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Voice source and acoustic measures of adolescent voices performing in 'Musical Theatre' and 'Classical' styles — a pilot study

Background

- While the literature on the singing voice has increased rapidly in recent years, the majority of research has been focused on 'Classically' trained voices, (e.g. Howard, 1995) and there is still a relatively small amount of literature on Contemporary Commercial Music (CCM), such as pop/rock and musical theatre (MT) singing styles. While there has been recent documentation of the operatic vs musical theatre voice (Evans and Howard, 1993; Bjorkner, 2006), studies in this area are still limited.
- In particular the understanding of the singing voice of children and adolescents is still in its infancy, and there is still a lack of a general developmental model of the young voice (Stathopolous, 2000) in particular with relation to young singers. Despite the fact that young people are still the most likely demographic group to undertake training in singing (Barlow 2003), and particularly non classical styles, there is very little research on the voice of the young non-classical singer The theatre arts organization Stagecoach alone has over 39,000 students training in acting, dancing, and singing (Cole 2007).

Method

Over 100 subjects aged between 11 and 16 who were training in singing were recorded. These included young people training in 'classical' music in a UK Cathedral Choirschool (Wells Cathedral), training in 'theatre' music at a full time UK theatre arts school (Sylvia Young Theatre School), and training in both styles in a USA based professional children's chorus academy (Brooklyn Youth Chorus Academy ®).

Simultaneous recordings were made of both vocal fold activity and acoustic output using a Digital Laryngograph® recording into a Toshiba Libretto Micro-Laptop, sampling at 22.5 kHz and 16 bit resolution. Boys whose voices had started to change, with mean spoken F0 <200 Hz [Cooksey, 1993; Barlow and Howard, 2002] were disregarded for the purposes of this study.

Subjects were asked to: Read aloud a short passage of ~90 secs duration, sing an ascending and descending scale between G3 (196 Hz) and G5 (784 Hz) at a mezzo-forte volume to the vowel /a/, and sing unaccompanied a verse of a song that they knew well with the pitch range between D4 (293 Hz) and E5 (659 Hz) and at a volume of *mezzo-forte* (as determined by the vocal coach/teacher).

- Long Term Average Spectra (LTAS) were analysed for a sample of 20 female BYCA singers singing 'happy birthday' in the key of C major (C4-C5) in classical and then theatre music styles
- Average Vowel Spectra were calculated from a 750 ms excerpt of 5 vowels, taken from the root, 3rd, 5th, 7th and Octave of Happy Birthday to give a range of pitches sung by the BYCA students (Figure 1). Mean CQ were calculated from the same 5 notes.
- LTAS were generated from a 2 octave rising scale sung *mezzo forte* of male and female choristers who had trained in a UK cathedral choirschool (n=29) and 33 male and female students at a full time UK theatre arts school (n=33). Mean LTAS were also generated from the same groups of students singing a song they knew well at a *mezzo-forte* level over a pitch range between D4 (293 Hz) and E5 (659 Hz). Recordings were normalized for analysis.

