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PRIORITIES IN VOICE TRAINING: CARRYING POWER OR TONE QUALITY?

A four-bar seven-word phrase from a well-known song by an Estonian composer was recorded as performed by 41 students taking classical singing at the Estonian Music Academy. The length of the students' professional training ranged from 1 to 10 years. The voice quality was evaluated by four experts (three singers and one musicologist). The recordings were analysed acoustically in order to estimate the energy distribution in the voice spectrum. A singer's voice carries better (i.e. is perceived as louder with the same physical effort on the part of the singer) if the level of the voice is high between frequencies of about 2 and 5 kHz. (These are the frequencies to which the human auditory system is most sensitive.) It is possible to increase the level of harmonics at these frequencies either by rising the subglottal pressure (then the higher spectrum partials gain more in amplitude than the lower spectrum partials), or by clustering the higher formants into a single peak called the singer's formant. Acoustical analysis revealed that the more experienced students had higher sound levels between 2 and 5 kHz than the beginners. Different singers used different techniques to raise the level of harmonics. The average voice quality did not increase with the years of training. We can conclude that in the voice training process, the development of the carrying power was given priority over the development of the voice quality.

Introduction

As a rule, young people admitted to study opera singing at the Music Academy must have a good natural voice. In the course of vocal training, a student's voice often acquires operatic qualities at the expense of its former freeness. In the first few years a singing teacher has to deal with a number of difficult tasks. It is necessary to reshape several reflex habits of voice control. At the same time, the curriculum assumes that certain vocally demanding arias will be performed. It would appear that in order to obtain quick results, singing teachers tend to concentrate on developing the carrying power of student's voices rather than the voice quality. Our aim in this study is to test this assumption by investigating whether there is a correlation between the time that the student has spent on singing studies and such attributes of his voice as carrying power and perceived quality.

Carrying power is what makes a voice audible in large opera houses or concert halls and in the presence of a symphony orchestra (Vennard 1967). Singers make their voices carry by employing a special vocal technique, usually acquired during train-

ing. This enables them to sing sufficiently loudly, with a minimum of physical effort. To make the voice carry one has to rely on the fact that the human auditory system is most sensitive to the frequency range between 2 and 5 kHz (Helmholtz 1954), hereafter referred to as the MS area. If a singer is successful in articulation, and manages to configure the vocal tract so that the frequencies of the third, fourth and fifth formants (F3, F4 and F5) move close to each other (this occurs if one sings with a widened pharynx and a lowered larynx), this results in the formation of a joint reinforced factor called the singer's formant, the frequency of which (depending on the voice category) is 2.3 to 3.3 kHz, i.e. within the MS area (Dmitriev, Kiselev 1979).

The another way to make the voice carry better is to rise the subglottal pressure (i.e. to sing louder). In that case the growth of higher partials is greater than that of the lower partials. Unfortunately the increasing of subglottal pressure is possible only by applying an extra physical effort of breathing musculature. Using the singer's formant technique is more common among male singers and low female voices. Sopranos do not gain much from using the singer's formant technique because the distance between the harmonics in the case of high fundamental is wide and the chance that a particular harmonic coincides with the frequency of singer's formant is very slight (Sundberg 1987).

The quality of the tone is not so unambiguously described as is the carrying power of the voice. It is "hidden" in various acoustical parameters of the voice, as well as in the way these parameters change as a function of time (di Carlo 1990). As aesthetic values tend to depend largely on cultural context, they can be quite dissimilar in different geographical areas and in different historical eras. One way to estimate the quality of the voice is to use expert ratings. A person who listens to singers and advises them on a daily basis (e.g. a professional singer, a singing teacher or an opera critic) is able to perceive the problems of quality as an integral whole, and at the same time to distinguish between what is a deviation and what is an intentional device of expression.

Material and measurements

41 students of opera singing (15 males and 26 females) from the Estonian Music Academy were studied. We tried to determine the carrying power (i.e. the presence of strong harmonics in the MS area) and the perceived quality of their voice, and to find out how these change as a result of training. For this purpose we recorded each of the students singing a four-bar seven-word phrase from the melody of a well-known song by the Estonian composer Miina Härma "Ei saa mitte vaiki olla". Each voice was recorded three times: singing the phrase in E minor, singing the phrase in A minor and speaking the text. The fundamental frequency range was 330 to 494 Hz for females and 150 to 247 Hz for males in the E minor version, and 440 to 695 Hz for females and 220 to 330 Hz for males in the A minor version. At the time of this study, the students had been studying singing with different teachers (12 in all) for anything between 1 and 10 years.

