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EMPIRICAL RESEARCH OF CLASSICAL VOICE TRAINING FOR EXAMINING THE POSSIBILITY OF SWITCHING THE NOSE AND CONNECTING CAVITIES INTO THE SINGING VOICE

Summery of the Ph.D thesis

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Introduction

We started our research with an overview of the scientific literature, with special regard on voice training.

Historical review revealed that the relevant researches and studies had begun in antiquity and have got special élan in Europe in the Baroque and then in later centuries, after the singing developed as professional performing art with emergence of new music genres as oratorio and opera (*Kerényi*, 1985; *Szabadyné*, 2002).

After the exploration of the theoretical background, we examined the concepts of breathing, posture, holding the head, manipulation of the chin, during singing (*Kerényi*, 1985; *Jelenik*, 1991; *Miller, R.* 2004; *Nádor*, 2004; *Chapman*, 2006; *Dayme*, 2009).

We also reviewed the larynx, which is the source of the human voice, it's structure, and also the function of the vocal cords. We focused specifically on the so-called vocal tract, wich enhances with its resonating cavities the, in the larynx formed, so called "primary sound". To this topic is connected the nose and its connecting cavities which function in forming singing vowels is still controversial (*Sundberg*, 1987; *Hirschberg* et.al. 2013).

From the singing - as music with text - is inseparable the examination of the pronunciation, articulation, and the topic if registers (in caracter and function diffrent section of the voice range). A special area for classical singing is the aim and requirement of "balancing" which pertain to dynamic, vocal range, timbre, elasticity, vowel formation as well. It is also important to review the evolution of the concepts of the sound operation model (*Brown-Lamperti*, 1931; *Molnár*, 1966; *Marchesi*, 1970; *Tarnóczy*, 1982; *Rossing*, 2007; *Deme*, 2012, 2014; *Hirschberg* et.al. 2013).

To the official voice training is closely related the knowledge of protecting sound health, the sound gradual loading, and the correct way of life (*Tóvölgyi*, 1907; *Frint-Surján*, 1982; *Kerényi,* 1985).

We especially dealt with the examination of vocal warm-up, which is fundamental tool of voice training, why also our research topic is connected to it (*Langer*, 1870; *Farkas*, 1907; *Brown-Lamperti*, 1931; *Mihállyfy*, 1939; *Marchesi*, 1970; *Kerényi*, 1985; *Jelenik*, 1991; *Adorján*, 1995; *Miller R.*, 2004; *Nádor*, 2004; *Szamosi*, 2005; *Chapman*, 2006; *Dayme*, 2009; *Phillips*, 2012).

Within the subject we specially examined the experiences of the so-called „semi-occluded vocal tract" exercises (*Simberg-Laine* 2007; *Vampola* et.al., 2011; *Guzman* et.al.,

2013a, 2013b; *Andrade* et.al., 2013; *Hirschberg* et.al., 2013; *Dargin-Searl* 2015; *Duke* et.a., 2015; *Hampala* et.al., 2015).

1. Origin and definition of the research topic

In the scientific literature, we found contraversal in the topic of using the nose and connected cavities in forming vowels, without detrimental nasalisation of the singing voice.

One group of researchers declare that the nose and jointed cavities can only be connected into the vocal tract only for forming nasal consonants, avoiding detrimental nasalisation. They declare that the benefit and useful feeling of "head-resonance" is only a feeling – caused by the sound conduction of the skull bones - not mean a real function (*Miller R*. 2004; *Chapman*, 2006; *Dayme*, 2009).

The other group of researchers declare that the so called „head resonance" is a real function and is beneficial in forming vowels during singing. They consider it to be maintenancable by the fine adjustment of the soft-palate, simultaneously opening the oral and nasal cavities. According to them in this way can be avoided the detrimental - in classical style non acceptable - nasalisation of the singing voice. Furthermore the switching on these cavities is necessary for individual tone timbre, for reinforcing the high overtones, for better tone resonance, and for accurate intonation. By switching on the nasal and connected cavities the resistance of the vocal tract increases, and the larynx position becomes deeper. The deep larynx position regulates the vertical movement of the larynx, and by increasing the space difference between the larynx-port and the pharynx, helps in forming the so called „singers-formant" during singing (*Molnár*, 1966; *Sundberg*, 1987; *Austin*, 1997; *Sundberg* et.al., 2007; *Yiu* et.al., 2012; *Chen* et.al., 2014).

