008). Several techniques were proposed for evaluating intensity of the singer's formant and for differentiation of the true formant from other phenomena responsible for some intensification of spectra in the 2 kHz – 4 kHz range (Frøkjaer-Jensen & Prytz, 1976; Omori et al., 1996; Sundberg, 2001; Kenny & Mitchell, 2006; Ternström, Bohman, & Sodersten, 2006; Watts et al., 2006).

This peculiar voice quality is important, first of all, for large acoustical spaces without artificial sound reinforcement. Most probably, it is not that urgent for smaller chambers and for contemporary environments with sound reinforcement. Also it is not clear whether the singer's formant is relevant for other than operatic (or academic) vocal styles. For instance, traditional and generally non-Western singing is barely studied in terms of the singer's formant (cf. Sengupta, 1990; Delviniotis, 1998; Kovačić, Boersma, & Domitrović, 2003; Joshi & Raju, 2016). One could expect that, at least for certain acoustical conditions and certain styles of traditional singing, the technique that is normally applied to operatic singing could be applied as well.

2. TWO EXAMPLES OF VOCAL PERFORMANCES

Various cases of vocal performances with or without the singer's formant may be found in Lithuanian vocal tradition. It seems that the singer's formant could be investigated, first of all, in songs performed outdoors, the 'field song genres' characterized by resonant voices required for communication between (usually) quite distant groups of singers. Among these genres, rye harvesting and hay making songs are the most popular and the largest in number. For instance, according to the catalogue of Lithuanian folk songs (Misevičienė, 1972), rye harvesting and hay making songs contain, correspondingly, 348 and 152 variants of lyrics whereas the numbers for oat harvesting, buckwheat pulling, and flax and cannabis harvesting are, correspondingly, 25, 6, and 93.

Two typical traditional song performances belonging to the discussed quality of performance are chosen for the investigation. The first one, a hay making song (see the transcription in Figure 1), comes from Aukštaitija (Northeastern Lithuania). Hay making songs of this particular type (*valiavimai*) were usually performed by male singers-haymakers. The examined example is a recorded performance of 4 male singers; one of them presents the leading part and the others add the lower part (actually some women's voices are also heard in the background, yet they are very faint and their impact on the results of acoustical measurements is expected to be negligible). Thus the analysis would lead to certain

averaging of effects of the singer's formant, possibly somewhat different for individual singers. The second song, a rye harvesting song (see the transcription in Figure 2) comes from Dzūkija (Southeastern Lithuania). Rye harvesting was women's work and, naturally, songs of this type were performed by female singers. The chosen recording contains antiphonal performance of three women, i.e. they sing in succession, one after another, verse after verse. Thus they imitate the situation of communication of singers standing at a certain distance one from another. The performance of one singer, Ona Jauneikienė (2nd, 5th,.. verses), is chosen for the analysis as her voice seems to be the most resonant.

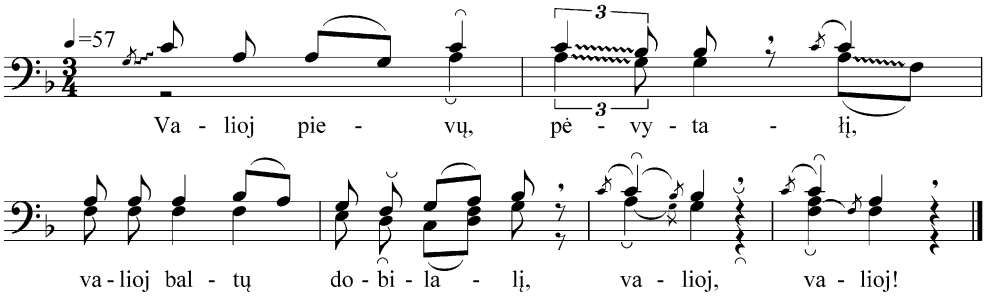

Figure 1. Transcription of the first verse of the song *Valioj pievų, pėvytalį* (Puponiai singers, Kupiškis Dst. Recording: Četkauskaitė, 1998, N18).