To estimate the quality of the voice, we used four experts (three professional singers and one musicologist), who were asked to evaluate voice quality on a 5-point scale. The criteria for quality evaluation were not specified. To estimate the carrying power of the voice, the recordings were analysed acoustically using the Kay Elemetrics Company CSL workstation, with a sampling frequency of 16 kHz. Long term average spectra (LTAS) were calculated for each recording using the Hamming window. From the LTAS we found the relative strength (in relation to the highest peak below 1 kHz in the spectrum — normally the fundamental or the first formant) of the maximum peak in the MS area.

Results and discussion

Three types of LTAS shape in the MS area can be distinguished. First, a distinct triangle with high sound level (Figure 1, top left). This group consists of 5 male singers. For 4 of those, the level of the triangle was between –4 and +10 dB in relation to the overall maximum. For one singer, the level of the triangle was between –10 and –12 dB. These singers use the singer's formant technique, this results in the bright and sonorous timbre of their voice. The second type of spectrum is characterized by two distinct peaks with a relatively high energy level (Figure 1, top right). This group included 9 male singers. The level of the strongest peak in the MS area was –8 to –10 dB. The two separate peaks indicate that the formation of the singer's formant was less consistent here than in the case of the singers belonging to the first group.

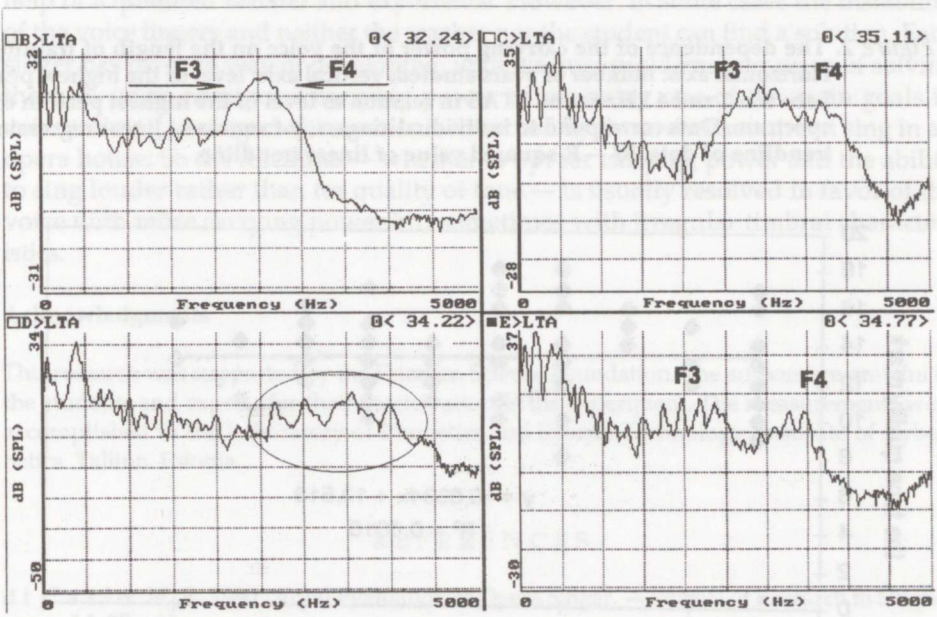

Figure 1. **The shape of the long-term average spectrum (LTAS). A male singer, using the singer's formant technique (top left); a male singer, using the singer's formant technique inconsistently (top right); a typical female singer (bottom left); a singer who does not use the singer's formant technique (bottom right).**

The shapes of the LTAS of the female singers (Figure 1, bottom left) resemble each other much more than those of male singers. The maximum level in the MS area was –12 to –25 dB, the average being –18.4 dB. Because of greater distances between successive harmonics, it is much more difficult to determine the clustering of the higher formants and the resulting formation of the singer's formant in female voices. By comparing the spectra of separate vowels in speech and in the singing voice, it is still possible to distinguish the singers in whose case F3 and F4 were more close, from the singers in whose singing voice spectrum there is no evidence of the clustering of the higher formants.

Next we will consider whether the level of the strongest peak in the MS area of the LTAS depends on the time that singer has spent on voice training. Regression analysis indicates (Figure 2) that the peak becomes stronger the longer the period of study ($p < 0.01$ for both males and females). It would appear that the voices of those students who have studied longer have greater carrying power.

