Pedersen M (2008). Update of acoustical standard measure for clinical voice analysis. *The 6th international conference on voice physiology and biomechanics.Tampere*

COST-2103

Tampere 2008

Update of acoustical standard measures for clinical voice analysis

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By:

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Introduction

- **Advanced measures for voice analysis in patients: not evidence based for clinical use, in randomised clinical trials as a basis for meta-analysis.**
- Lack of normal voice function values that can be used for medical treatment (effect) of allergology, infections of the upper airways as well as reflux, emotional and environmental voice disorders.
- Cooperation between different experts:
  - 1. Medical doctors
  - 2. Voice pathologists
  - 3. Engineers
  - 4. Phoneticians
- In the future updated evidence based voice analyses should be made regularly, for clinical use by all four groups.

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Material

- 18 healthy amateur female singers
- 12 healthy amateur male singers
- Between 20 and 40 years of age
- Normal values for phonetograms as well as the appearance of the averaged phonetograms in adults are given among others in the regime of F J Electronics

Methods

- Multi-Dimensional-Voice-Program (MDVP)
- Phonetograms
- Airflow measurements
- High speed films
- Standard deviations were made

Results

MEAN FLOW RATE	Average	Lowest	Highest
Male	0,204	0,031	0,527
Female	0,178	0,106	0,318
VITAL CAPACITY			
Male	5,138	3,460	8,876
Female	3,723	2,615	4,219
PEAKFLOW			
Male	10,993	8,880	19,920
Female	7,366	5,560	8,840

Table 1a
shows the mean flow rate, vital capacity and peak flow

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F0	Average	Lowest	Highest
Male	127,898	106,56	171,05
Female	227,405	198,260	262,700
Jitter (Speech)			
Male	5,469	3,04	6,77
Female	5,448	2,620	7,550
Shimmer (Speech)			
Male	18,047	13,95	20,9
Female	13,389	11,460	17,030
Average Qx (Speech)			
Male	51,248	46,07	58,55
Female	49,239	39,990	57,460
Average Fx (Sust.note)			
Male	140,048	116,04	169,4
Female	272,371	206,620	308,600
Jitter (Sust.tone)			
Male	0,32	0,2	1,08
Female	0,541	0,140	2,080
Shimmer (Sust.tone)			
Male	7,116	3,09	17,54
Female	8,227	2,010	18,690
Average Qx (Sust.tone)			
Male	47,944	39,9	63,33
Female	46,032	37,650	60,940

Table 1b: A comparison was made to frequency and intensity variation in reading of a standard text in this defined normal material.

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HARMONICS TO NOISE ratio	Average	Range Lowest	Highest	S.D.
Male	0,40	0,23	0,91	0,18
Female	0,37	0,21	0,86	0,22
Degree of voiceless ness				
Male	56,0	22,64	91,34	13,6
Female	66,0	25,26	86,90	18,1
Irregularity% (speech) Fx				
Male	19,518	6,41	71,49	
Female	8,525	7,36	14,89	
Irregularity% (sust.note) Fx				
Male	0,788	0,22	4,06	
Female	0,415	0,09	1,00	
Irregularity% (speech) Qx				
Male	40,209	28,35	82,01	
Female	33,211	3,79	63,77	
Irregularity% (sust.note) Qx				
Male	7,987	0,40	31,03	
Female	25,218	0,46	60,73	
Phonation time (in Air Phone II)				
Male	15	5,6	23,4	4,6
Female	18	9,02	26,8	4,9

Table 1c

The Harmonics to Noise ration and degree of voiceless ness measured with the Key Elemetrics program are shown for these normal persons in *table 1c.*

The cohesion factors or irregularity percents for all measures versus the ones were two resemble each other are presented. A division is made for reading of a standard text (the north win and the sun) and a sustained tone for 4 seconds. The phonation times are also presented.

