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Expressive gesture and style in Schubert song performance: Examples of measurement method

Measurements were made using PRAAT (www.fon.hum.uva.nl/praat/), which is a program designed for the phonetic analysis of speech. Audio files from CD recordings were imported into a computer and saved as a mono-audio file, because PRAAT only reads mono files (wave or aiff). The default settings of PRAAT are appropriate for speech signals. The settings need to be adapted for appropriate visualisation and analysis of singing, see the online PRAAT manual for musicologist written by Wim van der Meer (www.musicology.nl/WM/research/praat_musicologists.htm).

To get a good representation of the vocal line sung by sopranos on historical and modern records and an appropriate analysis of pitch and loudness, the pitch range has to be adapted and the spectrogram settings have to be adapted: The frequency range is much larger for sopranos [e.g. 200 – 1000 Hz] and the time-window for the spectrogram analysis can be a bit wider for the periodic signals of singing [e.g. 0.05 S], which also helps to filter away background noise in old recordings. Note that PRAAT often makes octave mistakes. For the analysis of vibrato, this is not a problem, but, for other analyses, this might be problematic. Note as well that PRAAT is made for the analysis of mono-phonic signals and not for polyphonic signals. Nevertheless, pitch periodicity detection is often accurate for recordings where the voice is much louder than the accompaniment, which is the case in most historical recordings.

Examples of a spectrogram representation of a passage from *Die junge Nonne* sung by Elly Ameling in 1975 and Susan Strong 1907 are shown in Figures 1 and 2, respectively.

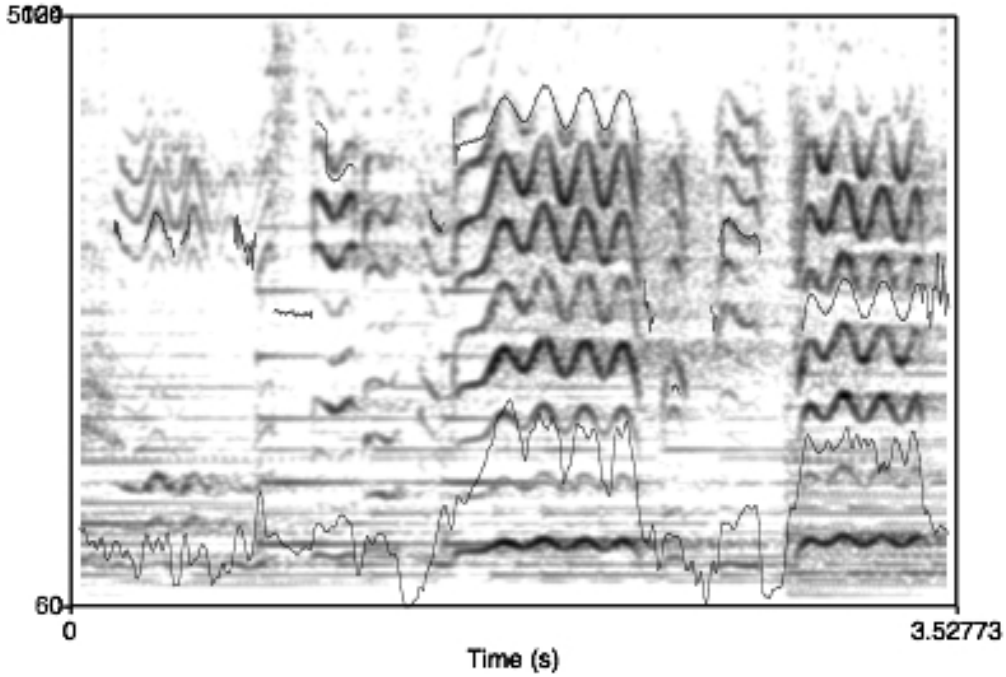

Figure 1 Spectrogram representation of fragment sung by Elly Ameling in 1975. Thin lines show the detection of pitch (top) and loudness (bottom).