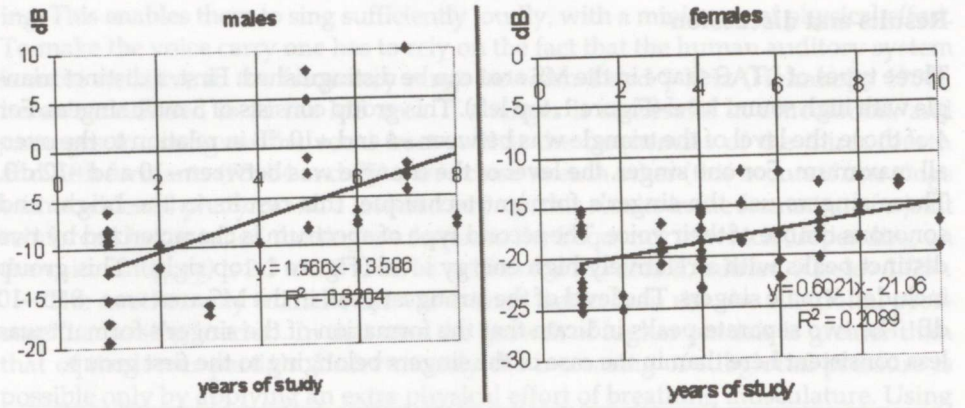

Figure 2. **The dependence of the carrying power of the voice on the length of training. Horizontal axis: number of years studied, vertical axis: level of the highest peak between 2 and 4 kHz in the LTAS in relation to level of the highest peak in the spectrum. Dots correspond to individual singers, y-formula of linear regression trendline of dots, R^2 — R squared value of linear trendline.**

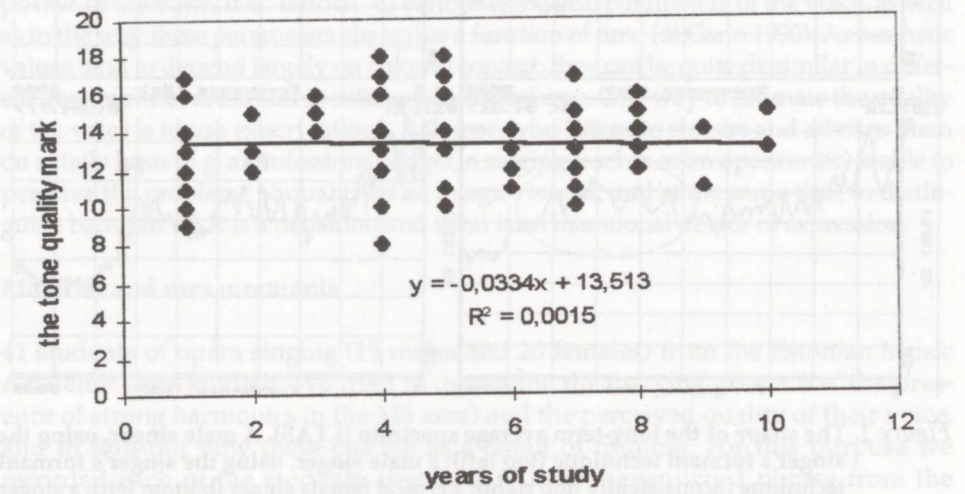

Figure 3. **Rating of the voice quality as a function of the length of training. Horizontal axis: number of years studied, vertical axis: the sum of the marks (on a 5-point scale) given by 4 experts. Dots correspond to individual singers.**

The sum of the ratings (on a 5-point scale) given to each voice by 4 experts ranged from 8 to 18, the average being 13.3. Regression analysis was carried out in order to determine whether there was any correlation between these ratings and the number of years of professional experience. No significant correlation was found (Figure 3). We concluded that the carrying power of the voice was greater for those students who had been training for a longer time, while the average expert rating of tone quality did not depend on the duration of studies. We believe that the reason for this lies in methods of teaching which give priority to the development of the carrying power of the voice over the quality of the tone.

Conclusions

A good opera singer's voice must have sufficient carrying power in order to be heard in large halls without the use of amplification systems, or when accompanied by a symphony orchestra. At the same time, the voice must be smooth, with no irregularities in phonation or articulation. In order to make his voice carry better, a beginner must either use an unfamiliar type of articulation to cluster the higher formants, or change the type of phonation so as to increase the level of upper overtones. As singing teachers well know, a beginner cannot usually retain the natural smoothness of his voice if he is asked to sing "with a supported tone", or louder (i.e. with a voice that carries better), or using some other technique necessary in opera singing. In the case of talented student, the former quality can be restored with the help of a qualified teacher and experience. However, in some cases the instability of the voice lingers and neither the teacher nor the student can find a solution. Each singer has his own way of developing, with his own problems and ways of solving them. A voice with good carrying power is inevitably one of the main goals in voice training. A singer whose voice is drowned by the orchestra, cannot sing in an opera house. So the dilemma — whether to opt for carrying power and the ability to sing louder rather than for quality of tone — is usually resolved in favor of the voice with more carrying power but sometimes with irregular timbral characteristics.

Acknowledgments

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