

# Comparison of auditory assessment of voice pitch and acoustic values of F0, formant frequencies (F1, F2, F3 and F4) and region assessment of Croatian speakers

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The aim of this research was to compare auditory assessment of speakers' voice pitch and regional origin based on neutral speech recordings. Previous research showed that articulatory settings of some regions can influence voice quality and might have influence on voice speech assessment (Varošaneć-Škarić, 2005). 20 speakers with origin in different parts of Croatia read the same text. 30 seconds of recordings were used in acoustic analysis. F0, F1, F2, F3 and F4 formant values were measured from five stressed vowels [a, e, i, o, u]. The chosen vowels belonging to Croatian Received Pronunciation are notably different in different dialects (Škarić, 2009). Majority of Croatian cities were included in this research (Zagreb, Čakovec, Varaždin, Pula, Šibenik, Split, Dubrovnik), the speakers were aged between 20 to 70; had different education levels; belonged to different professions and lived most of their lives in those cities.

The listeners were 20 students of final year phonetic undergraduate studies and could be considered listeners with some expertise, but not experts. Their assignment was to assess voice pitch on the scale from 1 to 5 – 1 meaning a very deep voice (very low pitch), 2 – deep voice, 3 – medium pitch, 4 – high voice, 5 – very high voice. Preliminary results revealed the degree of regionalism of the speakers.

The acoustic analysis was made for all speakers for each of five Croatian vowels on five different tokens. The acoustic analysis included lexical words and not nonsense words because they were extracted from connected speech recordings.

Pearsons correlation was calculated for each vowel for auditory assessment and acoustic analysis variables (for both male and female speakers respectively). Further on, t-test was used to measure significance between regional and non regional speakers and the acoustic analysis variables.

The results show highly significant positive correlation between auditory assessment of voice pitch for female voices and F0 ( $r = ,952$ ;  $p < 0,001$ ), than F4 for vowel /e/ ( $r = ,895$ ) and /o/ ( $r = ,880$ ) and little less for F<sub>3</sub> of vowel /e/.

The results of male voice pitch assessment indicates medium and non significant correlation with F0 ( $r = 0,584$ ;  $p = 0,07$ ). The real value of F0 for female voices correlates significantly with F4 of vowel /o/ ( $r = ,881$ ,  $p < ,001$ ) and /e/ ( $r = ,875$ ). In the case of male voices the only positive correlation is between auditory assessment of voice pitch and F2 for vowel /i/ ( $r = 0,70$ ,  $p = 0,02$ ) which suggests the importance of front place of articulation. It is important for voice recognition to accurately assess the origin of the speaker and therefore it is important to determine the relation between regional markers and acoustic parameters. The results show that the speakers who were assessed as regionally marked regardless of gender differences have higher F0. There were more

laryngeal and supralaryngeal modifications in regionally marked vowel pronunciation in comparison to vowels of RPC (Received Pronunciation of Croatian). The results have shown greater differences between regionally marked and non-marked male speakers than in regionally marked and non-marked female voices. (Varošanec-Škarić, 2005).

Formant frequency differences of regional and non-regional male speakers are highly significant for F4 of closed vowels /i/ i /u/ ( $p < 0,01$ ) and less significant for F3 of all other vowels except vowel /a/. Regionally marked speakers have significantly higher frequencies for F3 and F4 which can be explained with raising of larynx in some Stokavian dialects of southern part of Croatia (Šibenik, Split) and Kaikavian dialect in northwestern part of Croatia (Čakovec). The Stokavian dialect of Dubrovnik, with distinctive lower back tongue placement in the pronunciation of some vowels was also assessed as regionally marked (Varošanec-Škarić, 2010).

The results have shown significant statistical difference of F1 and F2 vowel formants among male speakers, i.e. regionally marked male speakers had higher F1 of vowel /o/ ( $p < 0,01$ ) and vowel /e/ ( $p < 0,01$ ), and vowel /a/ ( $p = 0,05$ ), significantly higher F2 of both vowels /u/ ( $p < 0,01$ ) and /i/ ( $p < 0,01$ ). Regionally marked female voices had higher F2 of vowel /u/ ( $p < 0,01$ ) and lower F2 of vowel /i/. This indicates that vowel pronunciation of regionally marked speakers was closed back in comparison to regionally non-marked speakers.

It is interesting to note that regional assessment did not identify pronunciation of speakers from Zagreb as regionally marked and also the pronunciation of Pula, similar to that of Croatian capital, remained regionally unmarked. Other regionally unmarked speakers originate from other Croatian cities and had higher education levels.

As a conclusion, it can be said that the auditory assessment of female voice pitch correlates more to the acoustic values of F0 while male voices, due to different tubes ratio differ more in other formant values. This is particularly evident in assessment of regional markedness. Therefore it is important to interpret the results of auditory assessment and acoustic analysis separately. The results of this research will be used for further research in speakers' profiling in Croatia.

## References

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