With this research, we wanted to contribute to this debate with our experimental results, leaning on our experiences as singing teacher and professional opera singer. We have compared the effects of different singing voice warm-up exercises.

2. Hypotheses

1. Useful, especially in the formation of high singing tones, to switch in the nasal and connected cavities, because these small cavities work as suitable resonators for higher overtones and reinforce them.

2. Avoidable is the detrimental nasal thimbre of the singing voice by "fine-tuning" the adjustment of the soft-palate, with its simultaneously lifting and pulling apart, with what is possible the controlled opening of the nasal passage during singing on vowels.

3. Switching in the a nasal and it's connected cavities reinforces the air-resistance of the vocal tract during singing, which helps the function of the vocal gap, making it more effecient and also increases the regulation of vibrato, reinforces the volume either the voice and also it's higher overtones.

4. The changes can be demonstrated on the FFT (Fourier transformation) figure, designed from records of the sustained vowels, and can be find parameters for proving the changes.

5. After concious warm-up, effects will be detectable independently of gender, voice type, duration of singing education and age.

6. The changes can be demonstrated at every vowel on middle voice pitch, not only on extreme voice pitches of the personal tessitura.

7. Based on our empirical results and tested practices is possible to work out proposals for the order, structure and method of appropriate, tailor-made warm-up tasks and exercise.

3. Methods of the research

Beginning of the research we started with searching for partners. The Institute of Education of the University of Szeged helped the statistical analysis, the Department of Optics and Quantum Electronics of the University of Szeged helped the acoustical analysis of the recordings. In organizing participants helped us Vántus István Music Secondary School in Szeged, the Kodály Zoltán Music Secondary School in Kecskemét, Singing Department of Music Faculty at the University of Szeged and Singing Department of the Teacher's Faculty at the University of Szeged. This way, we were able to ensure in music and in singing trained participants to the experiments. Leaning on the sound-analysis acoustic programs, we did not asked expert listeners for rating the records, as the reliability of this method is disputed in the scientific literature yet (*Watts* et al., 2006).

For recording the voices we rented a studio for the pre-measurement and for the first experimental measurement. For further measurements, the recording equipment - provided by the Singing Department of Teacher's Faculty at the Ubiversity of Szeged - was always located

to the venue of the measurement. We built temporary distance-holder on both of the microphones to ensure a constant distance of the participants from the recording device.

During our measurements we applied three - Goldwawe, Spectrum Analyzer, Siegview2.4. - acoustic analysis programs, tried out different - sound pressure, F0, H1-H7 overtones, THT, number of distinct overtones, SNR of differente parts of the sound figure - parameters and different statistical – pair samples-t, correlation, cluster, ANOVA, Cohen-d, regression analysis - programms. We increased the number of participants and strove for the proportional representation of both genres. The melodies, the range, the rhythm, the texts of the tasks and the order of the warm-up exercises have been continuously developed.

4. The aims and results of our experiments

Goals of pre-mesaurement (1 female and 1 male participant) were to try out the FFT sound analysis, the effects of consonant environment in the text and the singing qualification. Results: it was verified that differences on the FFT (Fast Fourier Transformation) image can be detected. Can be distinguished trained and untrained singers, as well the influence of the consonant environment in the singing text. The more qualificated singer's sound image is more articulated, more overtones are separeted on it and the sound pressure of F0 is also higher.

Goal of first experimental measurement (2 women and 2 male participants) was to test the effects of short, 15 minute long warm-up exercises, based on humming and syllables with nasal consonants. Results: on the singing voice of the two males and on the high (palatal) vowels had more beneficial effect of this short warm-up. The internal coherence and cohesion of the parameters - according to the correlation analysis - has become more slack by this short warm-up (*Altorjay*, 2012a; *Altorjay*, 2012b; *Altorjay*, 2012e).