Figure 1: 'Happy Birthday' - notes for analysis circled

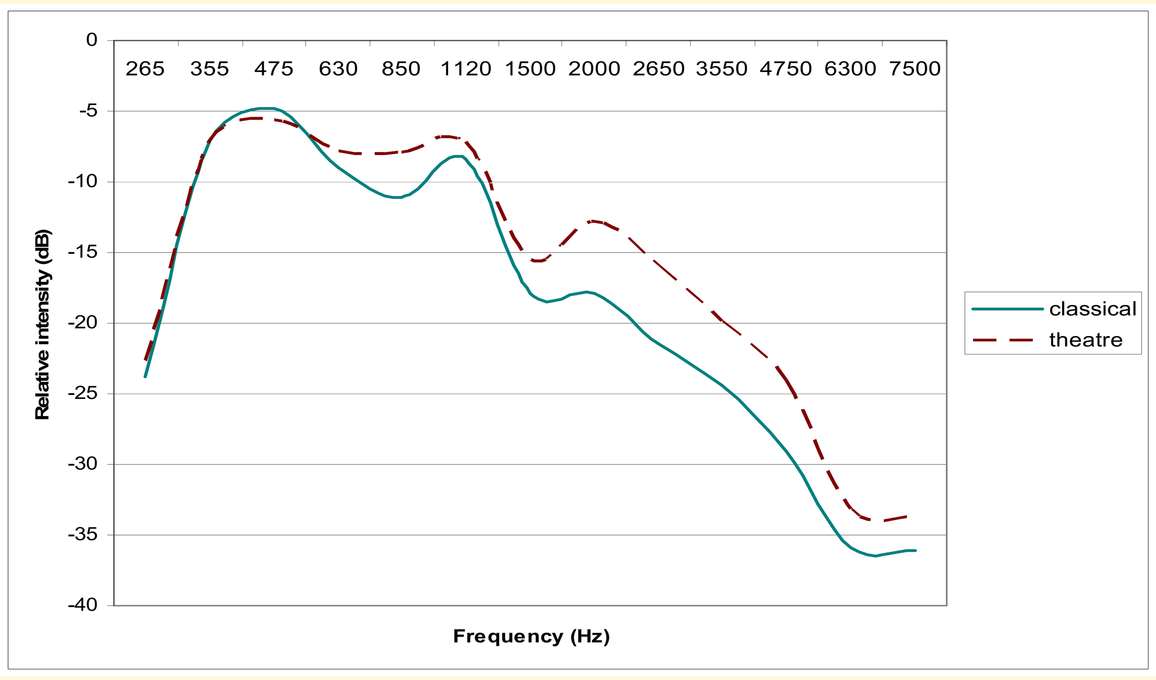

Figure 2: LTAS of 'Happy Birthday' sung in 'classical and 'theatre' voice

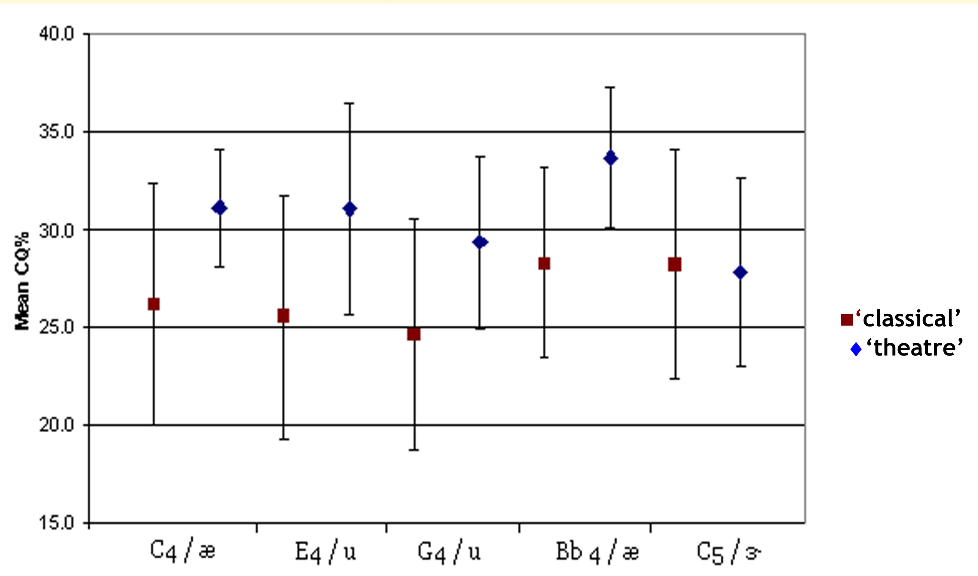

Figure 3: Mean CQ of 5 vowels from 'Happy Birthday' sung in 'classical' and 'theatre' voice

