

Comparison of F0 measures for male speakers of Croatian, Serbian and Slovenian

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Introduction

Fundamental frequency is, among other voice qualities, important in speaker identification (Traunmüller and Eriksson, 1995), especially because the F0 values are preserved in different recording conditions. An average F0 value for 104 male speakers of Croatian language is stated based on continuous neutral speech, with a duration of around 70 s and it is 117.36 Hz (setting between 75 and 176 Hz; S.D. 18.78 Hz) (Varošaneć-Škarić, 1998); for male speakers of Serbian language Jovičić (1999) reports average value of 121 Hz and S.D. F0 cca 16 Hz, measured for five standard vowels of Serbian language. Tivadar (2008) reported F0 values in Slovenian which were lower than values measured in Croatian language (Varošaneć-Škarić, 1998). However, Slovenian results were based on 6 elite vocal professionals.

Our goal was not to question previously measured values, but to measure and to compare F0 values on symmetrical groups. These findings are important in sociolinguistics and forensic phonetics.

The aim of this paper was to compare fundamental frequency measures expressed in Hz and in semitones which can be used for more robust, future speaker comparison. Second, pragmatic aim of this paper was to collect samples of voices in order to create Croatian database which could be used in future for comparison based on sex, age, education, voice health between speakers of very similar languages, e.g. Croatian, Serbian, Bosnian, Slovenian and for comparison between Croatian speakers with received and dialectal pronunciation.

It was expected that the younger groups of Croatian, Serbian and Slovenian speakers will not differ significantly for average value mean F0.

Method

In the first part of the research native speakers of Croatian (N=15), Serbian (N=15), and Slovenian (N=15) language were recorded under the same conditions during the 2015, 2016 and 2017 year in three country capitals: Zagreb, Belgrade and Ljubljana. Age of recorded speakers was similar with age median of 22.

Considering that the results of the first part of the research between three symmetrical groups of speakers have showed no statistically significant difference of mean F0 measures and that the values of

mean F0 between Croatian and Slovenian language were similar, the second part of the research was conducted.

The second part of the research included larger number of speakers in groups which showed differences in F0 measures i.e. Croatian (N=37) and Serbian (N=37) speakers. Spontaneous speech of every speaker was recorded (cca 3 min) and reading passages were used for fundamental frequency measures in Hz and semitones.

F0 mean, median, average baseline value Fb (based on median), average minimal and maximal F0 values, alternative baseline (Alt_Fb), standard deviation (S. D.) of F0 in both Hz and semitones were calculated. For the calculation special programs in Praat (Boersma and Weenink, 2015; Ver. 6.0.05) were used. The calculation was done on a limited setting between 65 and 300 Hz to get all the possible frequencies for the F0 range and to avoid octave jumps. Lindh (2006) used the setting between 75 and 350 Hz for the F0 tracker. Considering that the sample was comprised of only male speakers of received Croatian and Serbian without noticeable dialectal pronunciation, it has been shown that it is enough to limit the pitch ceiling to 300 Hz. The values above 300 Hz have been checked in preliminary testing and it has been shown that they are discontinuous octave jumps, harmonics and stridents. ANOVA: two-factor with replication was used to test the differences between groups and to test the difference between reading passage and spontaneous spoken utterance.

Results and discussion

In the first part of the research based on smaller number of speakers of Croatian, Serbian and Slovenian language there has been no statistically significant difference in mean F0 in Hz (Croatian 118.21 Hz; Serbian 123.70 Hz and Slovenian 119.13 Hz). Other variables of F0 were also not statistically relevant. The second part of the research which was conducted between groups that showed more differences i.e. Croatian and Serbian speakers ANOVA (single factor and two factor) analysis was used.

Results have showed that respectively the greatest difference between groups was in median F0 in semitones ($p=0.0005$; Figure 1) and in Hz (Croatian 117.25 Hz, Serbian 124.09 Hz; $p=0.0007$). It has been shown that younger Croatian speakers have

significantly lower F0 mean in both measurements than Serbian (Croatian 117.11 Hz, Serbian 126.64 Hz; $p=0.001$), significantly lower Fb (Croatian 90.86 Hz, Serbian 97.30 Hz; in Hz: $p=0.001$; in semitones: 0.002) and lower Alt_Fb. The overall results for both groups of speakers show less significant differences between reading passage and spontaneous spoken utterance for measures in semitones and in Hz for Fb ($p=0.017$; 0.015), respectively, median F0 ($p=0.014$; 0.018), for F0 minimums (in Hz, $p=0.016$; 0.022), for F0 mean ($p=0.02$; 0.024), for F0 maximums (Croatian 198 Hz, Serbian 201 Hz; $p=0.04$) and in semitones for Alt_Fb ($p=0.04$). The values of F0 mean from this paper correspond with the value reported in Varošaneć-Škarić (1998) for Croatian speakers, and for Serbian speakers it is somewhat higher than the F0 value reported in Jovičić (1999). It can be concluded from the collected data that intonation patterns are more different between groups of Croatian and Serbian speakers which is important for further research in the two similar languages. Overall, it can be concluded that clearer differences were found in the semitone measures, but both type of measurements, Hz and semitones, are useful for comparing speakers with different mother tongues. In wider context these results are similar and can be compared with the results in European languages (Traunmüller and Eriksson, 1995b) and the results of the research conducted aiming to compare Slavic and German languages (Andreevna et al, 2014). Results are also similar with the research in Swedish (Lindh, 2006) and Czech language (Skarnitzl and Vaňková, 2016).

Conclusion

Based on overall results we can conclude that Croatian and Serbian speakers are more different than Croatian and Slovenian based on measures of F0. Which is surprising because RP Croatian and Slovenian languages are more different linguistically. This can be explained with more similarities in intonation between these two languages. However, this should be confirmed with further research planned for the future including greater number of native speakers of Croatian and Slovenian language. These results are valuable also in the sense of the methodology because they indicated how important it is to have larger number of homogeneous groups (higher than 30) which can provide more sensitive intergroup comparisons of acoustical measures in spontaneous speech.

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