An acoustic analysis of the cattle call "kulning", performed outdoors at Säter, Dalarna, Sweden

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Abstract
This paper summarizes recent research on 'kulning', a surprisingly understudied Swedish cattle call singing style. In a previous study (Eklund, McAllister & Pehrson, 2013), we compared kulning and head voice ('falsetto') as recorded in a normal room and in an anechoic chamber. This paper reports from an analysis of the same "kulning" song recorded outdoors on location in Säter, Dalarna (Sweden), close to the singer's home, which makes the data more ecologically valid and allows comparisons between "clean" indoor recordings and more authentic outdoor recordings. Several recordings were made, but the present article analyses recordings made simultaneously at 1 meter and 11 meters from the singer. Results indicate that for the vowels [a] and [ɨ̟] partials in kulning, as compared to head voice, are visible at both higher frequencies and at a longer distance, which provides an acoustic rationale for the development of the singing style, intended to be heard at a long distance.

Introduction

The Swedish cattle call singing style 'kulning' is surprisingly understudied, despite its almost mythical status in Swedish folklore. Throughout history, long-distance calls have been created at several different locations where there has been a need of making oneself heard over long distances. Kulning is the most common term for a specific type of cattle or herding calls used mainly in the provinces Dalarna, Härjedalen and Jämtland (all in Sweden) and is used to call cows or goats when it is time to be milked. In Eklund, McAllister & Pehrson (2013) we compared kulning and head voice recorded in a normal room and in an anechoic chamber.

The present paper summarizes results in two recent publications (Eklund & McAllister, 2015a, 20015b) where the vowels [*a*] and [ɨ̟] were recorded in an outdoors setting in Säter (Dalarna, Sweden), close to the singer's home, yielding more ecologically valid data. The data consisted of simultaneous recordings at two distances from the singer, 1 and 11 meters.

For an account of previous research, the reader is referred to Eklund and McAllister (2015a, 2015b).

Data collection and method

The singer (FP) – the same singer as in Eklund, McAllister & Pehrson, 2013 – is educated in kulning at Musikkonservatoriet in Falun and Malungs Folkhögskola, and by Agneta Stolpe and Ann-Sofi Nilsson. Data consisted of FP singing the same cattle call as in our previous study and was recorded in both kulning and head voice (sometimes incorrectly referred to as "falsetto") modes. The present study is based on simultaneous recordings made at 1 and 11 meters from the singer, using the same kind of equipment. All recordings were made on 7 September 2013, on location in Säter, Dalarna in Sweden, close to where the singer grew up. The microphones used in this study were two Shure Pro Beta 58A that independently fed into two high-definition Canon HG-10 video cameras. Air humidity at the time of recording was around 70%, the temperature was around 21 degrees Celsius while wind speed was around 10 km/h (data from http://freemeteo.com). All data were resampled to 44.1 kHz, 16 bit, mono, using TMPGEnc 4.0 XPress. Acoustic analyses were carried out using Cool Edit Pro 2.0, Cool Edit 2000, WaveSurfer 1.8.8p4 and Praat 5.3.84.

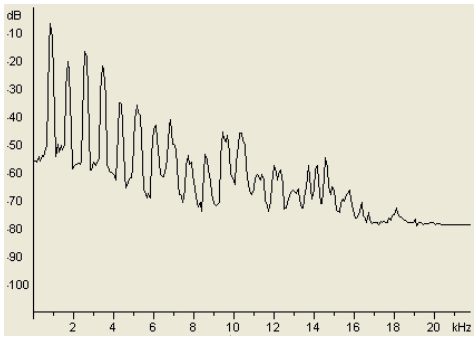

Figure 1a: Kulning [a] at 1 meter. LTAS/FFT/Hamming analysis.

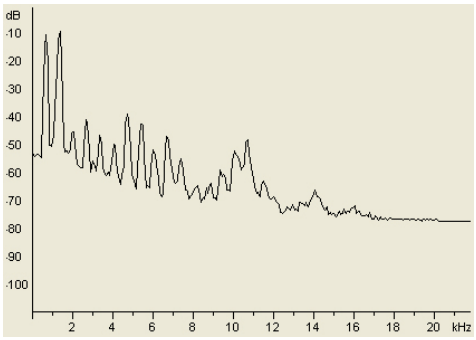

Figure 1b: Head voice [a] at 1 meter. LTAS/FFT/Hamming analysis.