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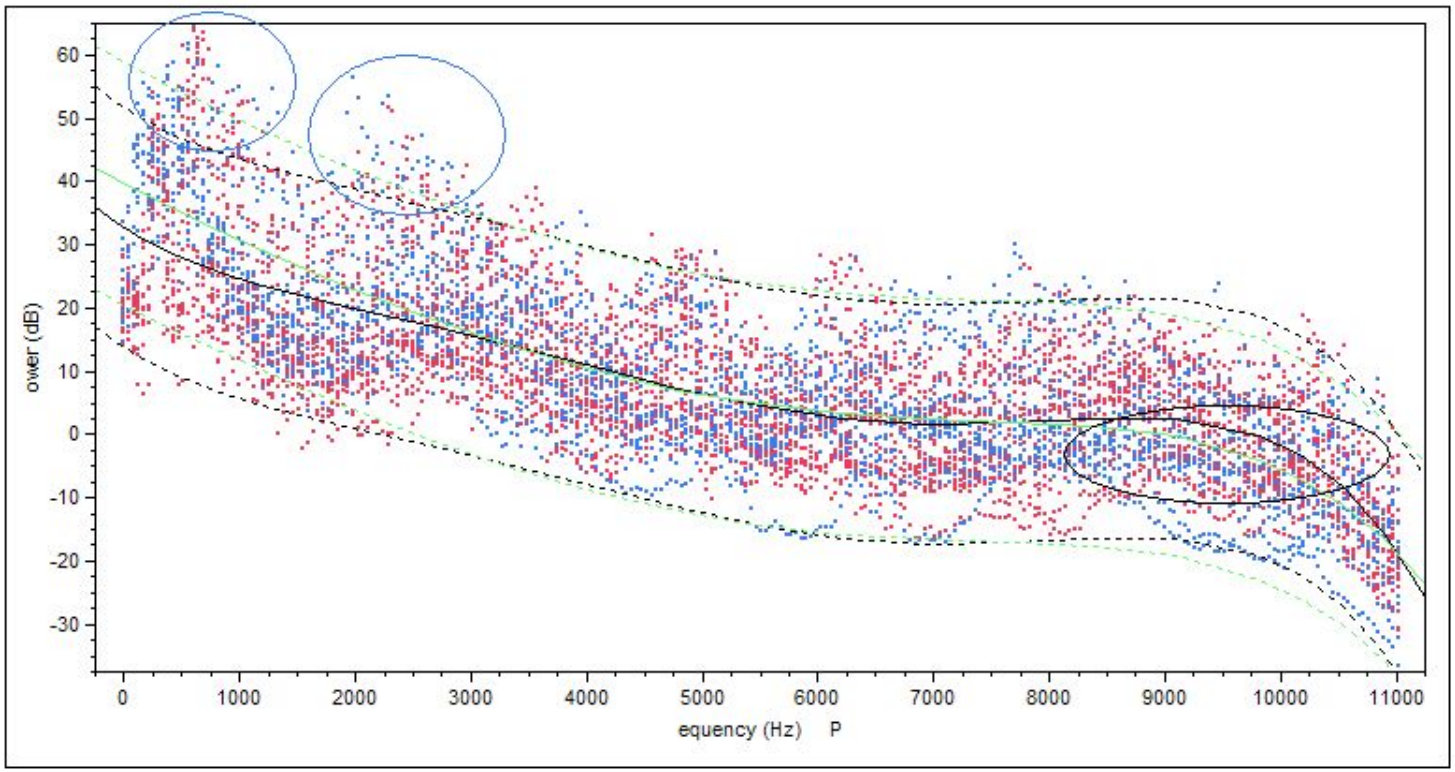
Table 1d:

table 1d,a: The sustained tones of both males and females are presented in polynomial fit degree=5 areas are marked from 200-800, 2300-2700 and also 9500-11000.

With one way analysis of power by gender a difference is found between resonance power, better for males at the area 200-800 Hz (40 vs 34 dB) at the area between 2300-2700 (23 vs 20 dB) the resonance power is also better for men but at 9500-11000 Hz there is a slightly better result for females.