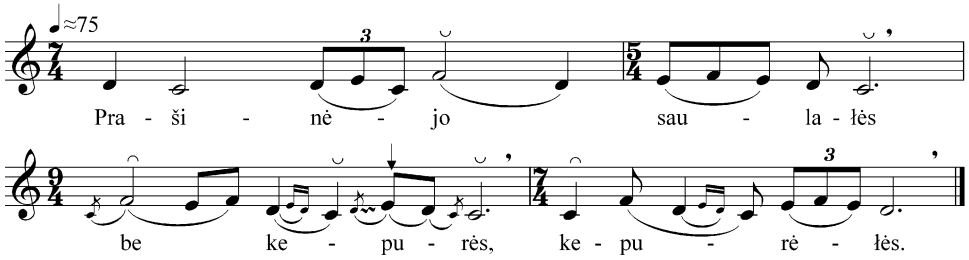

Figure 2. Transcription of the second verse of the song *Vaikštinėjo tėvulis* (Ona Jauneikienė; Masališkės, Varėna Dst. Recording: Četkauskaitė, 1995, N14).

3. METHODS

Praat software is applied for the acoustical measurements, composing of smoothed spectra, and calculations of different parameters. Five techniques of evaluation of the singer's formant are employed:

- **Initial evaluation**. The peak corresponding to frequency of the singer's formant (F_S) in the region around 3 kHz is visually evaluated and the frequency band around this peak (from the preceding dip to the corresponding, roughly symmetrical frequency) is manually selected. The ratio between the energy of the band and the total energy of the spectrum is calculated.
- The **singing power ratio (SPR)** "is calculated by measuring the ratio of the peak intensities between the 2–4-kHz and 0–2-kHz frequency bands in the context of sustained vowels or vocalic segments in sung/spoken samples" (Watts et al., 2006).
- **Energy Ratio (ER)** is a ratio between the total energy in the 0–2 kHz and 2–4 kHz bands (Kenny & Mitchell, 2006).
- **L3–L1**. It is the difference between the levels of the third and the first formant (applied by Sundberg, 2001).
- **Level of the singer's formant (L_{SF})**. It is the difference between observed and expected L3–L1 values. The measure of L_{SF} takes into account the effect of different vowels, i.e. the influence of formant frequencies on formants levels (Sundberg, 2001).

For the visual evaluation of a singer's formant, LTAS spectra are also composed, in the manner used in various studies noted above. Time spans of 20–30 seconds are considered, as in Sundberg, 2001.

4. RESULTS AND DISCUSSION

Melostrophes 1–4 (33 occurrences) of the male song *Valioj pievų, pėvytalį* and melostrophes 2, 5, 8, and 11 (30 occurrences) of the female song *Vaikštinėjo tėvulis* were considered. The results are presented in Figures 3–8 and in Tables 1–2.

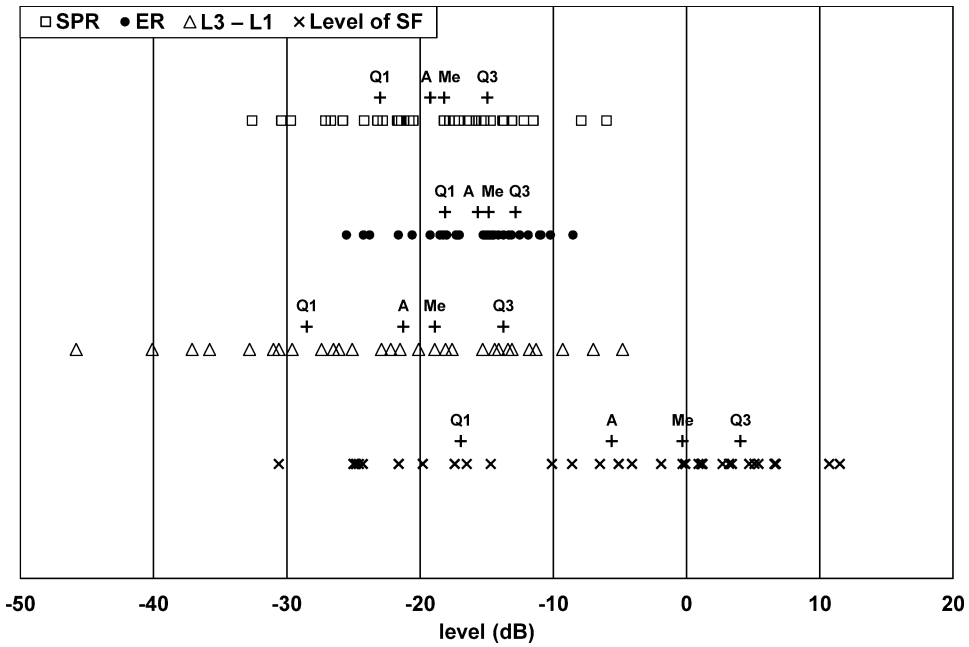

Figure 3. Values of four parameters for evaluation of a possible singer's formant; the male song *Valioj pievų, pėvytalį*. Averages, medians, and interquartiles (A, Me, Q1–Q3) are marked.