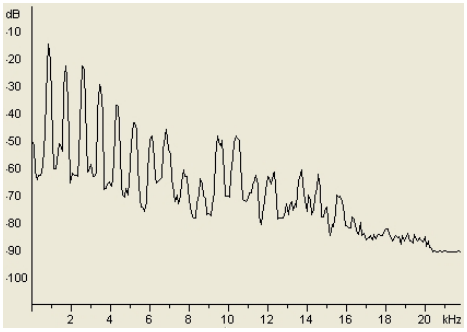

Figure 2a: Kulning [a] at 11 meters. LTAS/FFT/Hamming analysis.

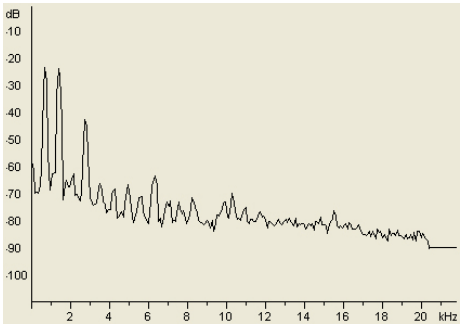

Figure 2b: Head voice [a] at 11 meters. LTAS/FFT/Hamming analysis.

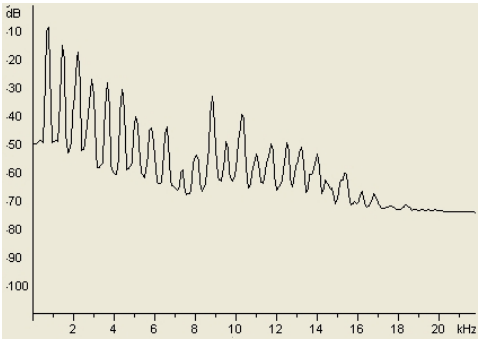

Figure 3a: Kulning [ɥ̟] at 1 meter. LTAS/FFT/Hamming analysis.

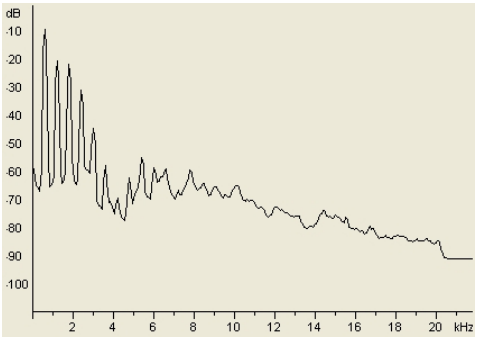

Figure 3b: Head voice [ɥ̟] at 1 meter. LTAS/FFT/Hamming analysis.

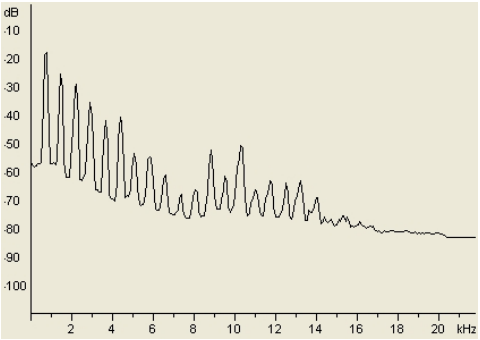

Figure 4a: Kulning [ɥ̟] at 11 meters. LTAS/FFT/Hamming analysis.

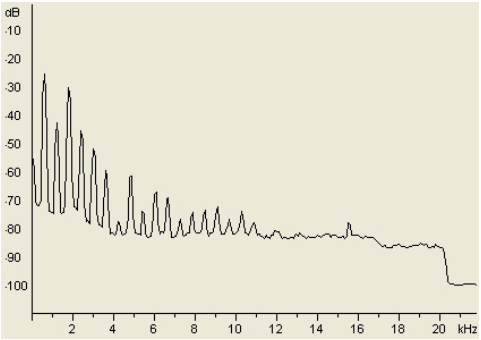

Figure 4b: Head voice [ɥ̟] at 11 meters. LTAS/FFT/Hamming analysis.