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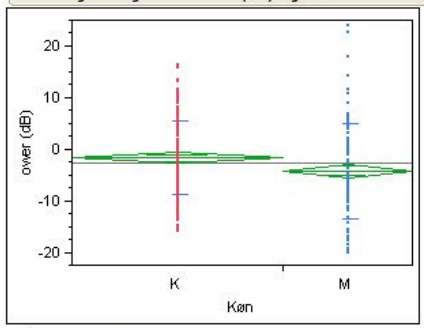
Measurements from 9500-11000 Hz based on a polynomial fit degree=5 of sustained tones.
Men & Women Fit Y by X of power (dB) by gender

Oneway Analysis of ower (dB) By Køn



Oneway Anova

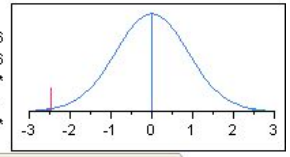
Summary of Fit

Rsquare	0,022147
Adj Rsquare	0,019321
Root Mean Square Error	7,990813
Mean of Response	-2,70526
Observations (or Sum Wgts)	348

t Test

M-K
Assuming equal variances

Difference	-2,4713	t Ratio	-2,79936
Std Err Dif	0,8828	DF	346
Upper CL Dif	-0,7349	Prob > |t|	0,0054*
Lower CL Dif	-4,2076	Prob > t	0,9973
Confidence	0,95	Prob < t	0,0027*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Køn	1	500,378	500,378	7,8364	0,0054*
Error	346	22093,171	63,853		
C. Total	347	22593,549			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
K	216	-1,7679	0,54371	-2,837	-0,698
M	132	-4,2392	0,69551	-5,607	-2,871

Std Error uses a pooled estimate of error variance

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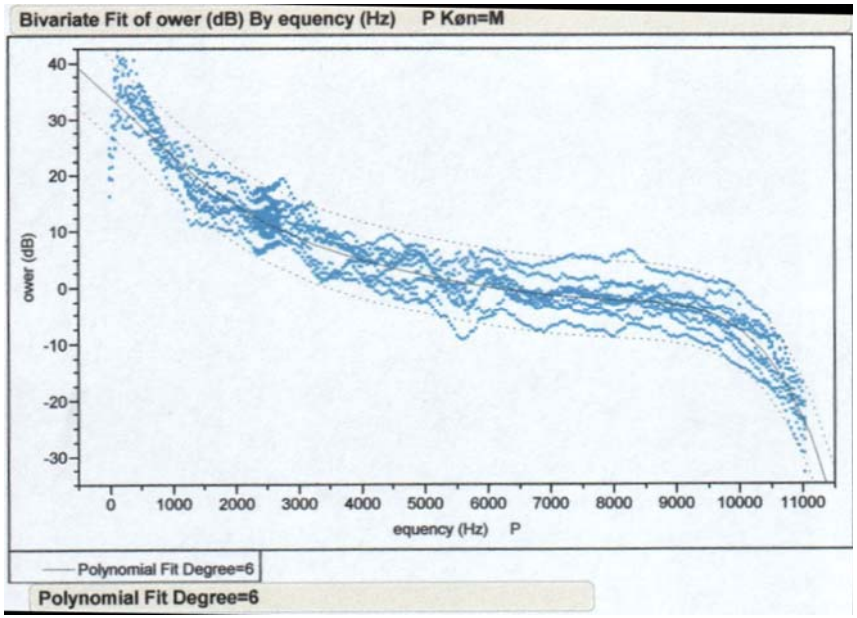
Table 1d,b:

The text (north win and the sun) of both males and females are presented in polynomial fit degree=6. The normal distributions at 200-800 Hz and 2300-2700 Hz are presented and the one way analysis of power (dB) by gender showed that the males had a larger resonance than the females (31 vs 28 dB) at 200-800.