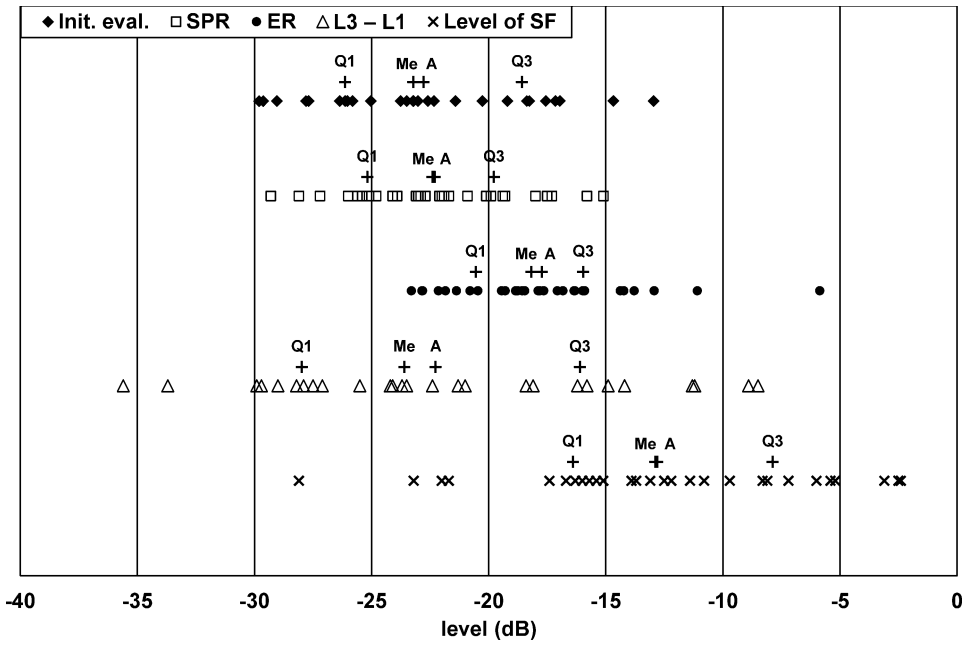

Figure 4. Values of five parameters for evaluation of a possible singer's formant; the female song *Vaikštinėjo tėvulis*. Averages, medians, and interquartiles (A, Me, Q1–Q3) are marked.

	SPR	**ER**	**L3–L1**
L_{SF}	.663	.719	.909
L3–L1	.821	.883	
ER	.935		

Table 1. Correlation between the parameters; male song *Valioj pievų, pėvytalį*.

	Init. eval.	**SPR**	**ER**	**L3–L1**
L_{SF}	.368	.288	.280	.815
L3–L1	.619	.484	.617	
ER	.856	.783		
SPR	.699			

Table 2. Correlation between the parameters; female song *Vaikštinėjo tėvulis*.

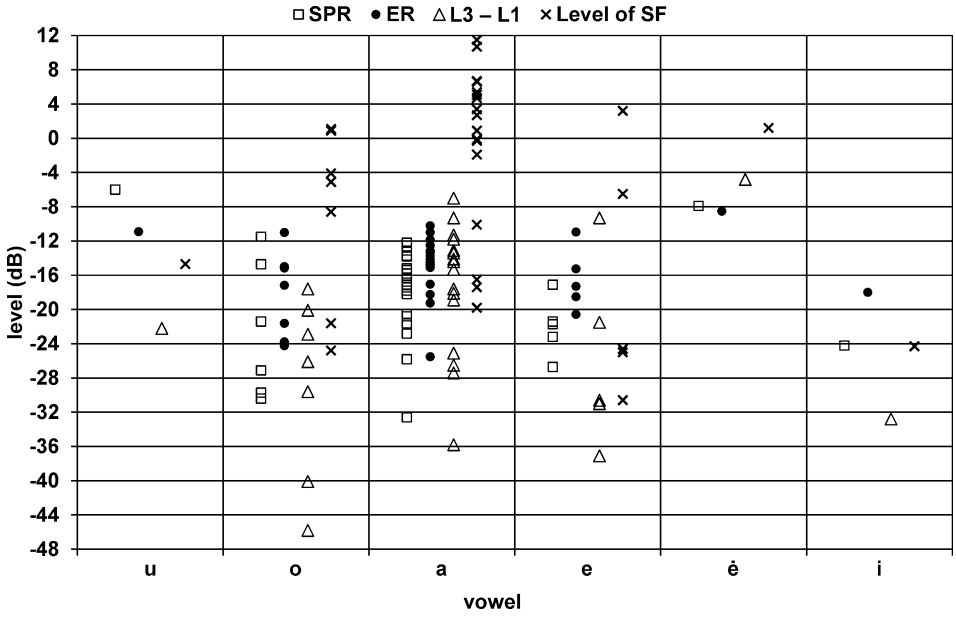

Figure 5. The same as in Figure 3. Occurrences of different vowels are grouped.