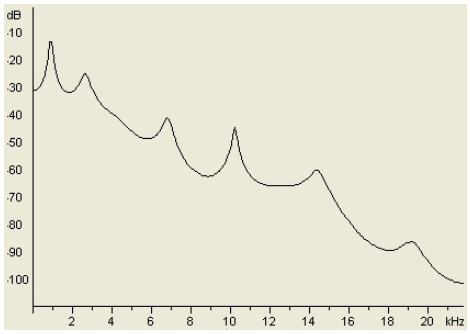

Figure 5a: Kulning [a] at 1 meter. LTAS/LPC/Hamming analysis.

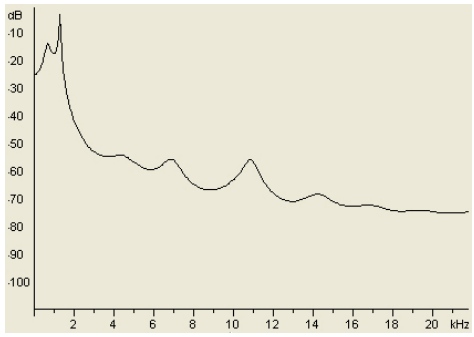

Figure 5b: Head voice [a] at 1 meter. LTAS/LPC/Hamming analysis.

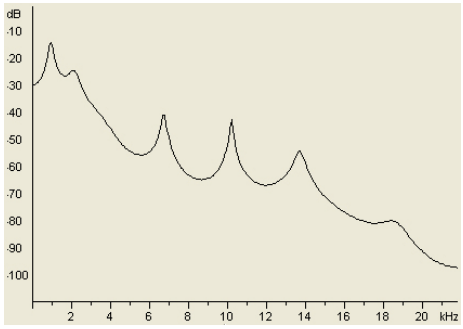

Figure 6a: Kulning [a] at 11 meters. LTAS/LPC/Hamming analysis.

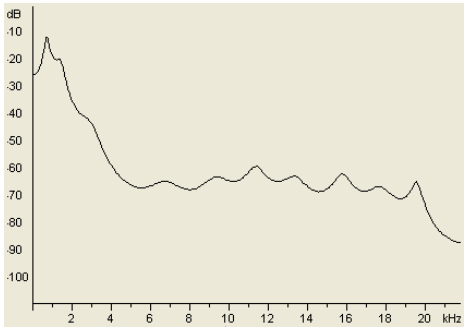

Figure 6b: Head voice [a] at 11 meters. LTAS/LPC/Hamming analysis.

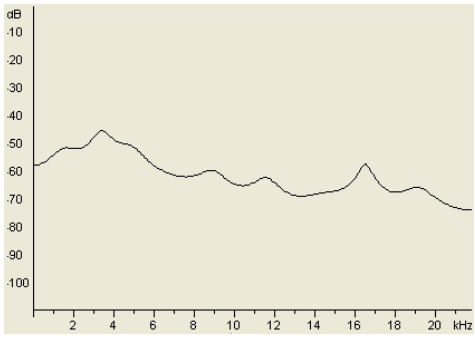

Figure 7a: Kulning [ʉ̟] at 1 meter. LTAS/LPC/Hamming analysis.

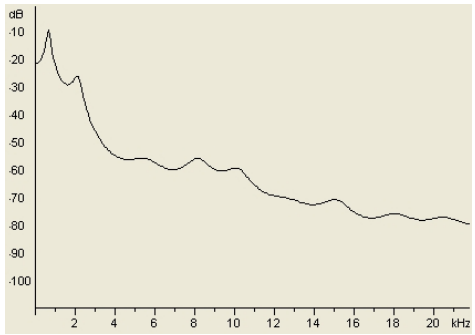

Figure 7b: Head voice [ʉ̟] at 1 meter. LTAS/LPC/Hamming analysis.