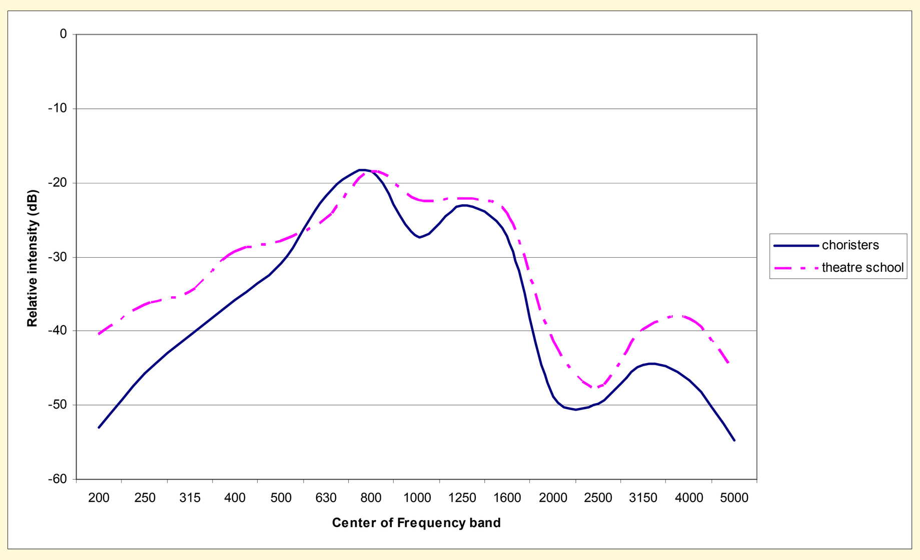

Figure 4: LTAS of scale sung in 'Classical' and 'theatre' styles

Results/Discussion

- LTAS were calculated from 'happy birthday' of each voice type of 20 BYCA students singing in both 'classical' and 'theatre' voices (Figure 2). Mean spectral slope is very similar between the styles over the pitch range of the song, suggesting similar intensities, but from above the 475 Hz band, spectral slope for the 'head' voice is steeper than for the 'mix' voice, with an average intensity 3dB higher than the 'head' voice across the range, with a maximum difference of around 6dB. A one tailed, paired students t-test shows a significant difference between the mean LTAS of the two vocal styles (p=0.00029).
- Mean CQ was calculated for each of the selected notes for both singing styles. Figure 4 demonstrates that mean CQ and standard deviation for 4 of the 5 notes analysed is higher in 'mix', with the mean for C5 being nearly identical. Analysed as individual singers across all notes, 76% of mean CQs were higher in 'mix' voice than in 'head'. A one tailed student's T-test of the means demonstrated a significant difference between the two data sets (p=0.018).
- Mean CQ and standard deviation for 4 of the 5 notes analysed is higher in 'mix', with the mean for C5 being nearly identical. Analysed as individual singers across all notes, 76% of mean CQs were higher in 'mix' voice than in 'head'. A one tailed paired student's T-test of the means demonstrated a significant difference between the two data sets (p=0.018).
- AVS were calculated for each of the 5 notes. 'Theatre' voice demonstrated higher intensities than the 'classical' voice in across the entire spectrum, with many notes demonstrating higher intensities in the second to fourth harmonics than in the fundamental. Mean spectral slope for each vowel (dB/octave) is shallower in all vowels for theatre voice than 'classical'. A one tailed paired student's T-test of the means demonstrated a significant difference between the two data sets (p=0.010). The 'classical' voice shows much weaker intensities in the spectrum, particularly above the 2nd
- LTAS of the normalized scale (figure 4) showed so significant difference between the choristers and the theatre school singers. However, there are two small differences between the groups: Intensity of the pitch range of the lower part of the scale is higher for the theatre singers than for the choristers. The spectrum above 800 Hz also shows higher intensities in all bands for the theatre singers, however, it is suggested that in accordance with Nordenberg and Sundberg (2003), this is likely to be caused by an increase in subglottal pressure.
- LTAS of the songs (figure 5) — while not directly comparable due to difference in the mean pitches — suggests however that the theatre voice has significantly higher intensities across the spectrum than does the 'classical' chorister voice, supporting the conclusions from the BYCA data. The slope of the classical choristers spectra above 800 Hz shows distinct formant peaks and has an average slope of over 10 db/octave while the spectral slop of the theatre singers shows a much flatter spectrum with low formant peaks and an average slope of 3.7 dB/octave. While some of this could be due to higher vocal loudness, it is suggested that the degree of difference evidences a difference in resonant strategy over the pitch range between the two singing styles.