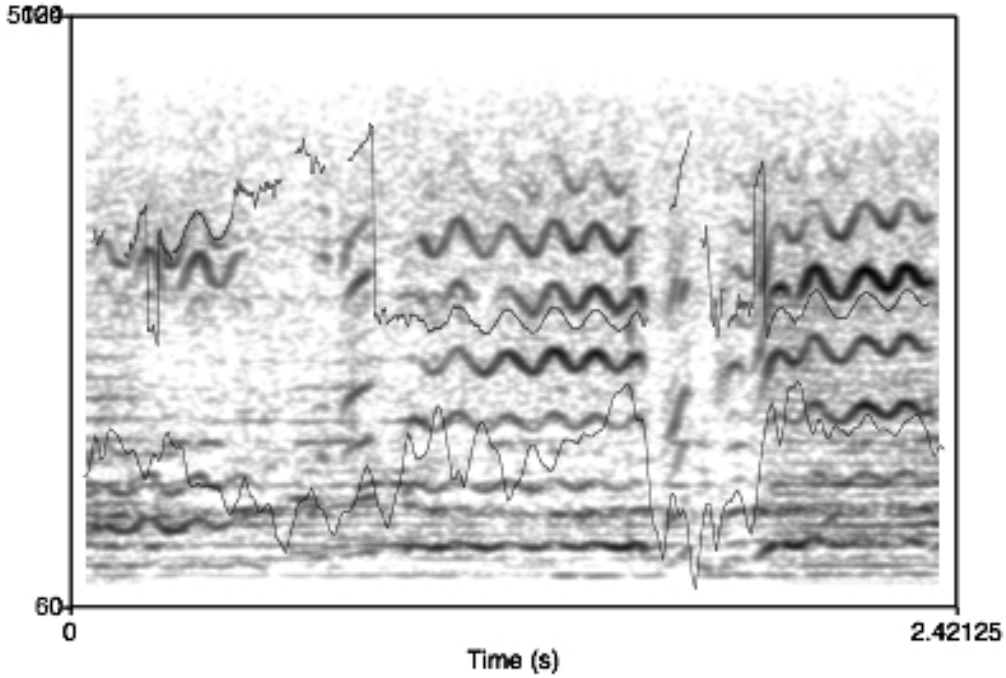

Figure 2 Spectrogram representation of fragment sung by Susan Strong in 1907. Thin lines show the detection of pitch (top) and loudness (bottom).

Analysis of pitch (top thin line within graph) and amplitude (bottom thin line within graph) are plotted on top of the spectrogram representation. Pitch, loudness and spectrogram have their own respective scales and the vertical positions should be interpreted independently and not in comparison to each other. The sung text in this passage is *brauste das leben wie jetzt*. The pitch detection functions well for the extended vowels of *brauste*, *leben* and *jetzt*. It does not function for consonants such as the r, s and t. The piano accompaniment can be easily distinguished visually from the voice for the recording of Elly Ameling. However, as mentioned before, PRAAT does not make such distinctions in its analyses of pitch or loudness.

These representations and analyses of sound were used to measure different aspects of the performances. First, the onset of the first note of each bar was located using an annotate-to-grid function in PRAAT, which provides the opportunity to select a point in time, locate a grid-point, and annotate the grid-point with text (as explained in the manual of Wim van der Meer). The location in time of each grid-point can then be exported as text together with its annotation. After importing the time markers into a table, the time between successive markers can be calculated, which gives the duration in seconds of each bar of a musical piece.

The second step consisted of the measurement of the average amplitude per bar. The grid-points that located the onset of each bar were used to select one bar at a time, thus to set the time window to the exact location and duration of one bar. A log-function was used that calculates the average amplitude for a selected passage, which corresponds to the open time window. Repetition of this calculation for each bar gives a list of amplitude values together with a time point relative to the start of the sound file. The time point locates the middle of the time window.

The third step consisted of the measurement of vibrato rate and extent. One long note of each bar was selected. The portion of the note that contains vibrato was selected using the mouse. Using the function “get selection length”, the duration of this portion was calculated. The calculated duration was copied and pasted into a

list of durations. The selection was always made from a peak to a peak in vibrato or from a trough to a trough. The number of cycles was counted. To get vibrato rate, the number of cycles is subdivided by the listed duration. Calculations were made using JMP 501, but could be calculated in any programming environment or spreadsheet program.

To calculate vibrato extent, a large vibrato cycle of the selected note in each bar was selected. The maximum and minimum pitches in semitones of the selected vibrato cycle were extracted using the corresponding queries in PRAAT. These values were listed in a table. The difference between maximum and minimum pitch gives the vibrato extent in semitones.

Finally, the number of pitch glides upwards and downwards per bar were calculated. The spectrogram representation was used to help to locate a pitch glide, although much can be done by ear alone. The grid-points locating the onset of each bar were again useful to navigate through the sound file.

All measurements were done at the bar level. This had the advantage of facilitating the comparisons between the different measurements and between different singers. It also makes the measurements less prone to noisiness due to inaccuracies in measurements. If the measurements were made at a smaller time scale, small inaccuracies become relatively large in size. Measurements per bar have the disadvantage that a considerable amount of detail about voice inflections is neglected. The result is that some of the differences between singers are neglected and similarities between singers become relatively prominent.

Reference to PRAAT: www.fon.hum.uva.nl/praat/