

pas5

5th International Conference on the Physiology & Acoustics of Singing

August 10-13, 2010



KTH, Stockholm, Sweden



The 5th International Conference on the Physiology & Acoustics of Singing

General information

Address of conference venue: Lindstedtsvägen 26
Nearest underground station: Tekniska Högskolan

Useful telephone numbers

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KTH emergency 08 790 7700

Meetagain, Ms Ewa-Karin Franck 070 725 1919
TMH, Dr Gláucia Salomão 076 794 3569
TMH, Ms Roxana Wahlström Romero 08 790 7559
TMH, Prof Sten Ternström 070 722 0911

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pas5

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Ronald Scherer, Harm Schutte, Johan Sundberg, Jan Švec, Sten Ternström

Organising Committee

Sten Ternström (chair)
Roxana Wahlström-Romero
Gláucia Laís Salomão

Conference Bureau

Meetagain
www.meetagain.se

Function	"LV"=Lindstedtsvägen
Welcome Reception	TMH Department, LV 24 level 5
Papers	Auditorium F2, LV 26
Workshops SOUNDS	Room 4136, LV 26
Workshops METHODS	Room Fantum, LV 24 level 5
Workshops CHOIR	Room F11, LV 22
Posters	"Sing-sing" LV 30
Coffee and lunch	"Sing-sing" LV 30

Your notes:

Welcome!

Dear colleagues and friends,

on behalf of the PAS5 organising committee, I am very pleased to welcome you to Stockholm, for the fifth international conference on the acoustics and physiology of singing! We are sure that you will find the conference programme busy and interesting, and that you will make many new contacts. We hope that this Stockholm meeting will meet your expectations, and that you will have time also to see something of our beautiful city during your stay.

The three days are loosely organised around the three themes of singing voice acoustics, singing voice physiology and applications of singing voice research. I am especially grateful to the introducing speakers for each day: Ronald Scherer, Nathalie Henrich and Matthias Echternach, who will outline and put into context the presentations of the day ahead.

I would like also to thank the sponsors of PAS5: the Wenner-Gren Foundations, KTH, the City of Stockholm, and Röstfonden, the Swedish Voice Fund for their contributions that made this conference possible.

Most of all, thank you for coming to PAS5, and enjoy the conference!

Sten Ternström

General Chair, PAS5

WEDNESDAY, 11th August

Registration opens		
08:15		
08:40	Ronald Scherer	
09:20	Fairborz Alipour	
09:40	Christian Herbst	
10:00	Laura Enflo	
10:20	Peter Pabon	
10:40		
COFFEE BREAK		
11:00	Johan Sundberg	
11:20	Brian Gill	
11:40	Maëva Garnier	
12:00	Wolfgang Saus	
12:20		
LUNCH		
POSTER PRESENTATIONS		
13:20	Asoke Datta	
13:40	Gláucia Laís Salomão	
14:00	Brian Monson	
14:20	Sten Ternström, R Sousa	
14:40		
COFFEE BREAK		
WORKSHOP SESSIONS 1 and 2		
	SOUNDS	
	METHODS	
	CHORAL	
15:00	Workshop Session 1	
	Alberto ter Doest	
	Anyepiglottic narrowing for singer's formant	
	Matt Speed	
	Modelling the vocal tract with VTK	
16:00	Workshop Session 2	
	Wolfgang Saus	
	Overtone singing	
	Donald Miller	
	The singing voice & the EGG	
17:00	(T-bana to T-Centralen, walk to City Hall)	
18:00	RECEPTION AT THE STOCKHOLM CITY HALL (pre-registration is required)	
20:00	Laura Avery	
23:00	Tuning your choral pipes	
	Martin Ashley	
	Young Male Participation	
Open mike evening at KTH room Fantum		

THURSDAY, 12th August

Doors open	
08:15	
08:40	<i>Nathalie Henrich</i> Current topics in Singing Voice Physiology
09:20	<i>Dirk Mürbe</i> Influence of laryngeal and vocal tract morphology on voice classification in singers
09:40	<i>Hyunhi Kim</i> The relationship between singers' body type and breathing in classical singing
10:00	<i>Viggo Pettersen</i> The movement and the electrical activity of the diaphragm during breathing for classical singing
10:20	<i>Monika Hein</i> Subglottal pressure, lung volume and breathing movements in Belting and Legit
10:40	COFFEE BREAK
11:00	<i>Marina Gilman</i> The impact of posture on EGG signal, acoustic and aerodynamic output
11:20	<i>Nathalie Henrich</i> Voice range profile of subglottal pressure in singing: a pilot study
11:40	<i>Sylvain Lamesch</i> How do singers manage vowels depending on the laryngeal mechanism?
12:00	<i>Pedro Amarante Andrade</i> Analysis of the dynamic mechanisms behind VF muscle contraction in the chest-to-head passaggio
12:20	LUNCH
	POSTER PRESENTATIONS
13:20	<i>Johanna Devaney</i> A study of horizontal and vertical intonation tendencies in SATB ensembles
13:40	<i>David Howard</i> Intonation drift in a cappella quartet singing of choral repertoire
14:00	<i>James Daugherty</i> The effects of riser step heights and singer spacing [...]
14:20	<i>Laurier Fagnan</i> Ingressive vocal fry: its acoustic and physiological properties and usefulness in choral singing
14:40	COFFEE BREAK
	WORKSHOP SESSIONS 3 and 4
15:00	SOUNDS
15:00	<i>Ken Bozeman</i> Application of F1/H2 in the male passaggio
15:00	<i>John Nix</i> Smoothing lower register bridge in females
15:00	Workshop Session 3
15:00	Workshop Session 4
16:00	<i>Marina Gilman</i> Posture for singing - what do we teach?
16:00	<i>D R Karna</i> Using the IPA in choral rehearsal
17:00	Free time
19:00	Dinner, aboard M/S Gustavsberg VII
23:00	Departs from Nybrokajen at 19.00

FRIDAY, 13th August	
	Doors open
08:15	
08:45	<i>Matthias Echternach</i> Current Applications of Singing Voice Science
09:20	<i>Filipa Lá</i> Sex steroid hormones and intonation accuracy in singing
09:40	<i>Deirdre Michael</i> Assessing intonation: perceptual strategies and acoustic parameters
10:00	<i>Mäva Garnier</i> Physiological and acoustic comparison of four qualities used in the female Music Theatre voice
10:20	<i>Ann-Christine Mecke</i> Gender differences in childrens' singing voices: Acoustic analyses and results of a listening test
10:40	COFFEE BREAK
11:00	<i>Jan Hammar</i> Computer software in singing teaching: advantages, risks and the roles of teacher and student.
11:20	<i>Joana Mariz de Sousa</i> Metaphors in vocal pedagogy: a research on imagery in different styles of singing
11:40	<i>John Nix</i> Singer self-perceptions regarding singing with and without vibrato
12:00	<i>Richard Morris et al</i> The Effect of Training on Passaggio Transition Gestures
12:20	LUNCH
	POSTER PRESENTATIONS
13:20	<i>Orietta Calcinoni</i> Dosimetry to assess vocal load in classical choir singers
13:40	<i>Christopher Gaskill</i> Comparison of the accumulated vocal dose across three singing styles
14:00	<i>Stephen Robertson</i> Conservatoire singers' development using the spectrograph
14:20	<i>Matthias Echternach</i> Vocal tract configurations in tenor register functions on different vowels
14:40	COFFEE BREAK
15:00	WORKSHOP SESSION 5
	SOUNDS
15:00	Workshop Session 5 <i>Laura Avery</i> Musical Theatre Bel Canto technique for choirs
	CHORAL <i>Laurier Fagnan</i>
16:00	BEST POSTER AWARD
17:00	NEXT PAS CONFERENCE, CLOSING REMARKS

Poster Abstracts

In alphabetical order by first author

Vocal imitation in the general population

Magdalena Berkowska

University of Finance and Management in Warsaw

Recent evidence obtained with acoustical methods indicates that occasional singers are proficient in singing well-known melodies with lyrics from memory provided that they sing at a slow tempo (Dalla Bella, Giguere, & Peretz, 2007; Dalla Bella & Berkowska, 2009). Other studies focused on vocal imitation abilities in normal individuals (Pfordresher & Brown, 2007) and in congenital amusics (Hutchins et al., 2010). In this study we aimed to examine nonmusicians' accuracy in imitating single pitches, intervals and short unfamiliar melodies, as compared to the results obtained in singing from memory tasks. Fifty occasional singers imitated single pitches, intervals (ascending and descending), and six novel melodies. All stimuli were adapted to participants' vocal range. Each performance was analyzed with an acoustically-based method (as in Dalla Bella et al., 2007; 2009) yielding objective measures of accuracy in terms of absolute and relative pitch and time. The obtained results allowed to elucidate vocal imitation abilities in the general population and to qualify some individuals as being poor vocal imitators.

REFERENCES

- Dalla Bella, S., & Berkowska M. (2009). Singing proficiency in the majority: Normality and "phenotypes"; of poor singing. *Annals of the New York Academy of Sciences*, 1169, 99-107.
- Dalla Bella, S., Giguère, J-F., & Peretz, I. (2009). Singing in congenital amusia. *Journal of the Acoustical Society of America*, 126(1), 414-424.
- Dalla Bella, S., Giguère, J-F., & Peretz, I. (2007). Singing proficiency in the general population. *Journal of the Acoustical Society of America*, 121, 1182-1189.
- Hutchins, S., Zarate, JM., Zatorre, R. & Peretz, I. (2010). An acoustical study of vocal pitch matching in congenital amusia. *Journal of The Acoustical Society of America*, 127(1), 504-12
- Pfordresher, P.Q., & Brown, S. (2007). Poor-pitch singing in the absence of "tone-deafness", *Music Perception*, 25, 95-115.

Environmental influence on the vocal status of professional classical singers

Kåre Bjørkøy

Norwegian University of Technology and Science, Trondheim

97 professional classical singers situated in Norway, Sweden and USA were interviewed about their vocal health, vocal development and voice training habits. Most of the interviewees have a background as opera singers. The article presents a survey of how Scandinavian Opera Houses handle indoor climate problems, through moisturising and cleaning routines. The questionnaire focused on how the singers react to dry and dusty air, and to which extent the singers had experience of any kind of allergy.

The material shows that most classical singers are prone to voice problems due to dry and dusty air. The symptoms were described as loss of range and flexibility, and as an unreliable voice quality.

The material does not reveal any differences in how singers connected to certain opera houses or countries describe their vocal problems due to indoor climate. The symptoms are the same. However, sopranos seem to have slightly more voice problems caused by dry and dusty air than do other voice categories.

These problems occur equally frequently in young and old singers.

Singers as a group seem to be especially aware of how mental health and voice condition are connected to each other. The questionnaire supports the hypothesis that indoor environment, especially the air quality, has a great influence on singers' vocal status, and that this in turn influences their mental condition.

On capturing the essence of raga from actual vocal performances

Asoke Kumar Datta

ITC Sangeet Research Academy

A quantitative method for assessment of progress of students of Hindustani music is proposed. In the present study the accuracy of notes and their variations and the depiction of the general concept of a raga is only attempted. In Hindustani music because of the need of instant improvisation and maintenance of vadya pinpoint accuracy of note placement need not be adhered to. Some variation in note placement is necessary. Further there is no rigid standard of the concept of a raga. This can be viewed to reside, inter alia, in the relative preponderances of different allowable notes as well as in the selection of phrases. In the absence of a comprehensive general standard, the parameters, which define these basic elements of description, the song of an eminent is taken as the reference. There are five basic points on which the assessment is to be made. These are accuracy of notes, variability of notes, frequency distribution of notes and the nature of the distribution of sung pitch values.

The parameters defining these basic elements are obtained from the pitch extracted from the songs. Notes are extracted through developed software. In the present study two idols for the students are taken as standards for assessment. The data consists of notes extracted from the ragas rendered by four students under idol 1 and three students under idol 2 as well as the performances of the idols in the ragas required. The ragas used for analysis are ten in number. The analysis shows reasonable compliance of most of the students with their chosen idols. The relevance of each parameter reflected through the analysis of the data is also presented.

Subjective evaluation of voice properties in singing performance

Marek Fric

Musical acoustics research centre, Czech Republic

The goal of presented experiment was to judge the singing voice in listening tests applied to a group of subjects in different level of voice education. The group consisted of 18 subjects (2 operatic singers, 6 professional actors and 10 beginning students of acting). Recordings were made of singing of a generally known Czech folk song in two tonalities (distance 5 semitones). Recordings were evaluated separately for each tonality in psychoacoustic listening tests. Firstly, by mean of subjective rating scale procedure (PROV) described in [Oates, J. M., Bain, B., Davis, P., Chapman, J., and Kenny, D.(2006): Development of an auditory-perceptual rating instrument for the operatic singing voice, *J. Voice*, 20, (1), 71 - 81], which rates following properties: overall vocal performance, appropriate vibrato, resonance balance, ring, pitch accuracy, breath management, evenness through the range, and strain. Secondly, evaluation was based on the dissimilarities between all stimulus pairs from all used recordings. Pair comparison test also consists of preferences in overall quality, and operative spontaneous word description tasks. Results of listening tests were statistically analyzed by mean of multidimensional scaling (MDS). MDS analysis, based on dissimilarities, places the used stimuli into multi-dimensional model of a subject's perception space. Our statistical results indicate: PROV evaluation procedure only describes subject's singing abilities but does not classify them; MDS creates model with more than 4 dimensions. This model was interpreted by emersion of different types of external parameters (PROV and also spontaneous word descriptions). In contribution there are discussed the results of experiment, which indicate a need for a next research.