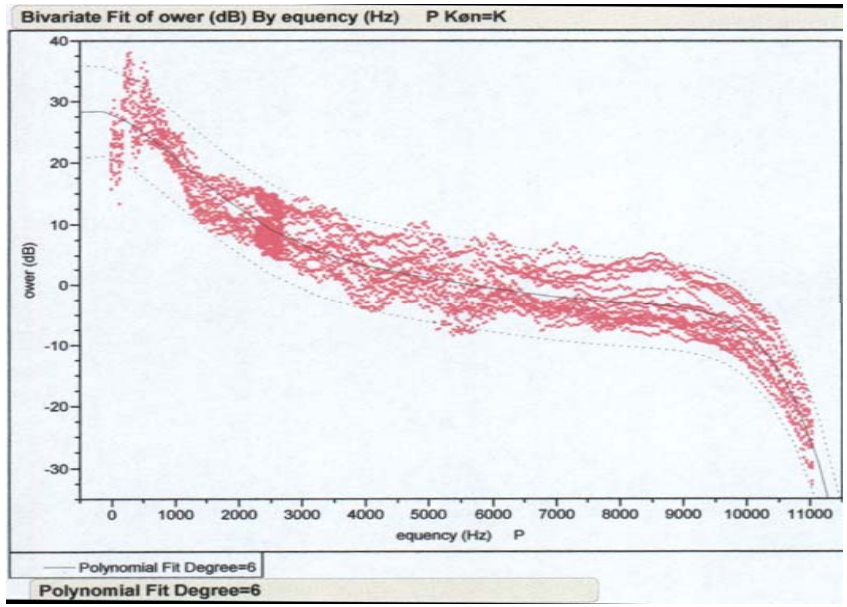


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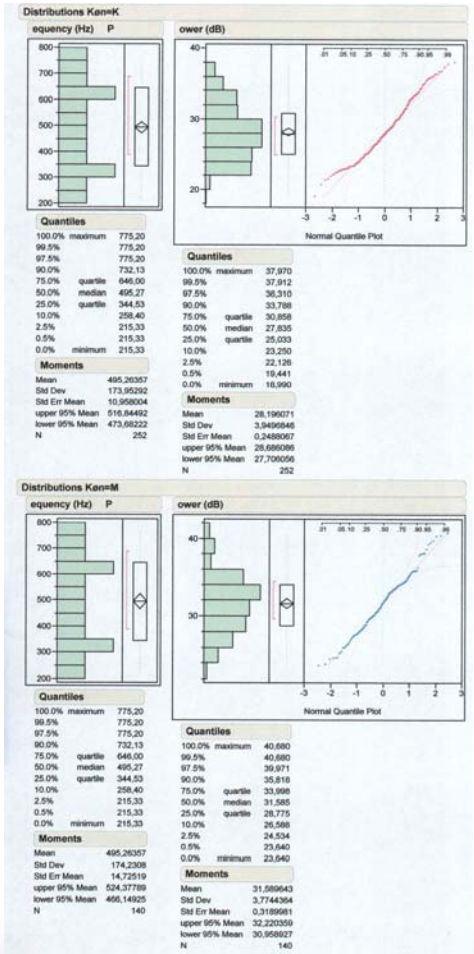
Table 1d,b:

The text (north win and the sun) of both males and females are presented in polynomial fit degree=6. The normal distributions at 200-800 Hz and 2300-2700 Hz are presented and the one way analysis of power (dB) by gender showed that the males had a larger resonance than the females (31 vs 28 dB) at 200-800, and also between 2300-2700 Hz (12 vs 9 dB).



