

Effects of Face Covering on Acoustic Properties of Voiceless Fricatives in Farsi: A Forensic Approach

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1- Introduction

This research attempts to investigate the effects of forensically-relevant facial concealment on voiceless fricatives /f, s, ʃ/ in Farsi. There are various types of face-concealing garments that are commonly worn by people for the occupational, recreational, religious, and cultural purposes. These coverings may be typically used as disguises during the commission of crime by delinquents. Among these face coverings, one can refer to surgical masks, motorcycle helmets, and niqāb. Certainly, face coverings have an effect on the way the speech is produced. The way we produce speech is likely to be modified when a mask is covering our face. In such situations, the default motor activity of certain articulators such as lips make an effect on normal facial surface behaviours and natural jaw motions. Llamas (2008) claims that even more minor modification to the articulatory gestures during speech production may alter the resultant acoustic signal. When a fabric or other material is covering the mouth and nose, the propagation of the sound wave will be impeded, and the sound energy of certain spectral components of the signal will be absorbed. Nowadays, forensic speech scientists are encountered with such cases. The purpose of this study is firstly is to contribute to facewear research within forensic phonetics and secondly to prepare the experts to take that knowledge into account during their analysis when they are working on speech materials produced through facewear. Therefore, the present study centers on this question: Are the acoustic properties of facewear speech different from those of control speech. Thus, the current study explores the acoustic properties of voiceless fricatives /f, s, ʃ/ in Farsi both in control and facewear conditions.

2- Methodology

Five female speakers were recorded in a professional acoustic laboratory at the University of Alzahra. The mean age of the five selected speakers was 29. They

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aged from 27 to 31. The speech material consists of 18 non words. Each non word was repeated twice. These were extracted from the /CaC/ syllables. The total data set comprises 900 tokens: 5 speakers \times 18 non words \times 2 repetitions \times 1+4 facewear conditions. Five types of facewear including unconcealed face, motorcycle helmet, rubber mask, surgical mask, and balaclavas without mouth hole, were tested in this study. Phonetic samples were analyzed using PRAAT version 5.2.34 and the statistical analysis of the data was performed by IBM SPSS version 21.0. To examine the effects of facewear on the acoustic speech signals, intensity and spectral parameters including friction intensity, center of gravity and spectral peak were measured.

3- Discussion

The statistical analysis of the intensity of data revealed that facewear significantly affected the intensity of all voiceless fricatives. The main effect of facewear on intensity was significant for /f/ [F (4, 595) = 56.198, sig= 0.000], /s/ [F (4, 145) = 41.424, sig= 0.000], /ʃ/ [F (4, 145) = 40.481, sig= 0.000]. The intensity of the /f/ was smaller than 50 dB; while the intensity of /s/ and /ʃ/ were higher than 50 dB. The intensity of /s/ and /ʃ/ were more similar to each other than the intensity of /f/. For all the three voiceless fricatives, the effect of facewear on intensity was most noticeable in case of the helmet condition. Furthermore, surgical mask didn't provoke large intensity changes relative to the control condition.

The statistical analysis revealed a significant main effect of facewear on the spectral peak of all fricative, namely /f/ [F (4, 595) = 20.319, sig= 0.000], /s/ [F (4, 145) = 11.476, sig= 0.000], /ʃ/ [F (4, 145) = 3.524, sig= 0.009]. The peak measures for /s/ and /ʃ/ were similar across facewear condition. In general, the peak measures for /s/ and /ʃ/ have been minimally affected through facewear condition. The peak measures for /s/ and /ʃ/ were acoustically less affected than those for /f/ because /f/ has diffuse spectral pattern.

The statistical analysis indicates that there was a significant main effect of facewear on the COG of /f/ [F (4, 595) = 50.245, sig= 0.000], /s/ [F (4, 145) = 20.683, sig= 0.000], /ʃ/ [F (4, 145) = 5.992, sig= 0.000]. The results revealed that when /s/ is produced through facewear, it has the highest level of variation. This implies that sound energy is absorbed in higher frequency bands of the spectrum. This effect was most prominent in the rubber mask and helmet condition. Moreover, for /f/, the highest level of variation was in the helmet condition. The result indicates that the COG was only minimally affected when /ʃ/ was produced through facewear.

4- Conclusion

This survey attempts to explore the effects of forensically relevant face coverings on acoustic properties of voiceless fricatives /f, s, ʃ/ in Farsi. The voiceless

fricatives, namely /s/, /ʃ/ and /f/ were chosen in this study because of the importance of fricative analysis in forensic phonetic caseworks and also for their energy distribution in higher frequency bands of the acoustic spectrum. To examine the effects of facewear on the acoustic speech signals, the intensity and spectral parameters including friction intensity, center of gravity, and spectral peak were measured. Phonetic samples were analyzed using PRAAT and the statistical analysis of the data was performed by IBM SPSS.

Findings indicate that facewear can considerably influence the intensity and spectral features of the voiceless fricatives /f, s, ʃ/. This was likely to be the result of some changes caused by face coverings which alter the acoustic-phonetic characteristics of the voiceless fricatives /f, s, ʃ/. The outcome reveals that intensity measure for the motorcycle helmet and COG measures for several face coverings (motorcycle helmet and rubber mask) show the highest values of changes. Furthermore, spectral peak of /f, s, ʃ/ compared to the intensity and COG has shown the least variation.

Keywords: forensic phonetics, acoustic phonetics, spectral features, voiceless fricatives.

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