Rapid pitch correction in choir singers

Anke Grell (1, 2) Eckart Altenmüller (2), Sten Ternström (1), Martin Ptok (3), Johan Sundberg (1)

(1) Royal Institute of Technology (KTH), Sweden

(2) University of Music and Drama Hannover

(3) Hannover Medical School Department of Phoniatriy and Paediatric Audiology

Previous investigations (Burnett TA, Freedland MB, Larson CR, Hain TC. Voice F0 responses to manipulations in pitch feedback. *J Acoust Soc Am* 1998; 103: 3153-61) have revealed that two neural pathways seem engaged in untrained voices' pitch control, one fast and one slower. Proprioception can be assumed to be relevant to pitch control. In the present investigation we examined the reaction time for pitch changes in three groups of subjects, highly skilled singers, moderately skilled singers and moderately skilled singers with anaesthetized vocal folds (topical application of Xylocain® spray). The singers listened to a perfect fifth and were requested to complement this fifth with the major third so as to complete the triad. While the subjects were sustaining the third, the reference fifth suddenly shifted up or down in pitch, by a semitone or a quartertone, and the singers were instructed to adapt as quickly as they could to the changed standard. The subjects repeated each of the four conditions fifteen times. The data showed a substantial inter- as well as intrasubject variation. The reaction time, averaged across conditions, amounted to 227 ms (SD 120 ms) for the highly skilled singers, to 206 ms (SD 135 ms) for the moderately

skilled singers and to 251 ms (SD 122 ms) for the moderately skilled singers with anaesthetized vocal folds. All these differences were statistically significant. However, the average reaction time varied somewhat depending on condition. Thus, it tended to be significantly shorter for semitone shifts than for quartertone shifts in all subject groups, possibly because a semitone interval was much more familiar to the singers than a quarter tone interval. The direction of the shift, on the other hand, did not seem to have any great effect.

For some of the singers, however, the mean pitch shift curve across the fifteen repeats of a particular condition was clearly divided into two phases, an early major shift followed by a later smaller shift. This seems to be in accordance with the earlier observation (Burnett and Coworkers) of a double pitch control pathway. The singers may perform the early main pitch shift relying on brain stem mechanisms and resort to the slower cortical mechanism in cases the first pitch change failed to reach the intended target.

Our investigation has shown that most singers have a rather quick reaction to a shift in an external auditory pitch reference. In a choir the fellow singers generally provide this reference and it is important that the entire ensemble synchronize their pitch changes. At least in many amateur choirs, one individual in each voice tends to act as a leader and the fellow singers mainly follow this leader when they sing.

Determining Optimal Fluid Intake for Singers

Anna Christine Hersey
University of Miami

The purpose of this poster is to give an overview of current research concerning fluid intake and hydration in order to give singers a source of concrete information when deciding how to adequately hydrate. The standard for hydration that many doctors, health experts, and the popular press have adopted is an intake of eight 8-ounce (237 ml) glasses of water daily. However, this recommendation is not backed by any scientific studies. How does one determine an optimal level of hydration? Recommendations are numerous and conflicting, and they leave many questions unanswered. Optimal hydration is crucial for singers on systemic, local tissue, and mucosal levels. Dehydration equal to just 2 percent of body weight has been shown to interfere with cardiovascular performance, body temperature regulation, nervous system function, and metabolism. Additionally, dehydration can cause fatigue and decreased cognitive ability, affecting motor control. At the local tissue and mucosal level, hydration of the vocal folds has been shown to decrease viscosity and stiffness, and therefore decrease phonation threshold pressure.

So how much water is enough? The Institute of Medicine (United States) recently published new recommendations for water intake, setting an Adequate Intake level for healthy adults. Current recommendations are between 2.7 L and 3.7 L daily for adults, although most liquid intake is through water-rich foods, such as fruits and vegetables, and beverages other than water, including milk, orange juice, decaffeinated tea, and even coffee.

While researchers do not agree how to determine optimal water intake, they concur that more research is needed. Therefore, hard-and-fast rules about water intake cannot be defined; each singer must determine how to adequately hydrate for peak performance.

Processing of linguistic and musical dimensions contained in songs: effects of an expertise

Pauline Larrouy-Maestri

Université de Liège

Songs are universal in our lives and also offer an ecological material that links linguistic and musical information. It therefore provides a tool for observing the relationship between music and language. To examine the specificity of language and music information processing in songs, we studied the influence of expertise (i.e. musicians or speech therapists) on the use of transitional probabilities (TPs) in learning an artificial language (AL) either spoken or sung. This type of implicit statistical learning is especially important in language development (Saffran, Aslin, & Newport, 1996). We used the paradigm designed by Schön, Boyer, Moreno, Besson, Peretz and Kolinsky (2008). These authors have demonstrated the benefit of structural and motivational proprieties of music contained in the song in the learning process of AL in individuals with no expertise. Compared to a spoken AL, learning was enhanced for a singing AL, especially when the TPs of musical and linguistic materials were congruent.

Our results did not replicate those of this study in participants having no music expertise. However, an interaction occurred between the type of AL and expertise of the participants. Indeed, only music experts seemed to benefit from the congruence between the TPs of musical and linguistic materials in extracting TP-based linguistic units. On the opposite, experts in language seemed to be favoured by the incongruence between the TPs of linguistic and musical information. These results are discussed in relation to the notions of the specificity of processing of lyrics and tunes in songs.

Changes in pitch and vowels in the singing and spoken production of professional and non-professional singers.

Antonio Carlos Silvano Pessotti

Lafape/Dinafon/Unicamp

Singers are safe when they sing with musical accompaniment. The tuning of singers is impaired if the singer has proficiency. This study investigates whether no influence of singing with accompaniment in vocal production. Reports show the non-professional singers improve their performances when they sing with musical accompaniment. The spoken production appears to be very different from singing, but reports show professional singers seem to shift the way of singing to speaking. Were performed recording ten singers (sopranos), five professional and five non-professionals. The chosen song (Conselhos, Carlos Gomes) was recorded with and without monitoring, as well as read. Analysis via Dynamic Time Warping (DTW) complemented the results of tuning.

The results were satisfactory regarding the alignment pitch of the professional singers when they sang with and without monitoring. Non-professional singers do not tune when they sing without musical accompaniment. Vowel change was noted in the production of non-professionals as a way to maintain the vowel sung posture in two recordings of professional singers, and recording spoken of the same singers. The findings seem to corroborate previous studies on perception and vowel change in

various contexts of musical harmony. Articulatory Phonology (or Gestural) was adopted as the theoretical basis of the possible chain of coupled oscillators performed in singing and variability in speech. Same theoretical basis could explain the variability of non-professional informants when they sing with and without musical accompaniment.

The movement and the electrical activity of the diaphragm during breathing for classical singing

Viggo Pettersen

University of Stavanger

Introduction: This study utilized ultrasound imaging (USI) to examining the movement of the diaphragm (DPH), and electromyography (EMG) to explore the electrical activity of the DPH by two student classical singers. Material and method: The anterior section of DPH (ADPH) was investigated by placing the probe laterally to the midline. The dorsal section (DDPH) was investigated by placing the probe on the back, left of the midline. EMG activity was recorded from both ADPH and DDPH. Results: Most of the USI recordings by the anterior scan showed that the ascending movement of DPH was close to linear during phonation of sustained tones and ascending and descending intervals, with the exception of small caudal adjustments observed by descending quart intervals and descending octave intervals initiated at high pitches. The corresponding recordings by the dorsal transducer showed an ascending linear movement during the sustained tones and a more bumpy movement pattern during phonation of intervals. The EMG recordings showed, firstly, that the DPH EMG activity increased towards the end of all sustained breathing sequences and was released during the first part of the following inhalation. If the inhalation was aimed at a new long breathing sequence, the DPH was activated during the second part of the

inhalation sequence. If phonation was not aimed at, the DPH was, in most cases, not activated during inhalation. Secondly, the minor descending adjustments observed in the ADPH by demanding descending pitch changes and, the bumpy movement patterns observed in corresponding tasks of the DDPH, are apparently influenced by activity of the DPH itself. By less demanding descending pitch changes EMG activity, for the purpose of lowering the DPH during phonation, are predominantly observed in the ADPH. Discussion: The results will be discussed.

Voice Onset Time in Singing at different pitch in Indian classical Singers*K Pramoda*

J.S.S. Institute of Speech and Hearing, Mysore, India

This article investigates the singing voice which fosters our understanding of the behaviour of Voice Onset Time (VOT) on singing at different pitches in trained singers. Aim of the study was to compare VOT in singers while speaking and singing and to measure VOT at different fundamental frequency. Study included 13 (8 female & 5 male) trained Hindustani singers with a mean age range of 32- 40 years. Procedure included performance of two tasks; task 1 in which singers were asked to speak, the list of Hindi words with six stop consonants of /p/, /t/, /k/, /b/, /d/, /g/ in initial positions in a natural manner (S) and task 2 where the singers were asked to sing the words in 3 different conditions, singing at low pitch (L), mid pitch (M) and High pitch (H). Samples were recorded and analysed using PRAAT software. Multiple paired t test was administered and the results revealed that there was significant difference (<0.05) obtained at low pitch and speaking (L-S) for stop /p/ and significant difference obtained between singing at high pitch and speaking (H-S) for stop /k/ in females. VOT change across different pitches indicated that, there was no significant difference obtained in values for all voiced stops (/ba/, /da/, /ga/). It can be due to the extra effort used to produce precise articulation during singing compared to speaking while production of voiceless stop production. It can also be probably related to articulatory differences due to phonatory changes, since the laryngeal position varies during singing, the singers may elevate the laryngeal position for high and to keep the laryngeal position down for low pitches, such variations of VOT occur as a result of timing shifts in the articulatory gestures and the laryngeal gestures.

Phase Related Features Applied to the Singing Voice

Ricardo Sousa and Aníbal Ferreira

University of Porto, Portugal

Time and frequency-domain techniques are commonly used to analyze the singing voice. For example, inverse filtering techniques are used to extract the glottal excitation of the singing voice, and real or complex filter banks are used to analyze the frequency content of singing, typically the magnitude spectrum or the spectrogram. Signal features based on the magnitude spectrum are common in speech and speaker recognition. However, the phase spectrum is rarely used because it is difficult to interpret and manipulate. Most often the phase spectrum is ignored despite evidence showing that signals with the same magnitude spectrum but with different phase spectrum in fact sound differently to a human listener.

We introduce new phase-related features that express the delay between the harmonics relative to the fundamental of any periodic signal, notably of voiced singing. These features are identified as Normalized Relative Delay (NRD) and denote the phase contribution to the shape invariance of a periodic signal. Thus, NRDs are amenable to physical and psychophysical interpretation and are structurally independent of the overall time shift of the signal, an important property that is shared with the magnitude spectrum in the case of a locally stationary signal. We describe the NRD and report on preliminary studies testing the discrimination capability of NRDs applied to singing signals. As a reference, we include in our tests well-established features including Mel-Frequency Cepstral Coefficients (MFCCs) and time-domain parameters of the glottal pulse that are obtained using the TKK's Aparat software environment. We use the WEKA pattern recognition and classification environment. Our tests using the Nearest Neighbor classifier and the 10-fold cross-validation method, indicate that NRDs have a surprisingly competitive discrimination capability regarding the identification of sung vowels, the identification of the singer, and the identification of the phonation type in speech (breathy, normal, and pressed).

Wednesday, 11 August

8:30 Welcome and Announcements

Prof Sten Ternström

8:40 Current topics in Singing Voice Acoustics

Invited overview

Professor Ronald Scherer

Bowling Green University

9:20 Acoustic Contributions of the False Vocal Folds

Fariborz Alipour (1), E Finnegan (1)

(1) University of Iowa, United States of America

The relation between the acoustic spectrum of phonation and the level of participation of the false vocal folds (FVF) was investigated through the canine excised larynx model. In normal human phonation, the FVF are partially adducted and do not vibrate. The active participation of FVF as a source of phonation has been correlated with some functional voice disorders such as ventricular dysphonia. However, the vibration of FVF has been a positive contributor in some throat singing styles with pressed voice quality. The purpose of this study was to understand the acoustic contribution of the FVF. Canine larynges were prepared and mounted over a 3/4 inch tube, which supplied pressurized, heated, and humidified air. Oscillation was generated by controlling the flow of air through the glottis. The FVF were kept intact in the first part of the experiment and were removed in the second part. The raw data, including EGG, subglottal pressure, flowrate, and microphone signals, were recorded on a DAT tape and later digitized with Windaq A/D board and software and processed with Matlab. The superior video image was observed using a stroboscopic light and saved on a DVD tape for a later analysis. As pressure and flow increased with a sweep, the true folds oscillated first and in certain configurations, the FVF oscillated beyond 1.4 kPa subglottal pressure. Increase of the subglottal pressure affected the spectral partials with some positive effect on the H1-H2 until the FVF started oscillation. When the FVF vibrated (usually at higher pressures) a low frequency component was observed in the spectral data. Also, a comparison between the audio spectra of larynx with and without the FVF indicated some additional energy in the higher frequency range of 4-8 kHz which might be due to the resonance of the ventricular cavity.