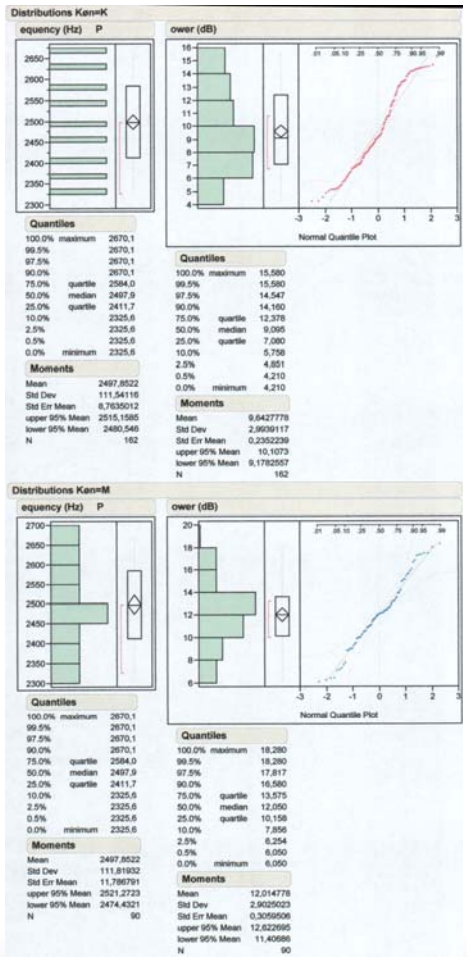


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Table 2:

The calculated results are presented for phonetograms of the lowest-, highest tones, the maximal dynamic area and the total area in semitones times decibels for males and females.

table 2 30 normal amateur singers

PHONETOGRAMS

Range

	Average	Lowest	Highest	S.D.
Lowest Tone				
Male	87	73,4	98	31
Female	160	131	220	33
Highest tone				
Male	716	622	880	154,8
Female	1084	1568	1245	204,3
Maximal dynamic range				
Male	32	24	57	8,4
Female	37	20	41	9,01
Total area in semitones times decibels				
Male	714	406	1054	202
Female	822	432	1047	214

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Table 3:

An attempt has been made to select some of the most important new airflow parameters.

table 3: 30 normal amateur singers

Aerophone II

	Range			
	Average	Highest	Lowest	S.D
Adduction –Abduction rate				
Male	8,41	11,87	5,64	1,70
Female	7,59	10,37	5,1	1,56
Target flow rate (l/sec)				
Male	0,24	0,45	0,17	0,117
Female	0,17	0,216	0,08	0,05
Target SPL (dB)				
Male	82,00	89,26	77,28	3,80
Female	79,43	87,12	70,86	6,36
Real air pressure (cmH2O)				
Male	8,30	12,22	5,15	2,23
Female	7,83	9,96	4,034	1,64

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Table 4:

The open quotients of the high-speed films are presented, in front, centre and rear as well as the area calculations of the general open phase %.

table 4 30 normal amateur singers

HIGH SPEED FILMS

		Range		
	Average	Lowest	Highest	S.D.
Open quotient front				
Male	0,45	0,14	0,92	0,32
Female	0,48	0,37	1,6	0,49
Open quotient centre				
Male	0,51	0,09	1,0	0,27
Female	0,58	0,12	1,0	0,29
Open quotient rear				
Male	0,59	0,07	0,99	0,32
Female	0,48	0,00	1,0	0,31
Area between vocal cords				
Male	0,60	0,04	1,0	0,43
Female	0,68	0,13	1,0	0,30

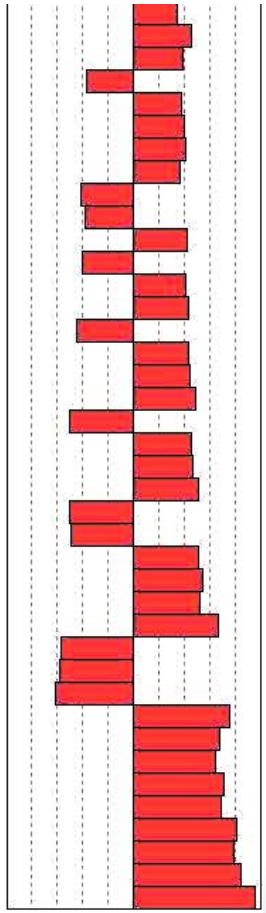
Table 5:
A multivariate statistics made with SAS institution showed many interesting connections

STATISTICAL CONNECTIONS

MULTIVARATE ANALYSIS FOR BOTH GENDERS, Qx means electroglottographical closed phase in sustained tones, Qx2 electroglottogaphical closed phase in speech, area: between vocal chords on high speed films, open quotient: between vocal chords on high speed films