Second experimental measurement**:** We gave exercises with melodies of different difficulty for the three experimental groups (**1.** 9 females, 6 males, **2.** 15 females, **3.** 8 females, 7 males). Goals: we have observed the effects of two types - for "skull cavity" and for "oral cavity" – of warm-up exercises provided with melodies of different difficulty for the different groups. The first group of exercises called for "skull cavity" were built on humming, on nasal and at soft-palate formed consonants and closed-velar vowels. The other group of exercises called for "oral cavity" were built on voiceless consonants and illabial, closed-palatal vowels. Results: the 15 minute long warm-ups seemed still short for efficacy. The effects on the

various vowels did not show any significant differences. There was no discrepancy in the efficiency of the warm-ups on groups with the different voice training antecedent. Between the parameters, the mean of sound pressure was more sensitive than the THT (Total Harmonic Distorsion). The paired samples-t statistical analysis signed by males, the correlation by the females more changes (*Altorjay*, 2012a; *Altorjay*, 2012b; *Altorjay*, 2012e).

Third experimental measurement**:** our goal was to test the effectiveness of longer, 25 minute long two types of warm-up exercises called „nasal" and „oral". The "nasal" exercises were based on the syllables compiled with [m, n, ɲ, g, ɟj] consonants and [u, o, ɒ] vowels. The "oral" exercises were based on the syllables compiled with [f, h, s] consonants and [ɛ, e, a] vowels. We recruited participants - 11 females, 11 males – with longer voice training experiences, and we also wondered whether the effect of the warm-up differs on the extreme – high and low - pitches of their personal voice tessitura. Results: we have found that the THT parameter is not sensitive enough to detect changes with overtones. The examination of extreme pitches did not produce any plus results, so the analysis of middle voice pitches seemed to be enough (*Altorjay*, 2013c; *Altorjay*, 2014a).

Fourth experimental measurement: our goal was to test warm-up task with two-section - first „for mouth", second „for nose" - with especially regard to the additional efficacy of the second – „for nose" - section. We were able to involve 14 females in this study. The duration of the warm-up sections were one by one 15 minutes. The syllables of the "for mouth" section were compiled with [f, r, l, j, t, ɟj, s, h] consonants and [a, e, i] vowels. In the second "for nose" section we used humming with closed and opened mouth, and syllables of [u, a] vowels only. Instead of the THT parameter, we analyzed the mean of sound pressure of the F0 (fundamental frequency) and of the first seven (H1-H7) overtones. Results: the beneficial plus effect of the second "for nose" section after the „for mouth" one has been clearly demonstrated. Instead of THT parameter, the analysis of H1-H7 overtones was efficient. For statistical analysis, the correlation was successfully replaced with the more picturesque cluster analysis. As a new analysis, we also tested the "repeated measures ANOVA" which particularly indicated the efficacy of the second warm-up – „for nose"- section at the [u] vowel. The analysis of the vowels [a, i, u] proved to be sufficient for demonstrating the effects (*Altorjay*, 2013d).

Fifth experimental measurement: our goal is to extend the experience of the fourth measurement by increasing the number of participants and extend also on two genres and

different voice categories. We could involve 36 persons - 25 females, 11 males – into the investigation. For the initial „for mouth" warm-up section we compiled syllables with [f, l, ʃ, h] consonants and [a] vowel, and for the second section "for nasal" we applied humming with closed and opened mouth, and [gu- ɲu], syllables. The vowels analysed and the analysed parameters remained the same as used at the fourth measurement. The cluster analysis was extended beside parameters on cases. Results: the paired samples-t, the cluster and the "repeated measures ANOVA" analysis showed also the beneficial, additive effect of "for nose"second section. From the results may be emphasized the sensitive reaction on the warm-up sections of vowel [a] and the mezzo subgroup (*Altorjay*, 2014b).

Sixth experimental measurement: our goal was to try out at the fifth measurement well-tried exercise sections but in reverse order. We wanted to investigate whether the warm-up exercises consist of 15 minute long sections with „for mouth – for nose" order or with „for nose – for mouth" sequence are more effecient. We were able to recruit 20 persons (10 females, 10 males) for this measurement, among those who already participated in the previous – fifth - measurement as well. The parameters analyzed and the statistical methods used, remained the same, tried out at the fifth measurement. Results: at the investigated 9 – mean of sound pressure, F0, H1-H7 - parameters, at the majority of vowels and groups the advantage of the „for nose-for mouth" warm-up sequence was proved. In the cluster analysis, it was found that the group of voice categories were mixed by the „for mouth-for nose" sequence, while the „for nose-for mouth" sequence reinforced the internal relationships inside the groups to a significant degree. "Repeated measures ANOVA" showed the advantage of „for nose-for mouth" sequence, at the female subgroup (*Altorjay*, 2015a).