Your notes:

9:40 Visualizing electroglottographic signals with wavegrams

Christian Herbst (1, 2), T Fitch (1), J Švec (2)

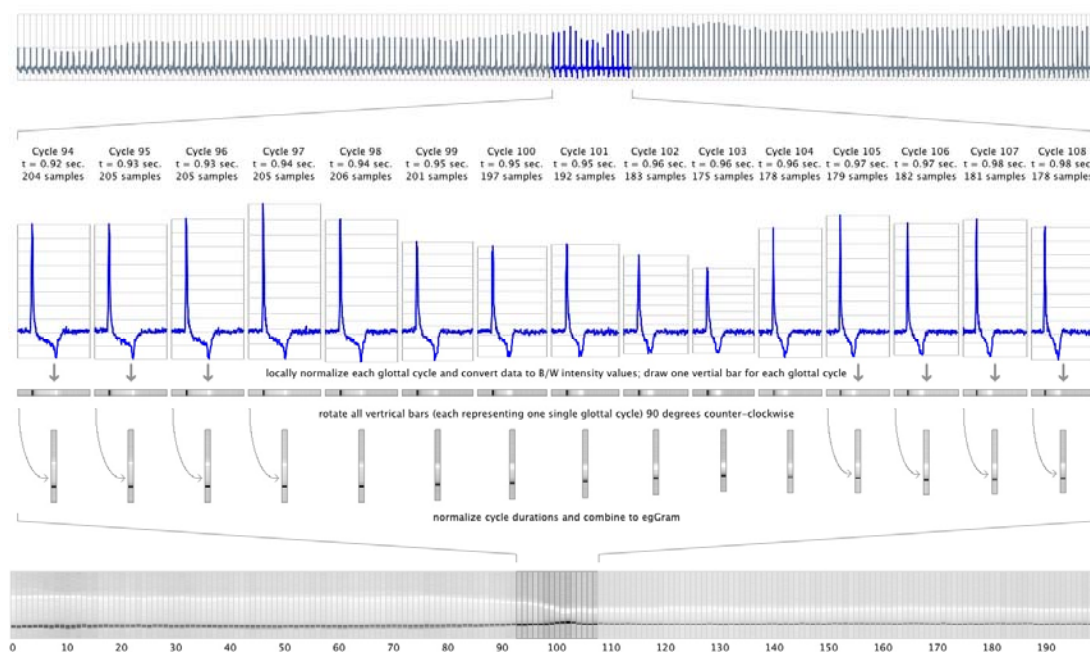
(1) University Vienna, Germany

(2) Laboratory of Biophysics, Dept. Experimental Physics, Palacky University Olomouc, Czech Republic

Electroglottography (EGG) is a non-invasive low-cost method to monitor relative vocal fold contact area (VFCA) during phonation. The increase and decrease of VFCA is related to glottal closing and opening, respectively. In this study, a new method for analyzing and displaying EGG signals (and their first derivative, DEGG) is introduced: the electroglottographic wavegram (short: wavegram). It (a) allows monitoring the EGG (or DEGG) signal over time; and (b) provides an intuitive means for quickly assessing the duration of glottal closure and its variation over time. Based on the EGG or DEGG signal, the time-varying fundamental frequency is calculated and consecutive individual glottal cycles are identified. Each cycle is locally normalized in duration and amplitude and the cycles are then plotted consecutively. The plotting process resembles that of a spectrogram, but instead of spectral amplitudes, the signal deflections are encoded by color intensity. The wavegram presents the time on x -axis, normalized cycle duration on y -axis and the signal deflection on the color-intensity-coded z -axis. The wavegram reveals changes of vocal fold contact duration in time. Besides of this, it shows phenomena that remain overlooked in traditional EGG-display techniques, such as multiple DEGG peaks. While these phenomena have usually been considered artifacts, the wavegram displays revealed consistent behavior of these peaks in a large number of subjects. They indicate subtle changes of vocal fold oscillatory regime. The wavegrams reveal that the phenomenon of vocal fold closing and opening is more complex than commonly assumed. Rather than a single event, vocal fold opening and closing should be considered a sequence of events, taking place over a period of time. Data show that the sequence of these events can change with pitch, loudness and register. The EGG signal thus promises to reveal more (physiological) information on vocal fold closure and opening events than previously thought.

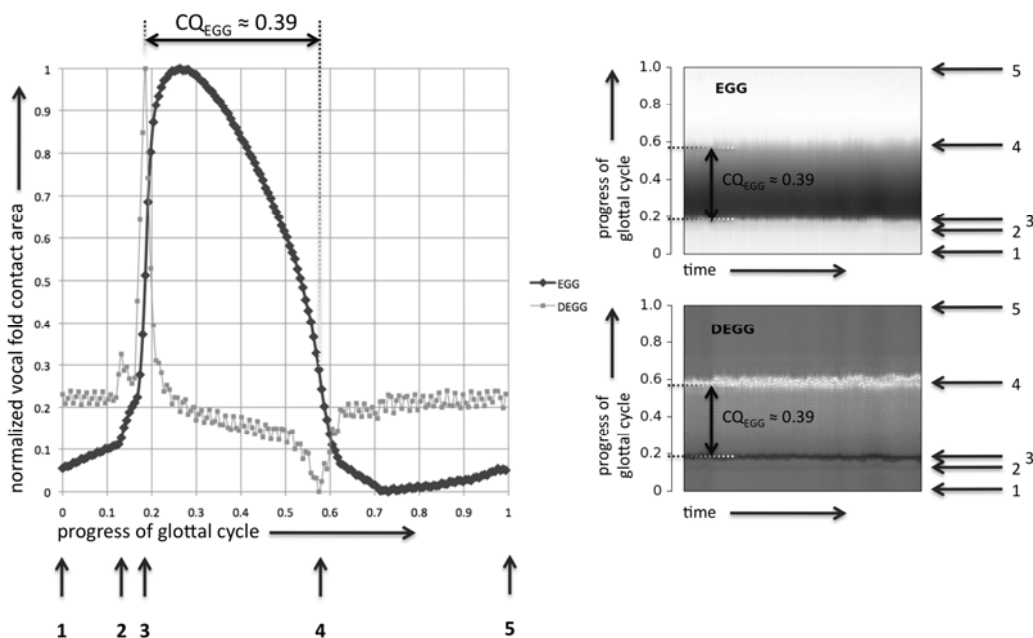
(figures on next pages)

Your notes:



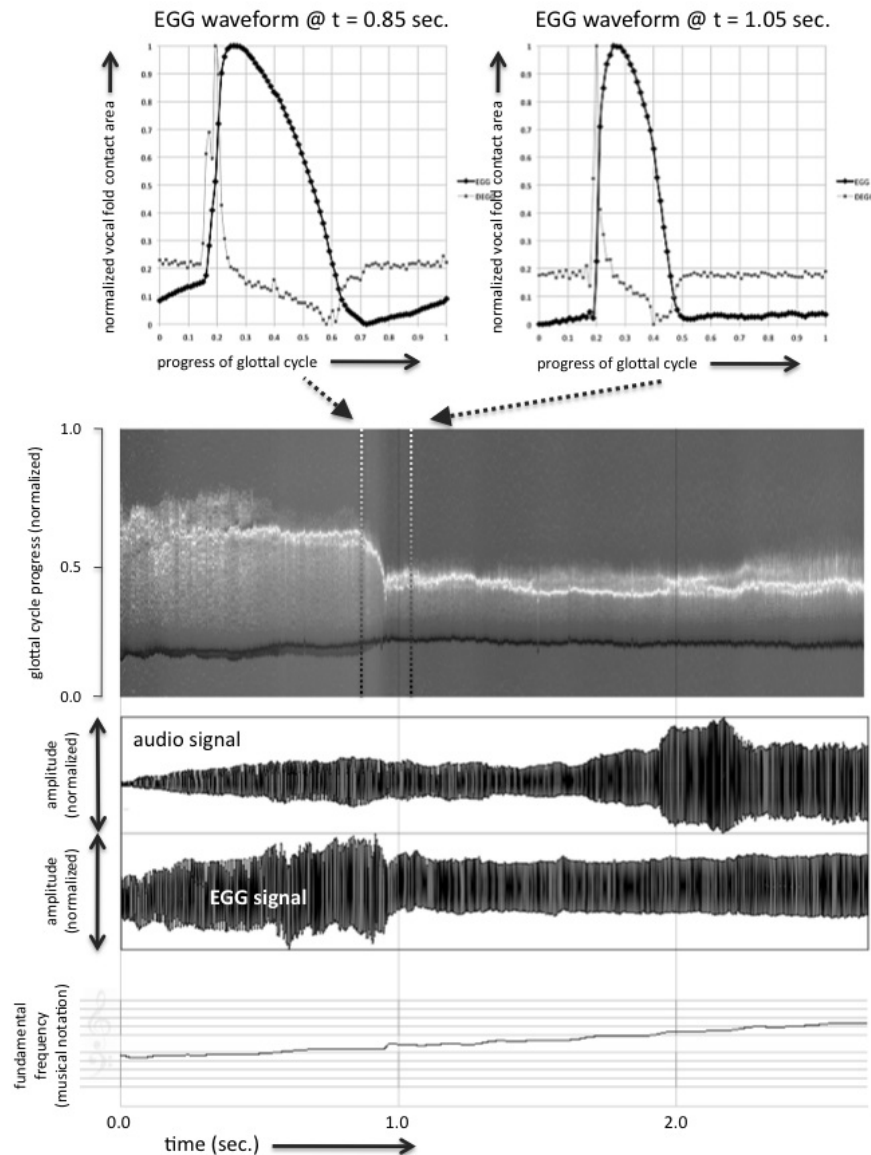
Wavegram

Illustration of the basic processing steps to create an electroglottographic Wavegram: consecutive glottal cycles of a DEGG signal are extracted (top row). The locally normalized data values are converted into monochrome color information, which is plotted as a temporary graph, representing one glottal cycle each (second row). Temporary graphs are rotated 90 degrees counter-clockwise. Glottal cycle duration is normalized by scaling the individual glottal cycle plots to the same height, and the resulting graphs are combined to form the final display, the EGG wavegram.



Landmarks

Typical Landmarks in the wavegram, both EGG-based [top right] and DEGG-based [bottom right], as related to the EGG signal of a single glottal cycle and its first derivative (left): (1) begin of glottal cycle, arbitrarily chosen in order to display the entire contact phase of the glottal cycle; (2) initiation of vocal fold closure; (3) maximum increase of vocal fold contact; (4) maximum decrease of vocal fold contact; (5) end of glottal cycle.



Register break

Changes of the EGG and audio signals in case of female phonation with increasing fundamental frequency. Top row: EGG and DEGG waveforms representing glottal cycles extracted at $t = 0.85$ sec. and $t = 1.05$ sec., respectively. 2nd row: DEGG wavegram; 3rd row: amplitude plot of audio and EGG signal; bottom row: fundamental frequency displayed in musical notation (ca. 208 Hz – 415 Hz). The data reveals an abrupt transition from chest to falsetto register at $t \approx 0.95$ sec, indicated by (a) a sudden decrease of glottal contact duration (wavegram); (b) a sudden decrease of EGG signal amplitude; and (c) an abrupt pitch jump.

Your notes:

10:00 Collision Threshold Pressure Investigations: Effects of Vocal Warm-Up and Vocal Loading

Laura Enflo (1), J Sundberg (1), F Pabst (2)

(1) Royal Institute of Technology (KTH), Sweden

(2) Hospital Dresden Friedrichstadt, Germany

Phonation threshold pressure (PTP), frequently used for characterizing vocal fold properties, is often difficult to measure. The first investigation analyses the lowest pressure initiating vocal fold collision (CTP). Microphone, electroglottograph (EGG), and oral pressure signals were recorded, before and after vocal warm-up, in 15 amateur singers, repeating the syllable /pa:/ at several fundamental frequencies with gradually decreasing vocal loudness. Subglottal pressure was estimated from oral pressure during the p-occlusion, using the audio and the EGG amplitudes as criteria for PTP and CTP. The coefficient of variation was mostly lower for CTP than for PTP. Both CTP and PTP tended to be higher before than after the warm-up. The results support the conclusion that CTP is a promising parameter in investigations of vocal fold characteristics. The phonation threshold pressure (PTP) has been found to increase during vocal fatigue. In the second study we compare PTP and collision threshold pressure (CTP) before and after vocal loading in singer and non-singer voices. Seven subjects repeated the vowel sequence /a,e,i,o,u/ at an SPL of at least 80 dB @ 0.3 m for 20 min. Before and after this loading the subjects' voices were recorded while they produced a diminuendo repeating the syllable /pa/. As in the first investigation, oral pressure during the /p/ occlusion was used as a measure of subglottal pressure. Both CTP and PTP increased significantly after the vocal loading.

Your notes:

10:20 On the transition to a state of accelerated closure

Peter Pabon (1,2,3)

(1) Royal Conservatory, Juliana van Stolberglaan 1, 2595 CA Den Haag, The Netherlands

(2) Voice Quality Systems, Utrecht, The Netherlands

(3) UIL-OTS, Utrecht University, The Netherlands

In its dynamic behaviour, the voice presents various non-linear phenomena that may not be immediately recognized as such. When the voice level rises, a sudden quality transition can be observed that is associated with a radical change of the voice waveform. The acoustic evidence surrounding this transition, like for instance the sudden overruling of the fundamental, points in the direction of the establishment of a vibratory state with accelerated closure. This phenomenon also seems to exhibit some state dependent behaviour, in that the accelerated closure regularly behaves as a "sticky attribute"; once established, the reverse transition becomes delayed. Efficient and/or fast closure is a well-recognized aspect of voice quality. However, its typical state-dependent behaviour, the characteristic suddenness of the dynamic transition, as well as its dependence on SPL and F_0 , have received little attention. Within the dynamic progression of a phonation, these aspects often remain concealed due to fact that an absolute reference is missing. The Voice Range Profile (VRP) presents a frame of reference for the study of dynamic manifestations of nonlinear phenomena. With the recording of a very diverse set of additional voice quality parameters, the outline of the above transition appears as one the most recognizable demarcation lines, one that comprises all parameters. Because the transition is so evident and perceptually transparent, yet so dynamically variable, it has remained unrecognized as an effective marker of voice function. In this paper, the manifestation of the transition with the different voice parameters is discussed and the state dependency is demonstrated. The conditioning of the transition and possible use as a marker of voice (dys)function is discussed. Also, the sometimes non-trivial influence of measurement conditions (such as microphone type and microphone distance) will be discussed.