SAS PROGRAME

Mean SPL (db)	Min (hz)	0,3490	30	0,0587
Area	Average Qx 2	0,4567	18	0,0568
Peak Air Pressure (cmH2O)	Average Qx 2	0,3878	25	0,0554
Ad-Abduction Rate (cps)	Mean Airflow Rate (l/sec)	-0,3675	28	0,0543
Target Flow Rate (l/sec)	Mean Airflow Rate (l/sec)	0,3770	27	0,0525
Target Resistance (Ns/m5)	Max (hz)	0,4078	24	0,0479*
Target Power (Watt)	Target SPL (db)	0,4114	24	0,0458*
Max Phonation Time (sec)	Dynamic range (db)	0,3677	30	0,0456*
Target Power (Watt)	Min (hz)	-0,4180	24	0,0421*
Vital Capacity (litre)	Max (hz)	-0,3764	30	0,0403*
Target Power (Watt)	Volume (litre)	0,4228	24	0,0396*
Phonation Quotient (l/sec)	Volume (litre)	-0,4072	28	0,0315*
Target SPL (db)	Target Flow Rate (l/sec)	0,4154	27	0,0312*
Target Power (Watt)	Mean Airflow Rate (l/sec)	0,4408	24	0,0311*
Target Power (Watt)	Max (hz)	-0,4467	24	0,0286*
Volume (litre)	Vital Capacity (litre)	0,4328	28	0,0214*
Target Flow Rate (l/sec)	Volume (litre)	0,4461	27	0,0197*
Target Resistance (Ns/m5)	Mean SPL (db)	0,4871	24	0,0158*
Target Resistance (Ns/m5)	Target Flow Rate (l/sec)	-0,5027	24	0,0123*
Ad-Abduction Rate (cps)	Phonation Quotient (l/sec)	0,4594	30	0,0107*
Max (hz)	Min (hz)	0,4651	30	0,0096*
Target Power (Watt)	Average Qx 2	0,5193	24	0,0093*
Mean Airflow Rate (l/sec)	Max Phonation Time (sec)	-0,5065	28	0,0060*
Peakflow (l/sec)	Max (hz)	-0,4903	30	0,0059*
Target SPL (db)	Average Qx 2	0,5125	29	0,0045*
Peak Air Pressure (cmH2O)	Target SPL (db)	0,5517	25	0,0043*
Average Qx 2	Average Qx	0,5261	30	0,0028*
Area	Open Quotient (front)	0,6748	18	0,0021*
Target Flow Rate (l/sec)	Max (hz)	-0,5743	27	0,0017*
Vital Capacity (litre)	Min (hz)	-0,5800	30	0,0008*
Peakflow (l/sec)	Min (hz)	-0,6123	30	0,0003*
Area	Open Quotient (center)	0,7574	18	0,0003*
Peak Air Pressure (cmH2O)	Target Flow Rate (l/sec)	0,6850	24	0,0002*
Dynamic range (db)	Area (db)	0,6524	30	<,0001*
Target Effeciency ((ppm)	Target SPL (db)	0,7153	24	<,0001*
Mean Airflow Rate (l/sec)	Volume (litre)	0,6880	28	<,0001*
Open Quotient (front)	Open Quotient (center)	0,8130	18	<,0001*
Target Power (Watt)	Peak Air Pressure (cmH2O)	0,7945	24	<,0001*
Vital Capacity (litre)	Peakflow (l/sec)	0,8461	30	<,0001*
Target Power (Watt)	Target Flow Rate (l/sec)	0,9591	24	<,0001*



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Conclusion

- The clinical usable tools: video stroboscopy and high speed films were evaluated in 30 amateur singers and the (normal) results were statistically compared with physiological and acoustical parameters measured at the same time.
- The results of air function must be used much more in the future since the significant values related to sound were high. The aspect of air pressure measurement is also a promising for clinical trials of treatment effect of upper airway disorders. For high speed films the quantitative measurements must be further developed.

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