How do they do it? The difference between singing and speaking in female altos

Introduction

Over the last seventy years much research has been done into the phonetic correlates of singing as opposed to speaking in male singers. In comparison, there has been little investigation of the phonetics of singing in female singers, presumably because the higher frequencies involved make it much more difficult to unambiguously attribute to style any phonetic differences observed between phonations by women. For example, the increased difficulty of accurately detecting formants at higher frequencies may mean that differences observed could be due to environmental or other incidental factors, not to differences in style which the "phonator" is attempting to produce. Though research is now also being done on female singers, there is still a gap in the research record due to its beginning later for women than for men; this paper aims to continue filling the gap.

Methodology

The paper presents the results of a study performed with nine experienced female altos, which aims to quantify the differences in the vowel phonemes /ah eh i o u/[1] when they are spoken and sung. It takes as its point of departure the work which has been done on singing phonation by males, which has identified three possible differences between speaking and singing done by experienced singers: (1) variation in the amplitude of the harmonics closest to f0, relative to one another (see Bartholomew 1934); (2) "formant tuning" (modification of the vocal tract to change the location of formants when singing); (3) the production of a "singer's formant": a rise in the amplitude of F4 and F5, and possibly also F3, which may or may not also merge the formants concerned so that they cannot be distinguished from one another. The phenomenon is illustrated in Fig 1; also see, for example, Sundberg (1987).

The data analysed are:

- Spoken: the five vowels set in carrier sentences, with the vowels spoken on two intonations each, downwards-upwards and upwards-downwards; singers produced these ten spoken vowels once before singing the required sung vowels and again after singing them, so that any effect of singing on the speaking voice could be investigated
- Sung: the five bare vowels, sung at all pitches between 196Hz and 392Hz, in four presentations:
  - *glissando* scales (sliding, with no clear distinctions between pitches), downwards-upwards and upwards-downwards
  - *staccato* scales (short notes, a half-step apart, with gaps between them), downwards-upwards and upwards-downwards

Analysis is through spectra (FFT and LPC) and spectrograms.

Preliminary results and further expectations

Preliminary results indicate that female altos may produce a singer's formant in order to project their sound. Their ability to produce one, and its location in the spectrum, varies with their amount of singing experience and with their most comfortable singing range (an example is shown in Fig 2). They may also vary the amplitude of the harmonics closest to f0, especially H2 (see Figs 3a and 3b, which are from the same singer's voice) and tune formants to bring them into the range where they are best able to amplify them. However, not all female altos will necessarily use all of these techniques all the time; which one is used depends on the individual voice and on the pitch being sung. These results indicate that female altos produce their "singing voice" in the same way as do male singers.

It is hoped that this study adds to the body of knowledge about singing by women by confirming that altos may produce their "singing voice" in the same way as many male singers. Specifically, it also defines the singer's formant better, by making clear that it may consist not only of an area of raised amplitude with no distinct formant peaks for F3, F4 and F5, but also of a set of formants which are still distinct but also raised in amplitude.

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[1] /ah/ = "low back ah", IPA *script a*, cardinal vowel 5; /eh/ = a mid-low front unrounded vowel, IPA *epsilon*, cardinal vowel 3.

Figures

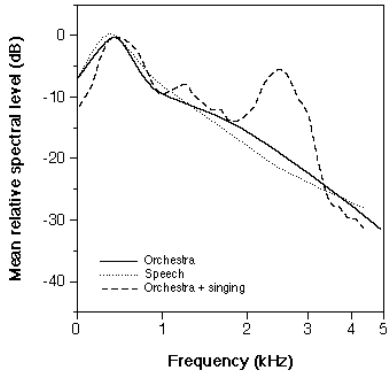

Figure 1 The singer's formant: in the dotted "Orchestra + singing" line, the area of raised amplitude between approximately 2 kHz and 3 kHz
(from National Center for Voice and Speech, n.d.)

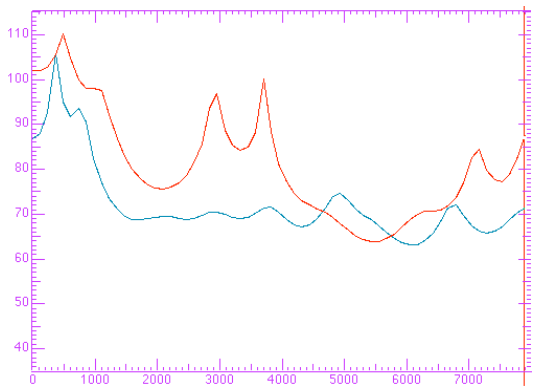

Figure 2 Production or lack of a singer's formant at different pitches
Blue spectrum (mostly lower amplitude): f0 ≈ 196Hz: no singer's formant
Red spectrum (mostly higher amplitude): f0 ≈ 294Hz: visible singer's formant, with peaks at approximately 3 kHz and 4 kHz
x axis: frequency/Hz; y axis: amplitude/dB

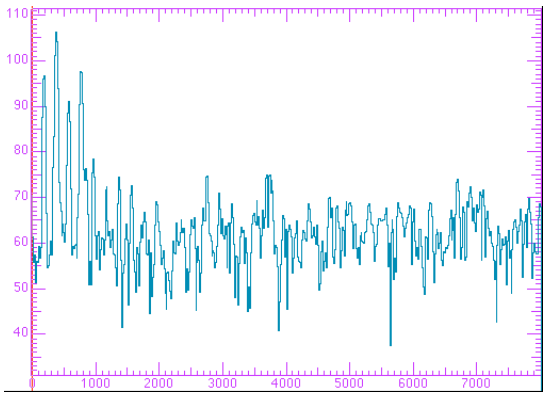

Figure 3a Amplification of H2 (lower, more comfortable f0)
No singer's formant
Sung vowel /u/; f0 = 201Hz
x axis: frequency/Hz; y axis: amplitude/dB

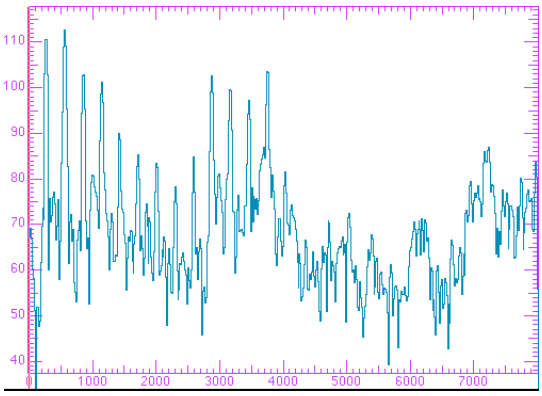

Fig 3b Non-amplification of H2 (higher, less comfortable f0)
Visible singer's formant
Sung vowel /u/; f0 ≈ 294Hz
x axis: frequency/Hz; y axis: amplitude/dB

References

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Sundberg, Johan (1987) *The Science of the Singing Voice* (DeKalb, IL: Northern Illinois University Press)