Your notes:

11:00 Two formant strategies of professional male singers

Johan Sundberg (1), FMB Lã (2), B Gill (3)

(1) KTH, Sweden

(2) Department of Communication and Arts, INET-MD, University of Aveiro, Portugal

(3) NYU Steinhardt School of Culture, Education and Human Development, United States of America

It is a common assumption that male singers tune formants to the frequencies of spectrum partials in order to gain sound quality and sound level. A set of spectrum characteristics have been identified as important in equalizing registers in classically trained voices around the passaggio. For example, tuning of the first formant (F1) on the second partial (H2) for the vowel [a], just below the passaggio, and shifting the tuning of the second formant (F2) on the third partial (H3) in the passaggio or just above it. With regard to front vowels, like [i], the tuning begins with F1 on the first partial just below the passaggio and then shifts to a tuning where F2 tunes to the fourth (H4) or fifth harmonic (H5), in or just above the passaggio. To test these assumptions we recorded 8 professional singers (two tenors and six baritones) who were asked to sing an ascending scale, ending on pitches F4, F#4 or G4 (350 Hz, 370 Hz, and 392 Hz, respectively) so as to include their passaggio notes. These scales were sung on the vowels [a], [ae], [i] and [u], with two different formant strategies: (a) as in their normal classical singing technique, and (b) as in a non-classical singing style. Formant frequencies were measured using the custom made Decap inverse-filtering software (Svante Granqvist). Results suggest that there were differences between the two formant strategies, F1 being higher for the non-classical singing style. Additionally, in the passaggio region the first two formant frequencies tended to approach a spectrum partial.

Your notes:

11:20 Analysis of High-range Production by an Exemplary Non-classical Singer

Brian Gill (1), DG Miller (1)

(1) New York University, United States of America

(2) Groningen Voice Research, Groningen, The Netherlands

This study aims to 1) advance the description of a viable and healthy non-classical singing technique within the same framework that applies to classical technique by 1) acoustic analysis of a performance by a singer with demonstrated adeptness in the technique and 2) direct measurements of singers who can imitate it convincingly. David Phelps is a long-time singer of Christian pop who is at home in the same F0 range as an operatic tenor. Without resorting to falsetto he sings to C5 and above, where he uses the typical resonance strategy of his operatic counterparts, although he delays, in a sort of 'male belt,' the execution of passaggio until he passes A4, rather than F4, as is customary among operatic tenors. In the imitations we measure closed quotient (by EGG analysis) and subglottal pressure (indirectly in the esophagus) and compare these with measurements of a robust operatic tenor.

Your notes:

11:40 Glottal behaviour, resonance tuning and the upper limit to the high soprano range

Maëva Garnier (1), N Henrich (2), J Smith (1), J Wolfe (1)

(1) Music Acoustics Group, UNSW, Sydney, Australia

(2) Département Parole et Cognition, GIPSA-Lab, Grenoble, France

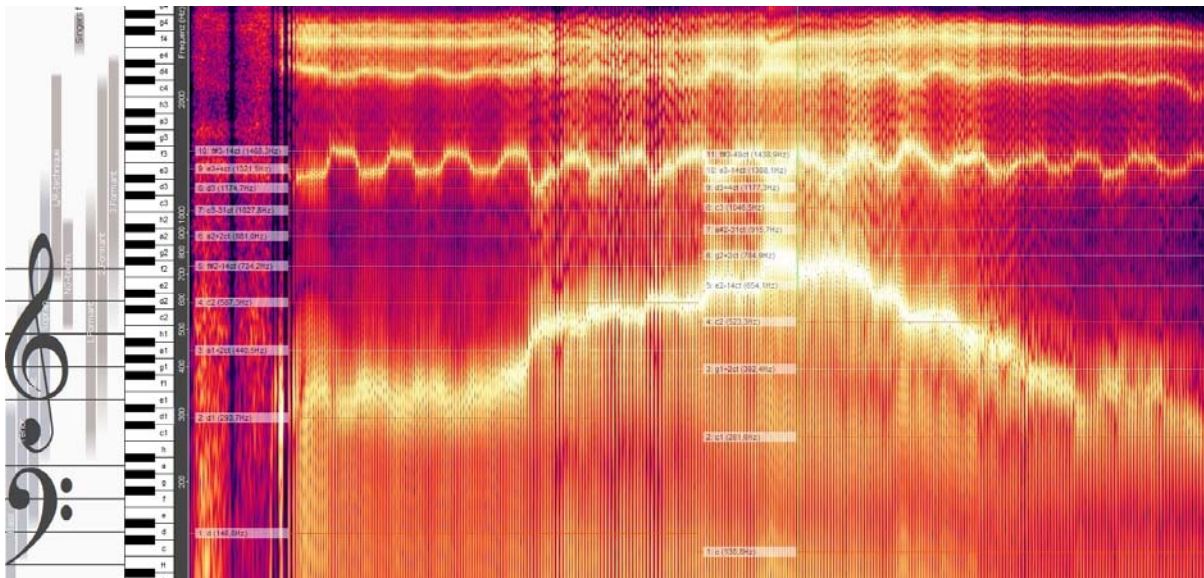
Twelve sopranos (4 non experts, 4 advanced, 4 professionals) produced *glissandi* up to their highest note (from 1000 to 2300 Hz). Later, they sustained pitches on [a] vowels, from A4 (~440 Hz) to their highest sustainable note. Between C5 and G5, all singers demonstrated a significant decrease in amplitude of the electroglottograph signal with increasing pitch, together with a change in waveform. This modification in glottal contact was either continuous, over a few tones range, or discontinuous, accompanied on glissandi by a pitch jump. Two singers could vary the pitch of this transition and therefore presented an overlap range over which they could produce either a 'full head' or a 'fluty' quality. Transition from one quality to the other on the same note was discontinuous and accompanied by a pitch jump. No other significant modification in glottal contact was observed at higher pitch. The frequencies (R1 and R2) of the first two vocal tract resonances were measured by broadband excitation at the mouth. Adjustment of R1 near to f_0 (R1: f_0 tuning) was observed below C6 for both expert and non-expert singers. Experts began this tuning at lower pitches. Some singers also exhibited R2:2 f_0 adjustment over the lower part of the R1: f_0 tuning range. In the very high range (above C6), the singers used one of two strategies. Some extended the R1: f_0 tuning as far as E6 or F#6. Others adjusted R2 near f_0 over the highest pitch range (up to D7). The limit of the sustainable range corresponded to the end of these resonance tunings. This strongly suggests that the upper limit of their useful singing range was determined by the upper limit of one or other resonance tuning mechanism. Further, it seems likely that learning R2: f_0 tuning might extend the practical upper range of some sopranos.

Your notes:

12:00 Formant Tuning Taken to a New LevelWolfgang Saus (1)

(1) Freelancer, Germany

Formant tuning is used by professional opera singers to achieve a brilliant and loud sound with minimal effort. It is also part of strategies to master the passagio. In professional choir singing, intuitive formant tuning is used to achieve homogeneous vowels. Overtone singing, by contrast, uses the formants as the primary musical instrument, clustering either first and second or second and third formants for intensified enhancement of individual harmonics. The formant configuration can then be varied over more than an octave. Training for overtone singing develops an exceptional control over formants, which can be utilized in conventional singing, taking formant tuning to a new level. Tuning of each of the first three formants individually can be achieved. Regarding vowels as formant chords, singers are then able to adjust formants to those partials that fit best into the musical context. Developing this skill requires training of conscious perception of formants as tonal pitches. In choral singing the choice of the enhanced harmonics can be critical to the intonation. Ingressive glottal fry is used to demonstrate the independent formant control in sonagrams. The author will demonstrate the varying effects of the second formant tuned to 8th, 9th or 10th harmonic in different vowels and different musical contexts.



Your notes:

13:20 Singing Synthesis Using Epoch Synchronous Overlap Add (ESOLA) Technique

Asoke Kumar Datta (1), A Saha (2)

(1) Society for Natural Language Technology Research, India

(2) CDAC-Kolkata, India

In singing three prosodic parameters, namely intonation, duration and intensity of the speech signal have to be controlled rigidly keeping the phonetic timbral quality undisturbed. The Indian musical score (swaralipi) presents the lyric and the rhythm (matra) on one line, the relative pitch information (sargam) and symbol for glissando on the second line registered properly. This paper presents a new technique Epoch Synchronous Overlap Add (ESOLA) for synthesizing a song from a given speaking voice using the swaralipi. The synthesizer consists of 2 parts, the processing of swaralipi to generate rhythm and pitch information and the speech signal modifier part. The speech signal is manually tagged indicating the start and end position of consonants, vowel and both the transition from vowel to consonant and vice-versa. This segmented part is mapped with the swaralipi for the duration calculation. The synthesis model consists of 3 units: Intonation control, Duration control and Amplitude control. The Intonation control unit generates the F0 contour of the singing voice by controlling three F0 fluctuations: overshoot, vibrato and fine fluctuation. The change of the F0 is done by ESOLA technique. It has been observed that changing of pitch by this method not only keep the formant structures of the speech signal constant but also introduction of spectral noise is insignificant. The Duration control unit lengthens or shortens the duration of each vocalic segment in the speaking voice by considering the duration of its musical note. The Amplitude control unit model controls the amplitude modulation of the modified speech signal for enhancing the melody of the synthesized song. One Rabindra sangeet and a small piece of raga sung on vowel /aa/ in style kheyal are generated. Experimental result shows that the quality of the song synthesized from the speaking voice resembles as that of actual singing voices.

Your notes:

13:40 Perceptual relevance of voice source characteristics in male singers' modal and falsetto registers

Gláucia Laís Salomão (1), Johan Sundberg (1)

(1) KTH, Sweden

It is commonly assumed that the voice source differs between modal and falsetto registers. However, singers often try to reduce the timbral differences between registers, some even doubting that they even exist. The purpose of this study was to investigate the relation between the perceived voice register and the voice source parameters in modal and in falsetto registers as analyzed by inverse filtering and electroglottography. A total of 52 falsetto register tones and 52 modal register tones, sung by 13 male more or less experienced choir singers, were classified by 16 expert listeners in a forced choice test. The listeners' classifications mostly agreed with the registers intended by the singers. For some tones classification differed substantially, presumably because the singers had learnt to reduce the timbral contrasts between the registers. The number of votes for modal was compared to the following voice source parameters: duration of the closed phase and closed quotient (Q_{closed}), peak-to-peak airflow amplitude, maximum flow declination rate (MFDR), normalized amplitude quotient (NAQ, defined as the ratio between peak-to-peak airflow amplitude and MFDR multiplied by the fundamental frequency) and level difference between the two lowest source spectrum partials. The results showed that: (1) tones with higher values of Q_{closed} and of MFDR, and lower values of H1-H2 and NAQ were typically associated with higher number of votes to the modal register, and vice-versa, (2) NAQ was the single voice source parameter that presented the strongest correlation with the register classification data, while (3) the combination of Q_{closed} and H1-H2 parameters was the strongest predictor of the voice source perceptual data.

Your notes:

14:00 Perception of High-Frequency Energy in Singing

Brian B Monson (1,2), B Story (1), A Lotto (1)

(1) University of Arizona, United States of America

(2) National Center for Voice and Speech, United States of America

Some recent studies have explored the characteristics of acoustical energy above 5000 Hz in the human voice and speech spectrum. Traditionally, this high-frequency energy (HFE) in speech and voice has received little attention from the scientific community. Recent studies have shown, however, that HFE is in fact audible and that small changes in HFE level are detectable. Percepts of quality and aesthetic can be affected by HFE, implying that it may play a significant role in perception of the singing voice. In this presentation, experimental results showing the presence of HFE and the sensitivity of human listeners to HFE changes in male and female singing voices will be discussed. The extractable information from HFE and its relation to possible percepts of the singing voice will also be presented.

Your notes:

14:20 Some features of the high-frequency spectrum envelope of sustained vowels

Sten Ternström (1), RJ Teixeira de Sousa (2), D Howard (3)

(1) KTH, Stockholm

(2) University of Porto, Portugal

(3) University of York, United Kingdom

Speech and voice analysis has conventionally focused on frequencies below 5 kHz where the bulk of the signal energy appears. However, in keeping with common experience, a few studies have reported that high frequency components > 5 kHz are also audible in many vocal sounds, possibly contributing to perceived realism or naturalness. At high frequencies, the spacing of vocal tract resonances inevitably becomes small and irregular, such that they would not be resolved as individual formant peaks by the critical bands of the ear. With the ultimate objective of high-fidelity syntheses of voice in mind, the high spectrum envelope of a corpus of vowel sounds produced by singer subjects was studied, in search of typical gross features that might be audible yet amenable to simplified simulation. In spectrograms, the visually most salient features were anti-resonances rather than resonances. Using several frequency domain methods, four regions of dips or anti-resonances were identified, including the two previously known at about 1.8 kHz (the velar port antiresonance), about 5 kHz (the dual antiresonance due to the piriform fossa) and two less pronounced anti-resonances at about 9 and 12 kHz, the causes of which remain to be identified. The anti-resonances would not be perceived by the ear, but the regions in between them would. Typically, but not consistently, there were about four resonances between 5 and 9 kHz, that would correspond to formants F6-F9 in an all-pole model.

