Yodelling - acoustic and physiologic properties

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Introduction

Yodelling is sustained phonation with nonsensical combinations of vowels and consonants. It is characterized by drastic timbral changes, caused by (a) abrupt changes of laryngeal mechanism (chest vs. falsetto registers); and (b) typical choice of vowels. The register transitions coincide with relatively large intervallic leaps.

The goal of this study was to better understand physiologic and acoustic properties of yodelling. In particular, the relationship between voice source characteristics and the vocal tract was

Methods

Three yodellers (two females, one male) were examined by means of flexible video-endoscopy, electroglottography and recording of acoustic data. Formant frequency estimation was performed manually with the aid of the Voce Vista software by visually interpolating the levels of the strongest harmonics of the spectrum.

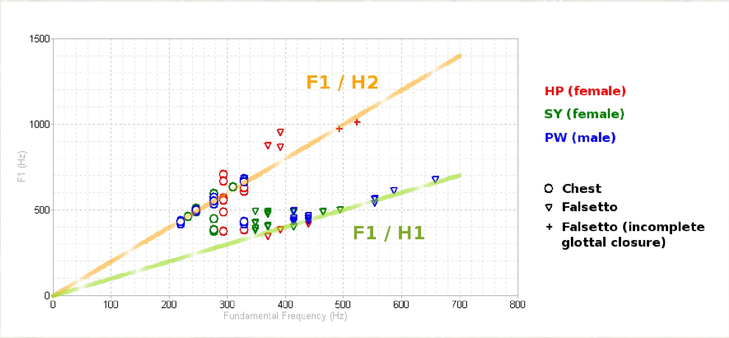

Figure 1: estimated first formant freqencies as a function of fundamental frequency for all subjects and all phonations. The green and orange lines indicate the ideal combinations for F1/H1 and F1/H2 tuning, respectively.

Results

The fundamenal frequency was balanced around the subjects' register transition (chest/falsetto), which was found to be at ca. 340 Hz in all subjects (figure 1). Changes in fundamental frequency that coincided with register changes were in the range of 3 to 10 semi-tones. Analyzed yodel excerpts had an average of 1.4 (HP), 2 (PW) and 5.3 (SY) notes per second, respectively. Subject SY achieved a remarkable maximum of 5 registration events (changes from falsetto to chest or vice-versa) per second.

Subjects SY and PW tended to use more uniform vowels (F1 below 700 Hz), whereas HP showed more variety in vowel choice (figure 2). For most notes sung in falsetto register, the first formant was found to be in the vicinity of the first harmonic (F1/H1 tuning). A similar, but less obvious tendency was found for chest voice and F1/H2 tuning (figure 2). Again, subject HP's data did not always fit this trend.

Analysis of electroglottographic data showed distinct and consistent vocal fold vibratory characteristics for chest and falsetto phonation in all subjects (table 1). However, for subject HP two types of EGG waveforms where found for falsetto phonation: One with apparent vocal fold closure, and one with a very weak EGG signal amplitude and a quasi-sinusoidal EGG waveform, suggesting incomplete vocal fold closure. This finding could not be corroborated by video-laryngoscopic data, since the posterior part of the glottis was hidden.

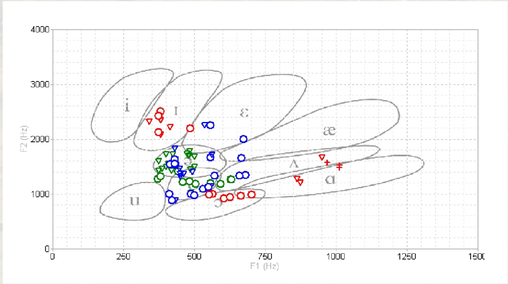

Figure 2: estimated first and second formant frequencies for all subjects and all phonations (for a legende see figure 1). Baseline vowel data after Peterson & Barney, 1952.

Discussion / Conclusions

The analyzed yodellers showed a clear tendency for F1/H2 tuning in chest voice and F1/H1 tuning in falsetto. In the middle octave (C4 to C5), more open vowels (higher F1) were used for chest as compared to falsetto, which was sung with closed vowels (low F1). It appeared that subjects were more accurate in tuning F1 in the notes sung in falsetto register, as compared to those sung in chest. This might be explained by the fact that the voice source is far stronger in chest, generally dominating the resonator (vocal tract). The falsetto voice source is considerably weaker, and phonation can even fail when not supported by F1/H1 tuning.

In an informal evaluation, subject HP was judged to be the least accomplished and most naïve yodeller as compared to the other subjects. This might explain why HP's data did not fit the general trends. In this context it is worthwhile to consider that the criteria for "good" yodelling are not yet well established. We might speculate that the accomplished yodeller is able to employ consistent formant tuning strategies.

This study presents preliminary data and is limited in both the degree of accuracy in formant estimation and the number of studied subjects/yodelling excerpts. Nevertheless, the data gathered seems to support the general hypothesis that the default model of yodelling is considered to entail a rapid alternation between an open (higher F1) vowel in chest and a close (lower F1) vowel in falsetto.

Subject	Chest	Falsetto
HP	60 - 70 %	35 - 45 % [1]
SY	60 - 65 %	25 - 30 %
PW	55 - 60 %	20 - 30 %

Table 1: EGG contact quotiens for all phonation types and all subjects. [1] Subject HP apparently had two types of glottal configurations in falsetto mode (see text). The data provided in this table relates to the falsetto phonation with vocal fold closure.

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