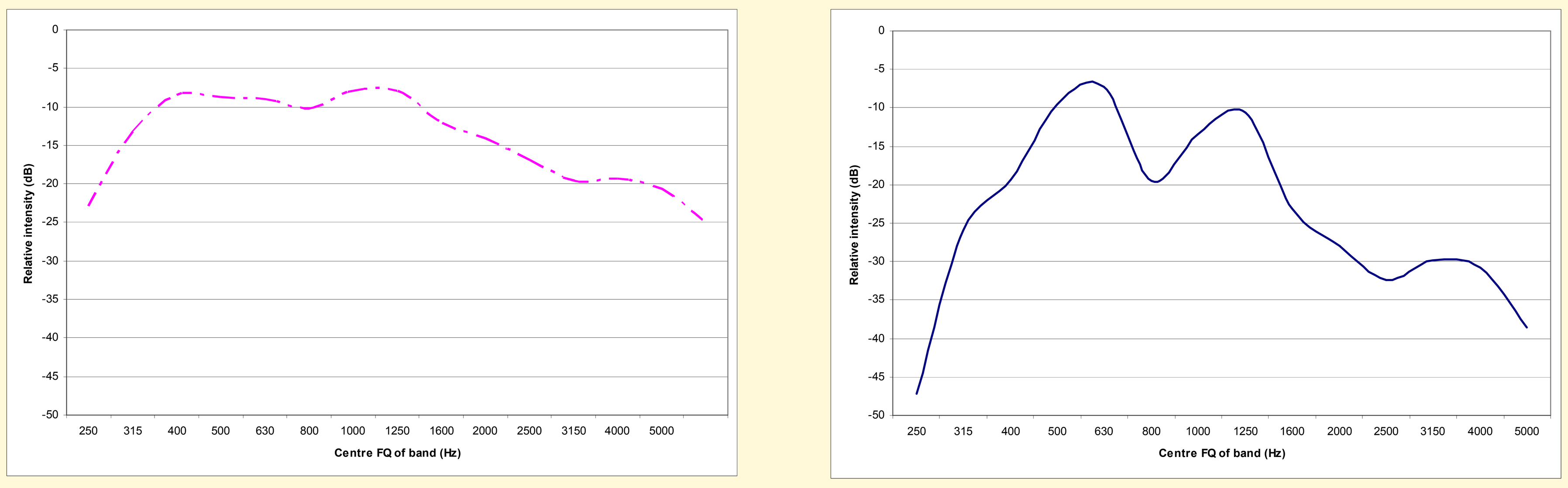

Figure 5— Mean LTAS of unaccompanied songs: theatre school (left) and choristers (right)

Conclusions

- Results clearly show differentiation in both vocal function and acoustic output between the two different singing styles.
- Higher CQ is shown for 'theatre' singing compared to 'classical', possibly suggesting stronger harmonics in the glottal waveform or a slightly higher intensity.
- Both LTAS and AVS show a distinct increase in intensity the spectrum above 475Hz for the 'theatre' voice compared to the 'classical' style of singing. This indicates potential differences in both voice source and resonance strategies for the performer between the two different singing styles.
- LTAS of the 'choristers' vs the 'theatre school' pupils support these conclusions, showing an increase in intensities across the spectrum that it is suggested are greater than can be accounted for by the gain factor of the loudness variation.

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