Your notes:

15:00 Training Aryepiglottic Narrowing for Singer's Formant

SOUNDS Workshop, Room 4136, LV 26

Alberto ter Doest (1), Hanny van Lankeren (1)

(1) Codarts, University for Music and Dance, The Netherlands

In this workshop we will show some new videos of narrowing the epilarynx or Ary Epiglottic Narrowing and its contribution to the Singer's Formant. We will play some examples of singers with a good singer's formant. We will use Voice Print to show the increase in the 2-4 kHz range when adding narrowing of the epilarynx. This Twang quality, so called in Estill Voice Training, will be demonstrated and taught in Nasal and Oral modes. We will use the EGG to point out the closed quotients of the Vocal Folds in either Nasal or Oral Twang and we will show video's of what happens at the Vocal Fold level. After the demonstration we will teach some exercises to find Ary Epiglottic Narrowing, than we will sing some exercises to find this Twang quality on different vowels and on different pitches. After these exercises, we will teach a more isolated control in Nasal Twang mode and add this to speech and music. We will show with Voiceprint the effect of this AE narrowing. From the Nasal Twang we will teach how to go from Nasal to Oral Twang and add this to speech and sung material, using Voiceprint as the reference.

Your notes:

15:00 Developing and manipulating models of the vocal tract using VTK

METHODS Workshop, Room Fantum, LV 24 level 5

Matt Speed (1), David Howard (1), Damian Murphy (1)

(1) Audio Lab, University of York, Heslington, UK

Over the past two decades, MRI (magnetic resonance imaging) scanning of the vocal tract has taken on considerable significance and without doubt sprung to the forefront of multiple fields in voice research. It has applications in the extrapolation of parameters for articulatory modelling, the generation of grids for finite-element and finite-difference based acoustics modelling and building visual models of the vocal tract for speech therapy and language tuition.

An inevitable restriction on the accuracy of MR imaging is imposed by the capture times required and the subject's ability to maintain a particular tract arrangement with/without phonation. Capture times have however shown very considerable improvement since 1991 when times were as high as 3 minutes for a single phonation, through around 30 seconds in the 2002 work of Engwall, to sub-second imaging achieved for instance in the recent RT-MRI (Real-time MRI) work of Bresch et al.

While this capability is of course a fantastic resource for the researcher, handling the data produced by MRI scanning can represent a significant undertaking. After collection of the imaging follows a demanding sequence of post-processing. Although tools do exist to process the output of MR imaging, voice specific analysis falls outside the scope of these predominantly neuroimaging focussed applications. Developing bespoke tools for this specialised postprocessing can therefore demand a considerable investment in time and skills.

VTK (The Visualization Toolkit) is an open source, OpenGL-based graphics toolkit, geared towards medical imaging. It is predominantly C++ based, yet features wrappers for Python, Java and tcl. Its design is object oriented, and processing is channelled through a strictly defined graphical pipeline. Whilst powerful and freely available, VTK's greatest advantage is surely the ease with which standalone applications can be developed. With a reasonable grasp of one of VTK's supported programming languages, MRI data can be processed and developed into powerful models in a fairly short space of time.

This presentation provides an overview of the key concepts of VTK development. The toolkit's application to vocal tract modelling is then demonstrated across various stages of MRI postprocessing, from data acquisition through to generating accurate 3D models.

It continues to show how these models can be manipulated to provide other representations of the vocal tract, such as lower dimensionality intersections (midsagittal cross-sections), developing grids for finite-element and finite-difference computation and useful visualisations of simulation.

15:00 Tuning Your Choral Pipes

CHOIR Workshop, Room F11, LV 22

Laura Avery (1)

(1) *Sam Houston State University*

As choir masters, many organists have the responsibility of hiring and working with paid singers as well as a dedicated group of volunteer singers ranging in experience from novice to advanced. How many times have we heard the comment, "What a set of pipes," given to an exceptional singer? The similarities of the human voice and the organ are numerous. Using these similarities and spectrograph analysis of the two instruments, one can familiarize oneself with the tuning system of the human voice. Unlike an organ pipe, the voice is not a fixed resonator. Singers are trained to modify their vowels, thereby changing the shape of the resonating chamber. This modification to the resonating chamber will result in an alteration of the acoustic signal. Instructing a body of singers to modify simultaneously while retaining the integrity of the acoustic signal is the beginning of tuning your choral pipes. Open and closed vowels are categorized based on the two-tube system model. If the front tube (oral cavity) is larger than the back tube (pharyngeal cavity), the vowel is labeled as "open." If the opposite relationship exists, then the vowel is considered "closed." Knowing which vowels to use for tuning is invaluable for choral directors. More important still is successfully communicating those vowels to a group of people with regional accent variations and pronunciation differences. Familiarizing yourself with an alphabet of pure vowel sounds and teaching your choir those symbols can expedite your tuning results. Understanding the acoustics of the human voice can immensely help organist choir masters achieve a greater degree of success when working with singers.

Your notes:

16:00 Overtone Singing Workshop

SOUNDS Workshop, Room 4136, LV 26

Wolfgang Saus (1)

(1) *Freelancer, Germany*

With some simple tongue techniques, everyone can easily learn to sing overtones. Overtone singing gives the impression of one person singing two tones simultaneously. Experts can sing two polyphonic melodies at the same time. The physics behind the singing technique is the clustering of two formants. The workshop teaches the basic tongue movements, which lead to significantly enhanced overtones.

Your notes:

16:00 The Singing Voice and the Electroglottograph

METHODS Workshop, Room Fantum, LV 24 level 5

Donald Miller (1)

(1) Groningen Voice Research, The Netherlands

The electroglottograph (EGG), which reflects the modulation of vocal-fold contact, is the technology of choice for routine non-invasive measurement of the closed quotient in the singing voice. The chief problem with the EGG is that the great variety of signals it furnishes, both intersubject and intrasubject, present challenges to extracting reliable and comparable measured data. This workshop will focus on the interpretation of the EGG waveform, together with its practical relevance for analyzing and training the singing voice, in conjunction with a parallel display of the waveform from the (likewise noninvasive) microphone signal in the software VoceVista-Pro.

Your notes:

16:00 Widening Young Male Participation in Chorus

CHOIR Workshop, Room F11, LV 22

Martin Ashley (1), D Howard (2)

(1) Edge Hill University, United Kingdom

(2) University of York, United Kingdom

Abstract text:

Widening Young Male Participation in Chorus is a substantial knowledge transfer project funded by the UK's Arts and Humanities Research Council between May 2008 and October 2009. The principal knowledge transfer partner is the National Youth Choirs of Great Britain (NYCGB). NYCGB, in common with the large majority of choral organisations in the UK, finds it significantly harder to recruit young males than young females. Earlier research by the principal investigator suggested that one reason for this is a lack of understanding amongst young people of the mechanics of voice production in boys. Neither boys nor their teachers in school understood why boys in mid-puberty often sing a soprano part even though their speaking voices may be descending in pitch. Important work such as that of John Cooksey remains relatively unknown in the UK. The approach taken in this project has been to present voice science in a way that is accessible to boys and their teachers. The question that is currently under investigation is that of whether a better understanding of this might be associated with more positive attitudes to singing in boys. The main output of the project has been the multi-media resource Boys Keep Singing which is a series of short films in contemporary styling with multi-screen format and high graphic content including animated diagrams of the vocal apparatus and scientific explanations of its functioning, addressed by voice experts to members of the National Youth Choir on behalf of an audience of boys. It has been supported by a digital interactive book for boys I'm a Boy, how high should I sing? which includes audio examples recorded by boys of the NYCGB. This proposed workshop will allow participants fully to explore the resources, try them out for themselves, interact with them and offer critical response and feedback.

Your notes:

Thursday, 12 August

8:30 Announcements and warm-up

8:40 Current topics in Singing Voice Physiology
Invited overview

Dr Nathalie Henrich
CNRS, GIPSA-Lab, Grenoble, France

Your notes:

9:20 Influence of laryngeal and vocal tract morphology on voice classification in singers

Dirk Mürbe (1), F Roers (1), J Sundberg (2)

(1) Department of Otorhinolaryngology, Technical University of Dresden

(2) Department of Speech, Music and Hearing, KTH, Stockholm, Sweden

Morphological measures of the larynx and the vocal tract affect the pitch range and the timbre of a voice. The present investigations were carried out to analyze the relationship between these measures and experts' classification of singer voices. Students admitted to the solo singing education at the University of Music Dresden, Germany, were submitted to a detailed physical examination of factors relevant to voice function, between 1959 to 1991 also including X-ray imaging of the singers' vocal tract profiles. From this material 132 images were selected for an analysis with regard to the relationship between voice classification and various aspects of laryngeal and vocal tract morphology, like the length of the total pharynx and mouth cavities as well as of the total vocal tract, the absolute and relative position of the larynx, the height of the palatal arch, and the vocal fold length estimated from the sagittal diameter of the trachea. Also studied were the relationships between voice classification and the body height and weight and the body mass index. Particularly strong relationships were found between voice classification and vocal fold length, pharynx length and body height. The data support the assumption that there are consistent morphological vocal tract differences between singers of different voice classifications.

Your notes:

9:40 The relationship between singers' body type and breathing in classical singing

Hyunhi Kim (1)

(1)The University of Sheffield, United Kingdom

There has not been much research regarding the relationship between body type and singers' breathing. The first aim of the current study is to investigate whether a singer's body type affects the breathing mechanism in western classical singing. The second aim of the current study is to investigate whether singers with different body type use different muscle forces or different combinations of muscles when breathing in singing. The hypothesis was that body type affects the use of muscles in breathing, and that singers with different body type would approach the task differently. The phasing of the activity in the intercostals (INT1, INT2) and in the lateral abdominal (OBL1, OBL2) muscles was obtained from 25 experienced singers. INT1, INT2, OBL1 and OBL2 muscles on the right side of the body were recorded by surface electromyography (EMG). The circumference of the lower thorax (LTX) and abdominal region (ABD) (at the navel level) were measured with two strain gauge sensors. Eleven different parts of the body including their height, weight, lower thorax, mid-shoulder to mid point, mid point to hips and nipple to lower rib were measured in order to discern the body types of all participants. Also, three different vocal tasks were performed three times. These tasks involved two phrases of an operatic aria, a glissando and a sustained tone. The muscle activity was measured for these tasks having been calibrated to account for each singer's individual range of activity. The results showed that there were significant differences in the way how intercostal muscles of normal weight singers were used compared to obese singers. This main effect across all singing tasks suggested that normal weight singers uses the muscles covered by the INT1 site of the EMG significantly more than overweight and obese singers.

Your notes:

10:00 The movement and the electrical activity of the diaphragm during breathing for classical singing

Viggo Pettersen (1), TM Eggebø (2)

(1) Department of Music and Dance, University of Stavanger, Norway

(2) Department of Obstetrics and Gynaecology, Stavanger University Hospital, Norway

Introduction: This study utilized ultrasound imaging (USI) to examining the movement of the diaphragm (DPH), and electromyography (EMG) to explore the electrical activity of the DPH by two student classical singers. Material and method: The anterior section of DPH (ADPH) was investigated by placing the probe laterally to the midline. The dorsal section (DDPH) was investigated by placing the probe on the back, left of the midline. EMG activity was recorded from both ADPH and DDPH. Results: Most of the USI recordings by the anterior scan showed that the ascending movement of DPH was close to linear during phonation of sustained tones and ascending and descending intervals, with the exception of small caudal adjustments observed by descending quart intervals and descending octave intervals initiated at high pitches. The corresponding recordings by the dorsal transducer showed an ascending linear movement during the sustained tones and a more bumpy movement pattern during phonation of intervals. The EMG recordings showed, firstly, that the DPH EMG activity increased towards the end of all sustained breathing sequences and was released during the first part of the following inhalation. If the inhalation was aimed at a new long breathing sequence, the DPH was activated during the second part of the inhalation sequence. If phonation was not aimed at, the DPH was, in most cases, not activated during inhalation. Secondly, the minor descending adjustments observed in the ADPH by demanding descending pitch changes and, the bumpy movement patterns observed in corresponding tasks of the DDPH, are apparently influenced by activity of the DPH itself. By less demanding descending pitch changes EMG activity, for the purpose of lowering the DPH during phonation, are predominantly observed in the ADPH. Discussion: The results will be discussed.

Your notes:

10:20 Subglottal pressure, lung volume and breathing movements in Belting and Legit

Monika Hein (1), J Sundberg (2)

(1)Universität Hamburg, Fakultät für Geisteswissenschaften, Fachbereiche Sprache, Literatur, Medien & Europäische Sprachen und Literatur, Germany

(2)Department of Speech, Music and Hearing, KTH, Sweden

Belting is a term commonly used for a loud, shouting-like singing voice quality frequently used in Broadway shows. Yet, there is still confusion amongst vocal coaches, when it comes to a definition of "Belting", presumably because of a lack of understanding of its physiological characteristics. The aim of this study was to find out whether or not the belting style is associated with some particular breathing patterns. Subglottal pressure, captured as the oral pressure during the occlusion for the consonant /p/, lung volumes and breathing movements, captured by Respitrace®, were analysed in five professional musical theatre singers, all performing belting on stage at the time of the experiment. They performed a series of vocal tasks both in belting and in the non-belting style commonly referred to as "legit", being a more lyrical, almost classical style, which is also commonly used in musical theatre performances. A listening test was performed in which a panel of professional experts were asked to classify single tones as either belting or legit. The results showed that the tones that the panel most unanimously classified as belting were produced (1) with higher subglottal pressures, (2) with higher lung volumes both in the initiation and the termination of phrases, and (3) with slightly lower air consumption than tones produced in the legit style. On the other hand the singers produce belting with different breathing strategies and breathing behaviours.

