AN ACOUSTIC ANALYSIS OF ‘KULNING’ (CATTLE CALLS) RECORDED IN AN OUTDOOR SETTING ON LOCATION IN DALARNA (SWEDEN)

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ABSTRACT
The Swedish cattle call singing style ‘kulning’ is surprisingly understudied, despite its almost mythical status in Swedish folklore.

While some physiological-productive aspects of kulning have been treated in previous work, acoustic properties are still much lacking description. This paper adds to and extends the results presented in a previous study (Eklund, McAllister & Pershson, 2013), where kulning and head voice (’halsettet’) was acoustically analysed in two indoor settings: a normal room and an anechoic chamber.

In the present study, the same singer, singing the same kulning in the same two modes (kulning and head voice), was recorded in an outdoor setting (close to the singer’s home), thus allowing for a comparison between ‘clinical’ and more ecologically valid data.

DATA COLLECTION AND METHOD
All data were collected on 7 September 2013 on location in Säter, Dalarna (Sweden), very close to where the singer (FP) grew up.

Weather conditions recorded (meteo.com)
Two types of microphones were used: two Shure Pro Beta S8A for simultaneous recordings at different distances (1 and 11 meters) and one Auditechnica AT811 for comparison with our previous study (2013)
Same kulning as in previous paper (2013), the vowel [a], at around 700 Hz
Data resampled to 44.1 kHz
Acoustic analyses done using Cool Edit Pro 2.0, Wavesurfer 1.8.8p4 and Praat 5.3.84

PREVIOUS RESEARCH
Kulning is mentioned in early works on Swedish folk music (Moberg, 1955, Ling, 1978)

Johnson (1984, 1986) reported that kulning is characterized by a strong correlation between frequency and amplitude (especially in higher registers), and that the larynx moves with the frequency and can be raised with ~39 mm

Johnson recorded amplitudes at 105 dB, 0.3 m from the source
Rosenberg (2003) largely replicated Johnson’s observations
Utman (2002) analyzed partials obtained from CD recordings and reported clear partials up to the 16-18 kHz register, as compared to ~6 kHz in normal folk singing

Eklund, McAllister & Pershson (2013) compared kulning and head voice in an indoor setting and replicated Utman’s observations on partials

RESULTS: AMPLITUDE
Simultaneous recordings at 1 and 11 meters from the source; results in Table 1 below:

<table>
<thead>
<tr>
<th>Mode</th>
<th>1 meter</th>
<th>11 meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needle</td>
<td>0.17</td>
<td>0.30</td>
</tr>
<tr>
<td>Kulning</td>
<td>842</td>
<td>748</td>
</tr>
</tbody>
</table>

Loudness was measured using an Eextech sound level meter, model 407732 (factory calibrated)

In head voice mode there is an amplitude drop of 25.2 dB at 11 meters compared to 1 meter

In kulning the corresponding figure is 9.4 dB, which means that the perceived loudness ten meters further from the source is about halved

RESULTS: PARTIALS AND FORMANTS

<table>
<thead>
<tr>
<th>Term</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moton 16–18 kHz</td>
<td>as compared to ~6 kHz</td>
</tr>
<tr>
<td>CD recordings and reported clear partials up to</td>
<td>16-18 kHz</td>
</tr>
</tbody>
</table>

were visible in far higher registers in kulning (~15 kHz) than in head voice (~5 kHz)

Partial "gestalts" were more or less unperturbed by the greater distance in kulning, and were more or less just downshifted c. 10 dB

For formants, the main observations were:
1. At 1 meter, formants are clearer in head voice
2. At 11 meters, formants disappear in both kulning and head voice

Note that exact vowel quality is difficult to establish in high-pitched singing

OBSERVATIONS AND DISCUSSION
• Results of our partials and formant analyses are shown in the figures on plate 6 (above/right)
• We created Long-Term Average (LTA) spectra for both FFT/Partials and LPC/Formant analyses, at the two distances 1 and 11 meters from the source (see above)
• For partials, two main observations were made: 1. Partially visible in far higher registers in kulning (~15 kHz) than in head voice (~5 kHz) 2. Partial "gestalts" were more or less unperturbed by the greater distance in kulning, and were more or less just downshifted c. 10 dB
• For formants, the main observations were:
  1. At 1 meter, formants are clearer in head voice
  2. At 11 meters, formants disappear in both kulning and head voice
  3. Note that exact vowel quality is difficult to establish in high-pitched singing

CONCLUSIONS AND FUTURE RESEARCH
• Compared to our 2013 study, this study is based on ecologically more valid data, using outdoor data instead of indoor (anecchic chamber)

It was observed that kulning was less perturbed as a function of a greater distance from the source than was head voice

The results were not surprising since kulning was developed to carry over great distances

Sound propagation is very dependent on the exact nature of the vegetation where the sound is produced, as reported in a number of papers on animal vocalizations (e.g. Martin & Marler, 1977; Richards & Wiley, 1980)

Our observation indicated that kulning is well adapted for long-distance propagation in its natural habitat

Ongoing studies also include high-speed film footage and EMG of vocal folds

REFERENCES

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