Seventh experimental measurement**:** our goal was to compare the effect of two types of – „for resistance" and „for fluxation" - developed, 25 minute long singing warm-up excercises with a larger – consists of 36 persons - group. Both genres - 27 females, 9 males - were represented. This number of participants also allowed investigating the subgroups of female voice categories. We organized two separate warm-up sessions. On the first so called. "for resistance" occasion, we used humming with closed and opened mouth, sometimes with finger-pinch, then singing [mœ-ɲœ-nœ, bœ-rœ-gœ] syllables and phonaion in PVC tube. On the second so-called "for fluxation" occasion after breathing and muscle relaxation exercises we used [fœ-ʃœ-lœ, sœ-lœ-hœ] syllables, then only vowels for singing. The investigated parameters were fulfiled with the number of separate overtones and with SNR (= Signal + Noise Ratio) of three sections of the FFT figure. The statistical analysis we fulfiled the well-

tried paired samples-t and cluster with Cohen-d and regression analysis. Results: the paired samples-t and the Cohen-d analysis at every vowel and at each group demonstrated the advantage of the "for resistance" warm-up occasion (*Altorjay*, 2015b; *Altorjay*, 2015c; *Altorjay*, 2016b).

Our experiences summarized**:** our results show that, beside great variability of personal capability and singing voice development, the resonating the nasal and connected cavities into the singing voice have real benefitial effect on overtones and on the sound pressure. Additionally, it is more efficient to initiate the warm-up exercises with exercises for enhancing the resistance of the vocal tract, and then to continue with exercises only using vowels and those that help the fluxation of the singing voice. With our results, all of our seven hypotheses could have been proven:

1. With the practicing of so called „for nose" warm-up exercises – enhancing the resistance of the vocal tract, enriching the overtone content of the voice - we can ineducate the resonance of the nasal and connecting cavities into the resonance of the vocal tract and so into the singing voice as well.

2. Our results demonstrated that the preferably compiled 10-15 minute long warm-up exercises are already effective, but with a further 10 to 15 minutes long extension are more effective (1. hypothesis).

3. The so called warm-up exercises „for nose" did not cause unavoidable nasalisation in the timbre of the singing voice (2. hypothesis).

4. For increasing voice volume, for making FFT sound image more articulated, to reinforze more overtones on the FFT figure, ensure better those exercises which enhance the resistance of the vocal tract. We called these exercises „for nose", „for resistance". These tasks consist of humming, and singing exercises, compiled from syllabes of nasal and explosive consonants and closed-velar-labial vowels. The exercises, called „for mouth", „for fluxation" compiled from syllabes of voiceless spirantes and laterales consonants and opened-palatal-illabial vowels ensure the above mentioned effects significantly less (1, 3, 4, 5, 6. hypothesis).

5. In practice, of course, it is impossible to lack both kinds of exercises. In singing texts we have to vocalize all kind of consonants and vowels, in several kinds of text-circumtences, in different order, arrangement, proportion.

6. From the previous statements is also clear that the order of warm-up exercises is also important for the practice of sound training. The present study has shown that it is most effective if we start with tasks that increase the resistance of the vocal tract and finish with those tasks that enhance the free fluxation of the singing voice (hypothesis 7).

7. Warm-up practice used consequently and regularly makes the singing voice not only temporarily, but permanently more loadable, flexible, more rich and more pervasive in timbre. The beautiful, for the audience enjoyable singing voice can be formed only with those cavities of the vocal tract which are opened, spacious, well resonated and so let the singing voice flowing facilely, unimpeded. For training such a beautiful singing voice we need to practice regularly both kinds of warm-up tasks in proper rate and order.

5. Usefulness of the research, conclusions

The exercises detailed in the dissertation are suitable for further thought, giving new ideas, inspire further creative scale compositions. For helping this goal, we collected together all the singing tasks in Chapter 11 – appendix - of the dissertation.

Our results highlighted the special benefit effect for voice training of the tasks, which increase the resistance of the vocal tract. These tasks can be cosciously used for demanding private voice training and for practise of the students at home as well.

We have gained our experiences with the individual warm-ups of adolescents and adults after their change of voice, but of course these can be extended for warming-up of adolescent and adult mixed and of homogeneous choirs. The results can also be used in classroom singing lessons. Without any further research, we do not recommend the automatic extension of our edifications for children, before of their change of voice.

6. Literature

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