Your notes:

11:00 The impact of posture on EGG signal, acoustic and aerodynamic output

Marina Gilman (1)

(1) Emory Voice Center, Dept. of Otolaryngology Head Neck Surgery Emory University, Atlanta, United States of America

It is commonly assumed that posture is essential to good voice use, whether singing or speaking. Little research has been done on the impact of posture on vocal production. Fishman BV and Shipp T (1970), Jones, FP (1972), Kooijman, PGC et al (2005), Giovanni A, Aki, L and Ouaknine M. (2008) have shown that postural shifts increase tension not only in the extrinsic laryngeal muscles, but also postural muscles impacting respiratory function and vocal production as measured by increased perceived effort, spectrographic analysis, the Voice Handicap Index and Dysphonia Severity Index. Posture is defined 'as an alignment of maximum physiological and biomechanical efficiency, which requires a minimum of stress and strain' Kendall et al, (1952). Therefore musculoskeletal imbalance (a poorly organized system) would negatively impact physiological and biomechanical efficiency or function. In a poorly organized system small changes in posture might result in poor vocal production. As voice teachers, speech pathologists and laryngologists working voice it is important to have a clear understanding of the effect of body positioning on voice. A pilot of this study was presented at the PAS4 conference in San Antonio. To date 21 subjects, both singers and non-singer have participated in the study. The impact of postural shift in head position in sitting and standing with knees locked and unlocked was examined. The KayPentax CLS was used to measure glottal signal (EGG) and acoustic data. Aerodynamic measures were taken with the KayPentax Phonatory Aerodynamic System. Results indicate that perceived phonatory effort increased with exaggerations in head position. Changes in spectral characteristics and/or shape of the EGG signal varied in ½ of the subjects in one or more position. These findings suggest subtle changes in the resonant space as well as alterations in the vocal fold closure pattern.

Your notes:

11:20 Voice range profile of subglottal pressure in singing: a pilot study

Nathalie Henrich (1), B Amy de la Bretèque (2,3), T Legou (2), A Giovanni (2,3), A Ghio (2)

(1) CNRS, GIPSA-lab, Grenoble, France

(2) LPL, Aix en Provence, France

(3) CHU La Timone, Marseille, France

Subglottal pressure is a key parameter for human phonation, essential for starting and maintaining vocal-fold oscillations. Yet, it is not easy to measure, and most studies estimate it from intra-oral-pressure burst during plosive-vowel sequences. In this study, the variations of aerodynamic subglottal pressure as a function of glottal properties are assessed in the case of singing-voice productions. The EVA2 device was used to record simultaneously audio and electroglottographic (EGG) signals, sound pressure level (SPL) and subglottal pressure (Psg). Subglottal pressure was measured directly by tracheal ponction between the cricoid cartilage and first tracheal ring. Fundamental frequency and contact duration time (closed and open quotients) were measured on EGG signals. The results on the case of one trained singer (co-author) is presented here, who is able to sing using both laryngeal mechanisms. The singer's comfortable vocal range is explored by tones, on crescendos and decrescendos produced at a sustained pitch. The singer's voice range profile is shown in a traditional way (f_0 in Hz – SPL in dB), but also as a function of subglottal pressure (f_0 in Hz – Psg in Pa). In the two main laryngeal mechanisms, the upper limit raises as a linear function of the logarithm of fundamental frequency. The lower limit, which corresponds also to phonatory threshold pressure necessary for starting the laryngeal-vibrator oscillations, raises with fundamental frequency in M2, in agreement with the literature. Yet, in M1, agreement is found only for the lower pitches (below F3 – 174 Hz), as phonatory threshold pressure decreases with fundamental frequency between F3 and F4. The dynamic variations of Psg as a function of f_0 , closed quotient, and SPL, which are measured on crescendos and decrescendos, illustrate the non-linear behaviour of the laryngeal vibrator.

Your notes:

11:40 How do singers manage vowels depending on the laryngeal mechanism? Acoustic measurements and verbal descriptions.

Sylvain Lamesch (1), M Castellengo (1), L Maxim (1), B Doval (1)

(1) LAM - IJLRA, France

Western classical singers are trained to use all the vowels regardless of their predominant tessitura and laryngeal vibratory mechanism. As opposed to them, Yodellers generally choose a given set of vowels depending on the mechanism they use: M1 (chest voice) or M2 (falsetto). In order to explore the possible relations between the laryngeal source and the resonance cavities, we have undertaken a study of Voice Range Profiles (VRP) with different mechanisms (M1 and M2) and vowels. 21 male and female singers produced crescendos and decrescendos on /a/, /i/ and /o/, from C3 to C5, first in mechanism M1 and then in mechanism M2. We recorded the sound signal in order to compute the vocal dynamics. VRPs were obtained for each singer and for each vowel, in M1 and M2 separately. Electroglottographic signal allowed us to check which laryngeal mechanism the singer was using. At the end, the subjects filled a questionnaire concerning the vowels they prefer to sing in M1 and in M2, respectively. The questionnaire prompted individual evaluations and comfort or technique related comments from singers. The analysis of the questionnaire showed that singers prefer singing /a/ rather than /i/ in M1, and inversely in M2. The study of the VRPs showed that the upper limit is 10 dB louder for /i/ than for /a/ in M1, but not in M2. Consequently the vocal dynamic is larger for /a/ than for /i/ in M1, and it is larger on /i/ in M2 than in M1, if compared with the dynamic for /a/. In M1, producing a given level on /i/ could require a higher subglottal pressure. The processed acoustical data provided us with elements which in turn allowed us to interpret more accurately the singers' verbal descriptions.

Your notes:

12:00 Analysis of the dynamic mechanisms behind vocal fold muscle contraction during the chest-to-head passaggio

Pedro Amarante Andrade (1)

(1) University College London, United Kingdom

The chest to head transition is characterized by changes of the vocal tract resonance and configuration. Earlier studies correlated the vertical displacement of the larynx and changes in the pitch of the voice. The increasing pitch was at first associated with the ascendant movement of the larynx; however subsequent studies have suggested that pitch could ascend whilst the larynx remains lower in the neck. The subtleties of larynx readjustment can be better understood by analyzing the chest to head passaggio. The aim of this study is to investigate the change in vocal quality between the chest and head registers. 31 sample recordings from 11 professional western classical singers were obtained through the laryngograph and analysed with the Voce-Vista Pro software. A repeated-measures ANOVA and a paired-sample t-test were applied to analyse the before and after the chest to head passaggio conditions. The results showed a significantly different scores between the before and after the passaggio conditions. An overall reduction of formant centre frequencies was observed. Additionally, an increase in amplitude of the Lx signal was observed indicating a larger vocal fold contact area after the passaggio. Furthermore a 1.6 cm difference was observed between the before and after the passaggio conditions, indicating a longer vocal tract after the passaggio. The results suggest that the larynx lowers after the passaggio and the vocal folds vibrate with a deeper vertical phase. For this readjustment to occur a different vibratory mechanism has to be executed. This mechanism is explained through the observed changes in the contraction of the thyroarytenoid muscle from isotonic to isometric. In addition, changes on the vertical displacement of the larynx cause the infraglottic tissue to amount immediately below the vocal ligament increasing the vocal fold contact area. These results indicated a very efficient system for voice production on singing.

Your notes:

13:20 A study of horizontal and vertical intonation tendencies in SATB ensembles

Johanna Devaney (1)

(1) McGill University, Canada

This paper presents a study of intonation tendencies in SATB ensembles of professional singers and explores the way in which any observable tuning tendencies are influenced by the organization of musical materials. In this study we examine ensembles' tuning of both melodic intervals and vertical sonorities. Specifically, we are looking at the tuning of ascending and descending minor seconds, major seconds, minor thirds, and major thirds in the melodic context, and minor thirds, major thirds, perfect fourths, perfect fifths, minor sixths, major sixths, and perfect octaves in the harmonic context. The repertoire consists of several short composed exercises, where the melodic intervals occur over a range of harmonic functions. The ensembles also performed Praetorius' "Lo, how a rose e'er blooming," so that we could examine intonation in a musical piece that all of the participants were already extremely familiar with. In addition to taking the mean of the fundamental frequency (F0) over the duration of the steady-state portion of each note, we also calculate the evolution of each note's F0 by taking the discrete cosine transform of the F0 estimates. By looking at the evolution of F0, we are able to look not only at the placement of the pitches but can also quantitatively evaluate directionality within the notes. The first discrete cosine transform coefficient provides information about whether the singers are gliding up or down and the second coefficient indicates the amount that F0 deviates from a steady pitch over the course of the note. We describe each ensemble's self-consistency in terms of the mean F0 and its evolution across multiple performances of the same piece of music as well as consistency across ensembles.

Your notes:

13:40 Intonation drift in a cappella quartet singing of choral repertoire

David Howard (1)

(1) University of York, United Kingdom

The pitch centre during music a cappella (unaccompanied) singing can drift if no reference pitches are available from, for example, accompanying instrumental forces. Singers tend towards non-equal temperament when they sing a cappella, and the author has shown that a cappella singers' pitch centre can drift if the music modulates away from the starting key and back again later in the piece. This paper will consider items from the choral repertoire which are associated with potential pitch drifting issues and an analysis will be presented of the inter-part tuning during the piece to identify any chord sequences within these items for which pitch drift is likely to manifest itself. These theoretical analyses will be supported by investigating pitch drift in commercial recordings of the particular items of choral music by extracting the relevant chords and finding the number of cents pitch shift required to bring them back in tune. The purpose of this work is ultimately to advise choral singers and choir directors of this phenomenon so that they can make a informed choice as to how to deal with it in performance.

Your notes:

14:00 The Effect of Riser Step Heights and Singer Spacing on Perceived Choral Sound, Vocal Production, and Obtained Long Term Average Spectra of an SATB Choir

James Daugherty (1), J Manternach (1), M Brunkan (1)

(1) Vocal/Choral Pedagogy Research Group, University of Kansas, United States of America

The purpose of this investigation was to determine what effect, if any, two riser step heights (standard and custom) used with an a cappella SATB choir performing in three chorister spacing conditions (close, lateral, circumambient) may have upon (a) choral sound preferences of choristers (N=32) and auditors (N=80); (b) chorister perceptions of vocal production; (c) obtained long term average spectra from each singing condition; and (d) ambulatory phonation monitor data acquired from two singers. Among controls instituted for the study were: (a) videotaped conducting, (b) a specially constructed unit of choral risers conforming in every respect to units currently marketed with the exception of an additional 4 in height between each riser step, (c) consistent chorister formation between conditions, and (d) a randomized order of digitally recorded excerpts subsequently heard and rated by choir members and other auditors. Additionally, all singers completed a brief survey soliciting scale ratings of individual vocal production efficiency after each condition.

Your notes:

14:20 Ingressive Vocal Fry: Its Acoustic and Physiological Properties and Usefulness in Choral Singing

Laurier Fagnan (1)

(1) *University of Alberta, Canada*

Various cultures have explored different means of singing very low notes: Slavonic basses are renowned for their legitimate basso profundo vocal production, while Tibetan monks have found a means of achieving yet lower frequencies. In this study, Ingressive Vocal Fry will be examined as a viable alternative to legitimate chest voice for the singing of very low pitches (32.5Hz - 65Hz). Several vocal and acoustic parameters will be presented including a study of vocal fold/laryngeal behaviour using ultra high-speed videography and electroglottography. Sound pressure levels on various frequencies and vowel sounds will also be compared with basso profundo chest voice use. Detailed harmonic analysis and comparison of formant structures will be made between modal voice and ingressive fry. Finally, legitimacy of use of this unconventional register in choral singing will be considered, as will be the influence of 'dropped octave potential' on a choir's spectrum.

Your notes:

15:00 Pedagogic Application of F1/H2 interactions in Training the Male Passaggio.

SOUNDS Workshop, Room 4136, LV 26

Kenneth Bozeman (1)

(1) Lawrence University, United States of America

It is generally agreed by classical voice teachers that a relatively stable tube length (laryngeal height) is necessary for timbral balance and consistency across range, since this stabilizes the general location of the singer's formant cluster. Untrained males instinctively tend to activate swallowing muscles to shorten the tube (raise the larynx) upon ascending the scale in order to preserve the strong acoustic coupling of the "yell," in which the second harmonic (H2) is near the peak frequency of the first formant (F1). Formant frequency locations are determined by tube length and shape. If tube length and shape are kept stable during pitch ascent, the yell can be avoided by allowing H2 to pass through F1. This results in a timbral shift referred to as covering or "turning over," which facilitates lighter laryngeal muscular adjustments with greater cricothyroid (CT) involvement. The variety of locations, vowel by vowel, where these shifts occur forms a basis for developing effective strategies for training the male passaggio. This workshop will explain and demonstrate this phenomenon and its resultant principles for training male singers.