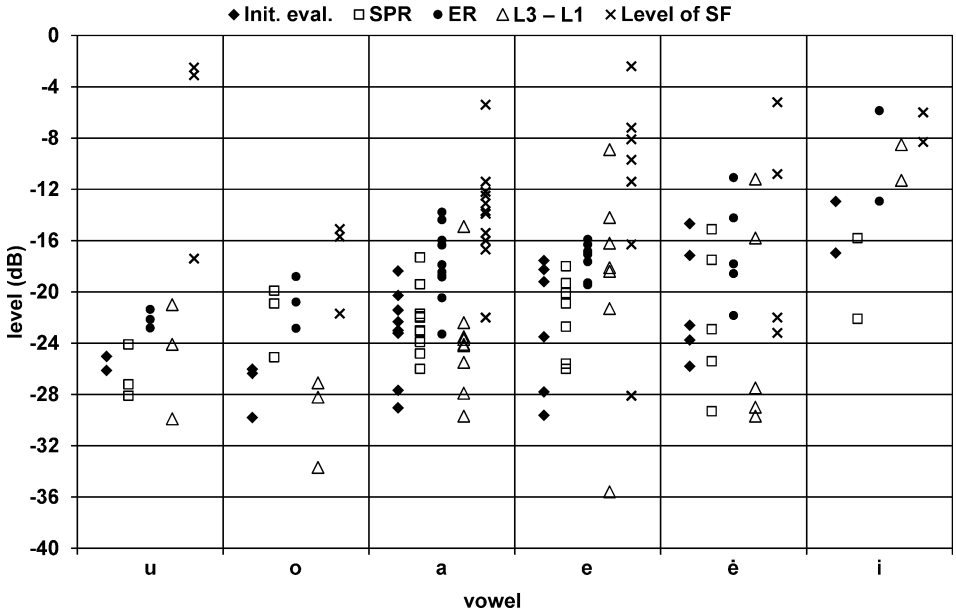

Figure 6. The same as in Figure 4. Occurrences of different vowels are grouped.

The obtained results show more or less prominent intensification of the spectra in the 2–4 kHz range. As expected, this quality is more distinct in the case of the male voice. Incidentally, the female example is characterized by two spectral peaks (Figure 8). The same tendency was observed by Seidner et al. (1985); they found that for female singers, two peaks can occur at frequency ranges of 2.5–3 kHz and 3–4 kHz.

Aural impression suggests that both examples are characteristic of resonant voices and possibly F_S is responsible for this. The problem is that there are no clear and undisputed referential values showing presence or absence of the singer's formant; the techniques for evaluation of the singer's formant proposed in the discussed previous studies and their results are quite ambiguous or even contradictory. For instance, Omori et al., 1996, presented the following values of SPR: roughly –14 dB for professional vocalists with S_F and roughly –23 dB for non-vocalists without S_F (the numbers were somewhat larger for males and smaller for females), while the evaluations by Watts et al., 2006, were, respectively, –23 dB and –31 dB. Kenny & Mitchell (2006) examined singing of advanced vocal students and found that their SPR ranged from –33 to –11 dB (–19,7 dB, on the average)

and ER ranged from –29 to –9 dB (–16,8 dB, on the average). However, their subjects were sopranos and mezzo-sopranos, thus naturally the values tend to be lower. Sundberg (2001) found L3–L1 ranging from –19 to –8, for basses and baritones, and proposed $L_{SF} > 0$ condition for quantification of presence of the singer's formant. Yet he did not recommend the use of this parameter for sopranos. L_{SF} technique proposed by Sundberg is not sufficiently reliable since it is also dependent on other factors, such as vocal volume (Sundberg, 2001) and chosen theoretical bandwidths of formants (Millhouse et al., 2002). This may be the reason this technique was avoided in later studies by other authors. Obviously, differences of F1 and F2 for various vowels can influence the results as well.

