

# VOICE CHANGES AS A FUNCTION OF VOCAL REHEARSAL – A STUDY WITH PROFESSIONAL SINGERS AND DANCERS

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Phonation in professional singers is somewhat athletic. It requires not only vocal technique, but vocal health as well. Both can be established by regular vocal practice. There has been little data on the acoustic effects of both vocal warm-up and artistic performance on the voice and even less is known about the effects of vocal rehearsal. While vocal warm-up tends to optimize vocal function, post-performance effect is often negative. In well-trained singers these voice changes are of acute nature and soon disappear. What about vocal rehearsal and its' acoustic effects?

In our investigation the effect of vocal rehearsal on fundamental frequency ( $f_0$ , jitter and shimmer) was examined in a group of seven female dancers and singers, members of Folk Dance Ensemble of Croatia known for its' 50 year old tradition focused on Croatian folk songs and dances. The mean age of subjects was 34, and mean length of professional career 13,5 years. It is important to stress that none of the subjects had ever had formal education in singing. They all are trained dancers who started to sing in the professional ensemble they work for. The subjects had to complete a set of vocal tasks - sustained phonation of vowel /a/ at comfortable, minimum and maximum pitch level and both ascending and descending glissando before and after one-hour vocal rehearsal. These tasks were designed to test for the fundamental frequency ( $f_0$ ) - habitual, minimum and maximum, and also jitter (in %) and shimmer (in dB) for each of these  $f_0$  values before and after vocal rehearsal. Voice samples were collected in a quiet room, recorded and stored on audio-tapes. The acoustic analysis was conducted by means of the EZVoice™ software v. 1.2. The data were processed on the univariate level. The differences in acoustic variables before and after vocal rehearsal were examined by the method of t-test for small dependent samples.

## RESULTS

The results of descriptive statistics for acoustic variables before and after vocal rehearsal are shown in *Table 1*. As it can be seen, changes in all variables in the direction of optimization are detected.  $f_0$ -values after vocal rehearsal are higher in all tasks (phonation at comfortable, minimum and maximum pitch level). The lowest mean value of jitter refers to  $f_0$  at comfortable pitch level while its' highest mean value is evident in phonation at minimum pitch level. The lowest mean value of shimmer refers to  $f_0$  at maximum pitch level and its' highest value is detected in phonation at minimum pitch level.

*Table 1.* The results of descriptive statistics for acoustic variables before (1) and after (2) vocal rehearsal where M=mean, SD=standard deviation, Min=minimum value, and Max=maximum value (N=7)

Variable	M1	M2	SD1	SD2	Min1	Min2	Max1	Max2
$f_0$	198,43	227,03	20,35	23,05	168,25	203,38	231,19	271,76
jitter	,73	,66	,22	,52	,49	,36	1,03	1,81
shimmer	,14	,11	,04	,11	,10	,02	,21	,32
$f_0$ -min	136,00	143,56	20,95	21,15	99,26	104,69	158,54	164,71
$f_0$ -min-jitter	1,61	1,55	1,03	,91	,77	,86	3,40	3,24
$f_0$ -min-shimmer	,23	,17	,11	,06	,12	,09	,44	,27
$f_0$ -max	717,92	743,66	311,31	314,77	471,26	489,34	1346,10	1369,60
$f_0$ -max-jitter*	,96	1,07	,23	,25	,67	,76	1,25	1,40
$f_0$ -max-shimmer*	,07	,07	,03	,04	,04	,02	,11	,11

\* N = 6 (in these variables 6 subjects were analyzed; the voice of one subject was not analyzed by the EZVoice™ v. 1.2 software because of technical limitation)

To test the statistical significance of these acoustic changes of the voice as a function of vocal rehearsal, t-test for small dependent samples was conducted. The results are shown in *Table 2*.

*Table 2.* T-test results for small dependent samples for acoustic variables before and after vocal rehearsal

Variable	t-test	prob.
$f_0$	<b>-4,86</b>	<b>&lt; 0,01</b>
jitter	0,32	> 0,05
shimmer	0,86	> 0,05
$f_0$ -min	<b>-3,26</b>	<b>&lt; 0,02</b>
$f_0$ -min-jitter	0,59	> 0,05
$f_0$ -min-shimmer	<b>2,78</b>	<b>&lt; 0,05</b>
$f_0$ -max	-0,85	> 0,05
$f_0$ -max-jitter	-0,10	> 0,05
$f_0$ -max-shimmer	0,59	> 0,05

It could be seen that differences were found on three variables -  $f_0$ ,  $f_0$ -min and  $f_0$ -min-shimmer; mean value of  $f_0$  is significantly higher in phonation at comfortable and minimum pitch level, and mean value of shimmer in phonation at minimum pitch level is significantly lower. These results reflect changes in some acoustic characteristics of voice as a function of vocal rehearsal. It can be concluded that voice after one-hour vocal rehearsal becomes more warmed-up (higher  $f_0$  values). These results, however, might not be consistent because of factors such as the repertoire rehearsed, vocal technique used, etc. It is important to stress that subjects in this investigation practice different techniques of singing which are the part of Croatian folk tradition (strident throat singing).

## **CONCLUSION**

Although the acoustic effect of vocal rehearsal on voice is positive in this investigation, the results should be taken with caution. In extreme cases it could be suspected that long lasting and very demanding vocal rehearsals may result in opposite results showing the signs of vocal fatigue. Together with the results of the present investigation, future studies on vocal rehearsal effects may highlight the optimum vocal rehearsal time. It must not be forgotten that the human voice is an extremely sensitive instrument.