Your notes:

15:00 < to be announced >

Workshop, Room Fantum, LV 24 level 5

Your notes:

15:00 Improvement of choir quality induced by research in singing and choir acoustic

CHOIR Workshop, Room F11, LV 22

Harald Jers (1)

(1) University of Music, Cologne, Germany

Research of the acoustics of choir singing is mainly executed at Universities and in an scientific environment. A lot of Colleges and Universities of music don't get in touch with the results of this acoustic knowledge, because this subject is fairly seldom taught at training places for music. Hence most of the choir singers and choral conductors unfortunately won't take the advantage for their music life. This tutorial will show the application of some of the results of singing and choir acoustic research for practical cases. For this purpose the author will give a demonstration rehearsal with a small demonstration choir and show how he uses acoustic knowledge to improve the quality of a choir as he does with his ensembles. On the one hand this serves as an explanation and clarification of instructed methods or rules, which are used by many conductors. On the other hand this workshop may give hints and detailed help, how a conductor could vary or change his rehearsals and concert performances with an acoustically informed background. The workshop covers and discusses aspects of beating technique, the use of the piano, rehearsing methods, voice training in the rehearsal and psycho-acoustic perception effects in choir singing.

Your notes:

16:00 Smoothing the lower register bridge in female singers

SOUNDS Workshop, Room 4136, LV 26

John Nix (1)

(1) *University of Texas-San Antonio, United States of America*

The lower register bridge for female singers can be troublesome. The author's workshop will provide specific exercises designed to facilitate singing in the C4-G4 transition area. Two important tools to be discussed in the workshop will be: (1) the use of vibrato as a means of promoting balanced function in the intrinsic muscles and encouraging flow phonation; (2) the use of real-time feedback in training.

Your notes:

16:00 Posture for singing, how and what do we teach?

METHODS Workshop, Room Fantum, LV 24 level 5

Marina Gilman (1)

(1) Emory Voice Center, Dept. of Otolaryngology Head Neck Surgery Emory University, Atlanta, United States of America

It is commonly assumed that posture is essential for optimal singing. Many clinicians and singing teachers stress 'ideal posture' in their teaching, insisting that the singer 'stand up straight, chin up, chest up, stomach in'. Yet ideal posture is defined in dynamic not static terms: 'an alignment of maximum physiological and biomechanical efficiency, which requires a minimum of stress and strain' Kendall et al, (1952). If this is the case, then the 'ideal' posture based on the 19th century concept of a plumb line from the top of the head, through the external auditory meatus, the midpoint of the shoulder, the highest point on the iliac crest, the knees and just in front of the ankle, is neither ideal nor functional. Good posture must be dynamic and depends upon the internal organization of the individual. How then can one teach posture in the voice studio or in the voice therapy room? How can the teacher identify musculoskeletal imbalance? What are the elements of the singers stance or movement that the teacher, or clinician that signify imbalance? How does one bring about the small changes in physical organization that are needed for good vocal production? This workshop will explore these questions. Using a 'hands-on' interactive approach, this workshop will explore how to recognize those aspects of musculoskeletal imbalance (a poorly organized system) that negatively impact the physiological and biomechanical efficiency in a singer. Several specific techniques will be explored. These techniques can be adapted by participants to facilitate students/clients in developing the self-awareness necessary to regain the coordinated movement and physiological and biomechanical efficiency needed for optimal freedom in singing.

Your notes:

16:00 The Use of the IPA in the Choral Rehearsal

CHOIR Workshop, Room F11, LV 22

Duane Karna (1)

(1) Ball State University, School of Music, United States of America

I believe that the teaching and use of the International Phonetic Alphabet's symbols for sound should be used for all singers within the context of the choral rehearsal. The IPA can be reinforced daily through the use of choral warm-ups that introduce new and familiar sounds and their corresponding IPA symbols. These "symbols for sounds" can be taught and reinforced during each choral rehearsal as the choir strives for uniformity of sound and more precise diction. And with a handout of an IPA transcription of a choral composition's foreign language text, the choral singers will be able to pronounce and practice pronouncing the foreign language text more accurately. It is my belief that, over time, a choir which has developed an understanding of The International Phonetic Alphabet will not only be able to communicate more effectively with their director, but they will also be more effective in communicating intelligibility of text to their audiences. The singers will also become more knowledgeable and capable of pronouncing foreign language choral texts with appropriate and accurate diction.

Your notes:

Friday, 13 August

8:30 Announcements and warm-up

8:40 **Current Applications of Singing Voice Research**
Invited overview

Dr Matthias Echternach
Freiburg University Medical Center, Germany

Your notes:

9:20 Sex steroid hormones and intonation accuracy in singing

Filipa Lá (1), Johan Sundberg (2)

(1) University Aveiro, INET-MD, Portugal

(2) Department of Speech Music Hearing, KTH, Sweden

Abstract text:

Cyclical variations in the concentrations of sex steroid hormones (i.e. oestrogens, progesterone and testosterone) associated with menstrual cycle have been reported to affect the pattern of vibration of the vocal folds. We present a double blind randomised placebo controlled trial on the effects of the menstrual cycle and the use of a combined oral contraceptive pill (OCP) on intonation accuracy during singing. Three recordings were made and three blood samples were taken for 9 singers for the three phases of the menstrual cycle (i.e. menstrual, follicular and luteal phases), for both placebo and OCP conditions randomly allocated. Participants were asked to sing an ascending octave followed by a descending major triad, starting in three different pitches. Blood samples measured concentrations of sex steroid hormones. The intonation accuracy was measured as the departure from the equally tempered tuning, using the start tone as the reference. On average, the ascending octave exceeded a 2:1 frequency ratio by about 40 cents for both conditions (i.e. placebo and OCP). The subsequent descending intervals were all wider than in equally tempered tuning, thus leading to a lower pitch of the final tone as compared with the starting tone. Results also indicated that for the placebo condition (i.e. when sex steroid hormonal vary greatly) intonation accuracy was greater for the menstrual phase (i.e. phase 1) than for the follicular and luteal phases (i.e. phases 2 and 3). For the OCP condition (i.e. when hormonal variations were minor), the variation of intonation accuracy was also smaller. These results thus suggest that intonation accuracy may vary during the menstrual cycle.

Your notes:

9:40 Assessing Intonation: Perceptual Strategies and Acoustic Parameters

Deirdre D. Michael (1), M Gilman (2)

(1) University of Minnesota, United States of America

(2) Emory Voice Center, Department of Otolaryngology, Head and Neck Surgery, United States of America

Of all the terms that describe the singing voice, "pitch" should be the most objective, as it is the perceptual correlate of fundamental frequency, which can be measured objectively. Although it should be possible to determine whether a singer is singing the correct note, the perceptual term "intonation" may not have a direct objective correlate. This was brought to light in a study in which 40 singers, each singing a 5-note phrase in the upper and lower parts of their singing range, were perceptually rated on 6 characteristics of singing: intonation, effort/ease, focus/clarity of tone, resonance focus, vibrato, and overall quality. Ten singing teachers rated each characteristic on a 120 mm visual analog scale, with the end-points marked "worst" (0 mm) and "best" (120mm). It was notable that the intonation ratings had a spread of 60mm to over 80mm in over half the samples. In the present study we examine these intonation ratings, in an attempt to determine what acoustic characteristics might account for the widely disparate judgments of intonation. In order to shed some light on the perceptual strategies employed by the singing teachers, we assessed parameters pitch contours and stability, vibrato, and spectral characteristics. Preliminary results indicate that some of the strategies seem to involve: extent of vibrato, pitch transition time, and characteristics of the vowel formant and the long term average spectrum. The interrelationship between these acoustic properties and the other perceptual characteristics is examined. It seems there may be a number of perceptual strategies for determining intonation. Individual singing teachers do not necessarily share the same strategies, suggesting that the term "intonation" may not have a single direct acoustic correlate. Implications for training of teachers of singing are explored in light of these findings.

Your notes:

10:00 Physiological and acoustic comparison of four qualities used in the female Music Theatre voice

Maëva Garnier (1), T Bourne (2, 3)

(1) UNSW - Music Acoustics Group, Australia

(2) University of Sydney, Australia

(3) University of Ballarat, Australia

Twelve sopranos (4 non experts, 4 advanced, 4 professionals) produced glissandi up to their highest note (from 1000 to 2300 Hz). Later, they sustained pitches on [a] vowels, from A4 (~440 Hz) to their highest sustainable note. Between C5 and G5, all singers demonstrated a significant decrease in amplitude of the electroglottograph signal with increasing pitch, together with a change in waveform. This modification in glottal contact was either continuous, over a few tones range, or discontinuous, accompanied on glissandi by a pitch jump. Two singers could vary the pitch of this transition and therefore presented an overlap range over which they could produce either a 'full head' or a 'fluty' quality. Transition from one quality to the other on the same note was discontinuous and accompanied by a pitch jump. No other significant modification in glottal contact was observed at higher pitch. The frequencies (R1 and R2) of the first two vocal tract resonances were measured by broadband excitation at the mouth. Adjustment of R1 near to f_0 (R1: f_0 tuning) was observed below C6 for both expert and non-expert singers. Experts began this tuning at lower pitches. Some singers also exhibited R2:2 f_0 adjustment over the lower part of the R1: f_0 tuning range. In the very high range (above C6), the singers used one of two strategies. Some extended the R1: f_0 tuning as far as E6 or F#6. Others adjusted R2 near f_0 over the highest pitch range (up to D7). The limit of the sustainable range corresponded to the end of these resonance tunings. This strongly suggests that the upper limit of their useful singing range was determined by the upper limit of one or other resonance tuning mechanism. Further, it seems likely that learning R2: f_0 tuning might extend the practical upper range of some sopranos.

Your notes:

10:20 Gender differences in children's singing voices: Acoustic analyses and results of a listening test

Ann-Christine Mecke (1), Johan Sundberg (2)

(1) Universität Freiburg, Germany

(2) KTH Stockholm, Sweden

This study tested the hypothesis that acoustic parameters exist which are specific to gender in children's singing voices, and that these parameters are relevant to listeners identification of gender of children's singing voices. A listening test was run with examples of singing produced by children belonging to different singing cultures, six boys and six girls from a Swedish music school and six boys from an elite German boys choir. Sustained vowels were analyzed with regard to formants and voice source properties (jitter, shimmer and glottal-to-noise excitation rate, closed quotient, and normalized amplitude quotient). Most of the measured parameters differed significantly between the boys belonging to the two different singing cultures. Regarding boys and girls from the same choir, only the closed quotient and the fourth formant frequency differed significantly. The listening test with was carried out by an expert panel. The listeners correctly identified the gender of the singer in 66.0% of the cases, i.e., far better than chance. A multiple linear regression analysis revealed that the listeners answers correlated well with the formant frequencies, with the fourth formant showing the highest correlation.

Your notes:

11:00 Computer software in singing teaching: advantages, risks and the roles of teacher and student

Jan Hammar (1)

(1) Hochschule für Musik, Nürnberg

The use of the computer becomes more and more widespread. In 1997 the first software for pedagogical use was presented at the Congress of singing teachers in Munich. In these 13 years the acceptance in Europe still is low, in the States higher. In my presentation I will discuss the possibilities and the risks in the pedagogical use of voiceanalysis. But also concentrate on one of the most important aspects in the low acceptance: misunderstandings of the role of the singing teacher and the interaction of teacher and student when using software in singing teaching.

Your notes:

11:20 Metaphors in Vocal Pedagogy: a Research on Imagery in Different Styles of Singing

Joana Mariz de Sousa (1), M Assumpção de Andrada e Silva (2)

(1) Pontifícia Universidade Católica de São Paulo PUC SP, Brazil

(2) Universidade Estadual Paulista UNESP, Brazil

Purpose: this study sought to find out which metaphoric expressions are most used by a group of singing teachers to teach vocal resonance in different musical styles and, according to them, which are the physiological purposes of their using metaphors. Method: a group of 20 singing teachers, five each teaching four different musical styles (classical singing, Brazilian popular music, American contemporary commercial music and a holistic approach) completed a survey involving questions about their formal education, their experience in teaching voice and if they make use of metaphoric expressions to teach vocal resonance. Teachers that make use of imagery were asked to describe three examples currently used in their studios, and to explain its physiological goals, if any. The survey was carried through open interviews that were recorded digitally. The results were transcribed, read, analyzed and classified according to categories created by the authors. Results: 90% of the teachers use imagery for pedagogical reasons, concerning either technical or musical matters. 88,8% of the teachers were not able to describe precisely what they were trying to achieve with their metaphors in terms of physiology, and often mixed physiological goals with the acoustic sensations they want their students to get or with musical purposes. Conclusion: The group of singing teachers investigated may not be completely aware of the physiological aspects involved in their using of metaphors while teaching singing. Also, it may not be important to them to keep separate the physiological aspects of voice production from the subjective process of artistic engagement.

Your notes:

11:40 Singer self-perceptions regarding singing with and without vibrato

John Nix (1)

(1) *University of Texas at San Antonio, United States of America*

Singers often adjust vibrato according to the style of music being sung. This is especially true in choral situations. Reasons for this may include the conductor's timbral preferences, concerns regarding intonation and historical practice considerations. Anecdotally, the ability to comfortably vary vibrato while singing differs widely between singers. Some pedagogues believe singing with reduced vibrato in choral situations hinders the artistic development of singers as classical soloists, and that it may be unhealthy. In light of anecdotal reports, studio observations and the ongoing debate between teachers of singing and choral musicians, a study was undertaken which examined perceptions of a broad selection of singers on the topic of vibrato, particularly in the choral music setting. Singers from six different choral groups (N = 360) ranging in ages from 18-75 years, from both genders, from Caucasian, African-American, Hispanic, and Asian ethnicities, and from a variety of training levels and musical interests participated. All subjects completed a 23 question survey which included questions about vocal training, styles of music sung, varying vibrato when singing different styles of music, how vibrato is varied, what is felt physically when varying the vibrato, any after-effects of varying the vibrato, and if so, how long do these after-effects persist. The results show that those singers who frequently sing without vibrato (regardless of musical genre being sung) often have not been trained how to sing without vibrato. Singers who sing without vibrato for extended periods of time often experience frequent symptoms of vocal fatigue (both vocal fold tissue fatigue and muscular fatigue). Subject responses are being used to guide the construction of a follow up study which will examine the physical impact of varying vocal vibrato under controlled conditions through objective measures.