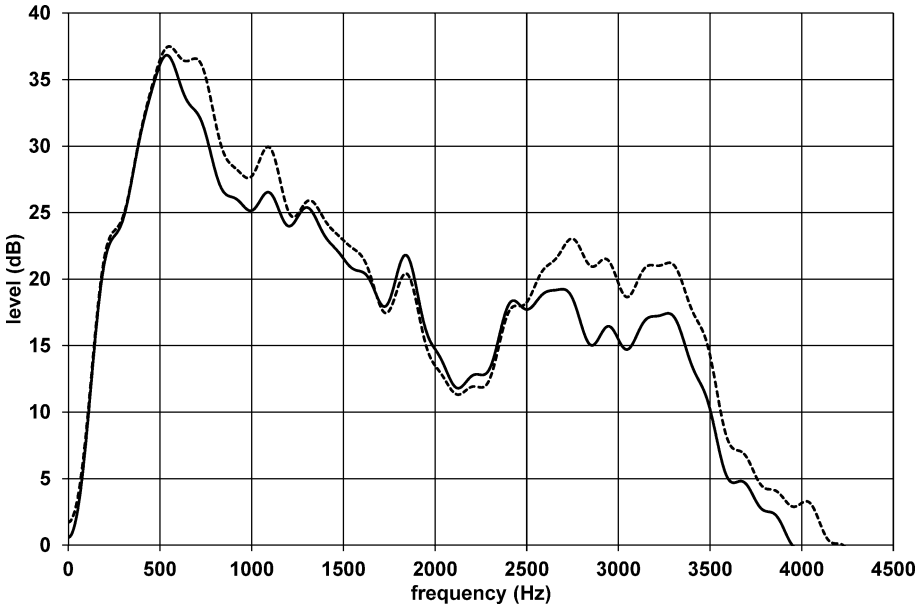

Figure 7. Smoothed LTAS spectrum; the male song *Valioj pievų, pėvytalį*, melostrophes 2 and 4.

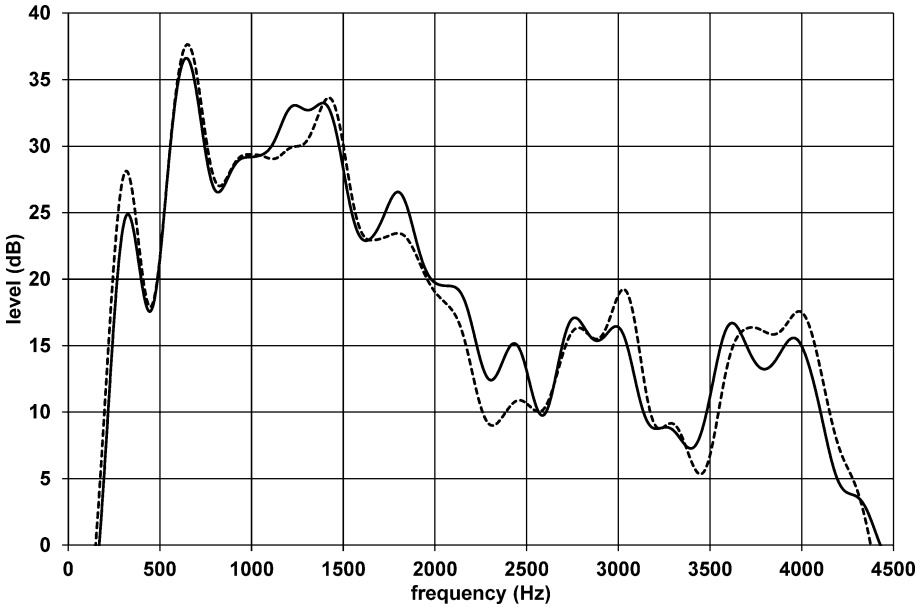

Figure 8. Smoothed LTAS spectrum; the female song *Vaikštinėjo tėvulis*, melostrophes 2 and 5.

Female singing (Figure 6) shows quite prominent differences of the parameter values for different vowels whereas the differences are not that clear for male singing (Figure 5). This might be attributed to the differences of male and female voices but, most probably, the differences of vocal dialects are at work: Aukštaičiai singing is characteristic of stronger voice 'covering', i.e., the vowels

tend to be acoustically more similar (Ambrazevičius, 2001).

The present study is, in part, oriented towards evaluation and comparison of several techniques for detection of the singer's formant. Correlations of SPR, ER ir L3–L1 (Tables 1 and 2) show that these parameters estimate the examined occurrences quite similarly; they also correspond to the initial evaluations fairly well.

At any rate, intensification of the spectra in the discussed frequency range found for the examined vocal performances suggests that discussed vocal quality is somewhat specific and partly marks a certain quality of the resonant voice.

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