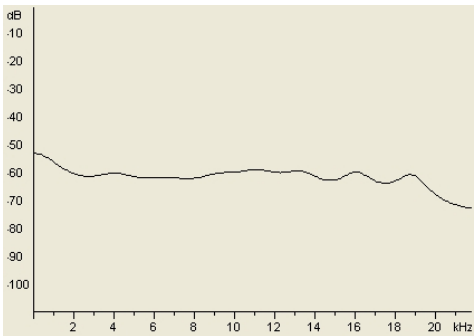

Figure 8a: Kulning [ʉ̟] at 11 meters. LTAS/LPC/Hamming analysis.

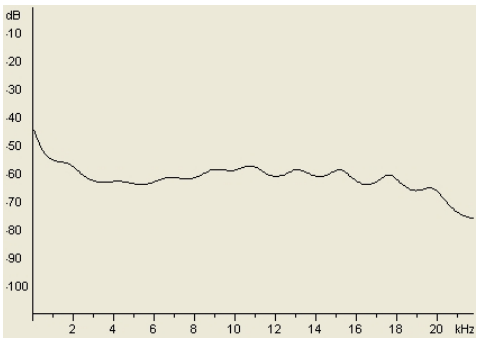

Figure 8b: Head voice [ʉ̟] at 11 meters. LTAS/LPC/Hamming analysis.

Results

Analysis material

In order to match the data in our previous study, we analysed the vowels [*a*] and [ɤ̟]. Both vowels were excised from the recordings and Long-Term Average Spectra were created for both partials (FFT) and formant (LPC) analyses.

LTAS/FFT/partials

The results from the FFT analyses are shown in Figures 1a through 4b.

SPL levels at one meter were 84.2 dB for kulning and 81.5 dB for head register and at 11 meters 74.8 and 56.3 respectively. The comparative lack of attenuation in kulning is striking. In general more partials are seen in the kulning rendition where partials are clearly visible up to 16 kHz for both vowels. However, this difference is not as striking as in our indoor recordings, where the head voice version only had visible partials up to around 6 kHz. Here, partials can be observed up to at least 11 kHz in head voice for both vowels.

LTAS/LPC/formants

The results from the LPC analyses are shown in Figures 5a through 8b.

The most striking observation is that for the vowel [*a*], curves are very similar regardless of distance in kulning. Formants are more or less unperturbed by adding an additional ten meters distance from the source. For the vowel [ɤ̟] results are somewhat different since no clear formant peaks can be detected in the kulning style. However, in head voice, the first formant is clearly visible. The difference between the two singing styles is most apparent at one meter from the singer; see Figures 7a and 7b.

Discussion and conclusions

In this paper, we report on the analyses of two vowels obtained from outdoor kulning singing. By and large, our previous observations were replicated, showing that kulning, compared to head voice, attenuates far less with distance than head voice. Kulning also has clearer partials at higher registers, and preserves partials patterns almost unperturbed at the greater distance of 11 meters, as compared to 1 meter, from the source. Partials were clearly observed for both vowels up to ~16 kHz at both distances.

Regarding formant patterns, those were preserved at 11 m for the vowel [*a*] but to a lesser degree for the vowel [ɤ̟] where flat LTAS spectra were found both at one and 11 meters. Of interest is the very flat formant curve, compared to *[a]*, where formants are still discernible. However, it should be noted that it is difficult both to produce and perceive "exact" vowel qualities when singing at high frequencies, which means that our chosen IPA characters can be considered somewhat arbitrary.

The main difference in partials and formant slopes between the two singing modes is the preserved loudness in kulning. This does in turn help explain why the singing mode was developed to call cattle that could be at considerable distances from the singer.

Future studies

Planned future studies include inverse filter analyses, fiberoptic endoscopic and electro-glottographic examinations in new data collections. We hope that such studies will help elucidate the underlying glottal configuration that produces the observed distance-resilient formants, with visible partials up to ~16 kHz and less loudness attenuation with distance, compared to the somewhat similar-sounding head voice alternative.

Acknowledgments

The authors would like to thank our singer Fanny Pehrson, who happily volunteered to be the subject of our studies. Thanks also to Ahmed Geneid for interesting comments.

References

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