Your notes:

12:00 The Effect of Training on Passaggio Transition Gestures

Richard J. Morris (1), David Okerlund (1), Donald G. Miller (2)

(1) Florida State University

(2) Groningen Voice Research, The Netherlands

"Uniting the registers" has long been recognized as an important goal in singing pedagogy. Integrating both the 'chest' and 'falsetto' vocal-fold vibratory patterns within a continuous scale is a challenge that confronts female classical singers, especially mezzosopranos. Taking as subjects female students at various stages of training in a high-level program in the U.S., as well as some professional singers, this study aims to describe the effects of training through analysis of scale passages through the primary register change around 300 to 400 Hz, as well as on sustained pitches containing shifts between registers. The analysis uses both spectrum and electroglottograph signals in the program VoceVista.

Your notes:

13:20 Dosimetry to assess vocal load in classical choir singers

Orietta Calcinoni (1, 2)

(1) INAIL, Italy

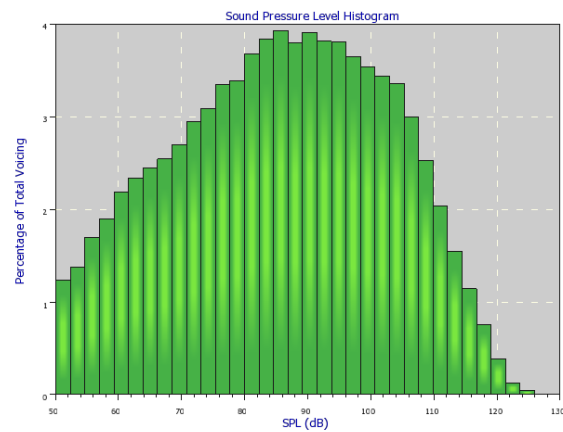
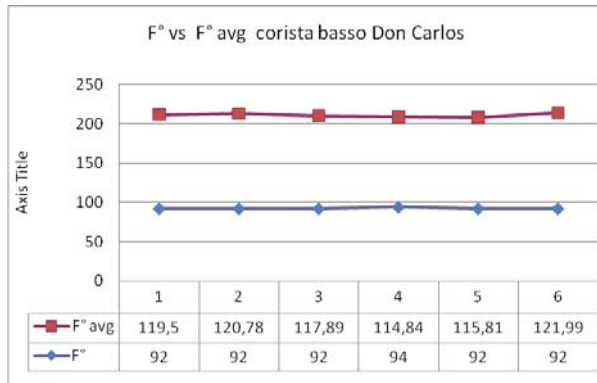
(2) Teatro alla Scala Milano, Italy

Abstract text:

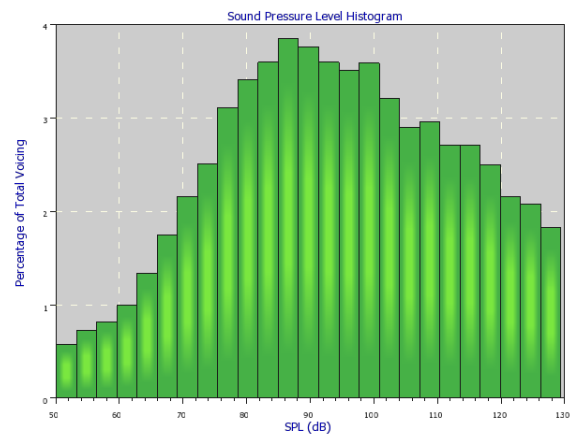
In a population of 103 lyrical choir singers of Teatro alla Scala in Milan, a few volunteers accepted to wear the vocal dosimeter (Kay Pentax APM) during rehearsals or even performances of different operas in the lyric season. Besides usual ENT service to treat sudden diseases in singers and together with a plan of surveillance against vocal abuse, dosimetry may help to describe quantitatively percentage of time in voice, mean loudness, averaging F° , ... the different types of work, meant as 'vocal load', required in a specified chorister role in executing his/her singing task in operas like Verdi's *Don Carlo* or *Aida*, Wagner's *Tannhauser* or *Rheingold*, Bizet's *Carmen* and others. Dosimetry lets us know (and measure) that choir singers reach in *Aida*'s Triumphant March or in *Tannhauser* levels as high as 120 – 130 dB, or that in *Carmen* the averaged intensity in singing is around 90 dB SPL. These and other values may help us understand 'in numbers' the voice task a choir singers has to plan in preparing an opera, especially while performing another one, as is common in a lyric season.

(figures on next page)

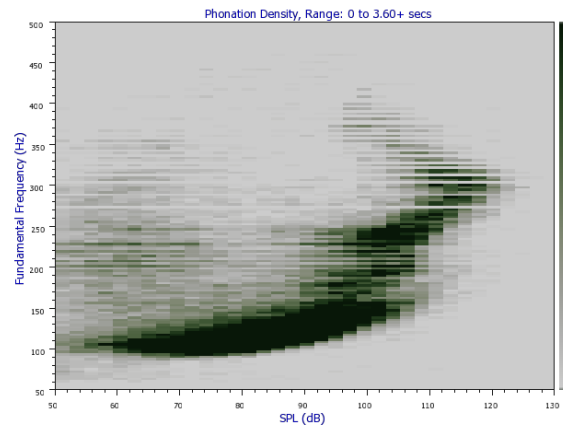
Your notes:



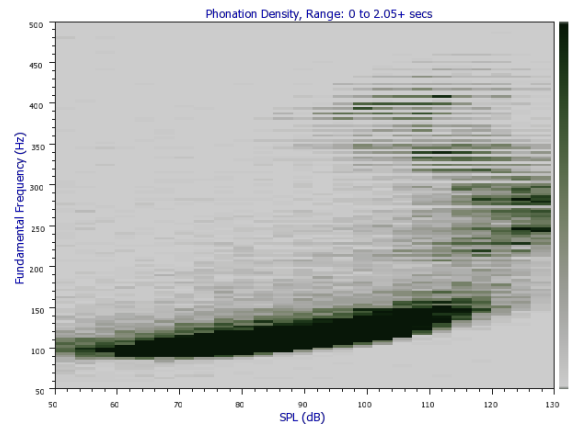
SPL Tannhueser



SPL Carmen



Phonation density, Tannhueser



Phonation density, Carmen

13:40 Comparison of the Accumulated Vocal Dose Across Three Singing Styles

Christopher S. Gaskill (1), M Gilman (2)

(1) The University of Alabama, Tuscaloosa, AL, United States of America

(2) Emory Voice Center, Atlanta, GA, United States of America

Vocal dosimetry is an emerging branch of both clinical and singing voice science. Now that there is a commercially available portable vocal dosimeter (APM-- Ambulatory Phonation Monitor, KayPENTAX), more researchers are able to use this tool to quantify the accumulated vocal dose of singers and increase our understanding of the unique demands singing places on the vocal mechanism. One area that remains to be explored with vocal dosimetry is the direct comparison of vocal doses across different styles of singing. This study represents an initial attempt to quantify and compare the vocal doses of three distinct singing styles: classical, musical theater, and jazz, during a continuous period of singing representative repertoire in each style. These three styles are assumed to have inherently different vocal demands regarding tessitura, range, intensity level, and degree of vocal fold contact. These different vocal demands are expected to result in different levels of overall vocal dose or vocal load. 3 professional female singers in each style (9 singers total) will sing selections from the standard repertoire in their style for 30 minutes with piano accompaniment in a average size classroom while wearing the APM. The pieces will all be familiar to the singers within each style and will be chosen to allow for nearly continuous singing for the 30 minute period (minimum of piano introductions or interludes). The APM data will be compared specifically regarding percent phonation time, phonation cycle dose, and vocal fold distance dose, both within and across singing styles. Given what is known about these singing styles, the hypothesis is that the overall vocal dose will be highest for musical theater, followed by classical, and then jazz singing. Implications for future research into the quantifying the vocal dose associated with different styles of singing will be discussed.

Your notes:

14:00 Conservatoire Singers' Development using the Spectrograph

Stephen Robertson (1)

(1) Royal Scottish Academy of Music and Drama, United Kingdom

Young baritones and tenors often initially exhibit problematic coordination through the passaggio zone and above, experiencing awkwardness in escaping observable phenomena associated with the so-called 'chest' voice. This multi-disciplinary study was executed by a senior vocal pedagogue in the context of a national conservatoire, The Royal Scottish Academy of Music and Drama. The two year project seeks to establish the effectiveness of using spectrographic analysis as an aid to teaching male Conservatoire singers. Singers ranging in level from undergraduate (aged 18-22) to Opera School (up to aged 31) were instructed using the theories which have been published since 2000, (partially summarized by Neumann, K., Schunda, P., Hoth, S. and Euler, H., *Folia Phoniatica et Logopaedica*. 2005, 57: pp. 308-327). Spectrographic real-time feedback was used during lessons to determine:- 1) if information about the balance of harmonics, (as demonstrated in research and confirmed by examination of professional recordings), could be utilised by students, and 2) if such an approach could constitute an appropriate and helpful method for students to acquire necessary technical skills. The same computer software that was used in lessons was employed to keep data showing student progress over an extended period of time. The main area of concentration was in the passaggio zone and above. These singers were able to make unusually quick progress in overcoming problems by deliberately aligning formants with partials so as to successfully access the registration events and qualities of singing which are professionally prized. The results strongly suggest that this is a very valuable method for learning highly specialized coordination, affording better clarity of student oriented tasks which can lead to accelerated learning.

Your notes:

14:20 Vocal Tract Configurations in Tenor Register Functions on different vowels

Matthias Echternach (1), L Traser (2), B Richter (1)

(1) Freiburg University Medical Center, Germany

(2) Charite, Berlin, Germany

Objective: The role of the vocal tract in registers is still unclarified. In previous studies, in 10 tenors strong vocal tract modifications were observed reaching high pitches in voix mixte on vowel /a/. The aim of this study was to analyse the influence of vowel conditions on vocal tract configurations in register functions. Material and Methods: Dynamic real time MRI of 8 frames per second was used to analyze the vocal tract profile in a single international recognized tenor, who sang on the vowels /a,e,i,o,u, ae/ an ascending scale between C4 (261Hz) to A4 (440Hz). The scale included his register transition from modal register to falsetto and voix mixte, respectively. Results: Register transitions from modal register to voix mixte were associated with stronger modifications of the vocal tract compared to transitions to falsetto. Magnitude of vocal tract modifications in register transitions was different in the different vowel conditions.

Your notes:

15:00 Training the Contemporary Musical Theatre Singer

SOUNDS Workshop, Room 4136, LV 26

Laura Avery (1)

(1) Sam Houston State University, United States of America

Over the last 15 years, an increasing number of academic institutions have branched out to offer degrees in the field of musical theatre. As educators of these future Broadway artists, it is imperative that college and university musical theatre voice faculty lead the way in establishing and keeping standards for appropriate vocal qualities and correct stylistic parameters in alternative styles of singing. While there remain roles that should be sung using predominantly head register or with cricothyroid muscle dominant function, there are many roles written after 1960 which are considered contemporary (non-legit) and should be sung primarily in chest register or with predominant use of the thyroarytenoid muscle. Successful contemporary musical theatre vocal production starts with sensation, identifying the registers and muscles involved. Much of what we hear on the Broadway stage today is some measure of mix extending from the chest register. Isolating the muscles involved in producing a predominantly chest voice sound (thyroarytenoid) and predominantly head voice sound (cricothyroid) affords a singer the ability to better control muscle function throughout their range. Today's Broadway singers are expected to extend their chest muscle activity beyond their natural registration shift while diminishing vibrato activity. Understanding vocal physiology before training a voice to be flexible and functional in CCM (Contemporary Commercial Music) styles increases your ability to recognize and systematically rectify poor approaches to this technique. For vocal pedagogues who choose to expand their teaching palate to include Contemporary Musical Theatre performers, acquiring as much knowledge, knowhow and tools about training in that style is the key to being a successful and trustworthy CCM voice teacher.

Your notes:

15:00 Bel Canto Vocal Technique for Choirs: The Auditory and Scientific Proof that it Really Works

CHOIR Workshop, Room F11, LV 22

Laurier Fagnan (1)

(1) University of Alberta, Canada

Choral sound can be so exhilarating: at once full of colour, human emotion and perfectly in tune. Yet it is undeniable that in a quest to achieve a tone where all voices blend into one cohesive whole, certain important aspects in an ensemble's tone are often neglected and blend can become rather bland. This session will present an alternative approach by advancing the core principles of the bel canto method of singing and how they can transform a choir's tone, vocal technique and acoustic energy in a very positive manner and in a style that is completely appropriate for choral singing. Delegates will learn to apply the fundamentals of focused core vibration (not to be confused with vibrato), *chiaroscuro* resonance balancing and *appoggiare la voce* (what support should be) to their choir's sound to make it more beautiful, easier to control and emotionally compelling. Principles of tone will be presented from both artistic and scientific perspectives. Objective, state-of-the-art acoustical analyses will help to reveal why these techniques allow choral sound to be more pleasing to the ear; why when used effectively they enable a choir's tone to carry over the sound of an orchestra with less effort and to be more consistently in-tune while also enabling each word to be understood. Conductors and choristers alike will hear and see how *bel canto* principles not only elevate the level of choral singing from a technical and acoustical standpoint, but also enhance the expressive character of the human voice in the context of that most fascinating of musical instruments: the choral ensemble.

Your notes: