

# An acoustic analysis of bam and zil singing by female Azerbaijani mugham singers using the Long Term Average Spectrum (LTAS)

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In: Jakubowski, K., Farrugia, N., Floridou, G.A., & Gagen, J. (Eds.)

Proceedings of the 7th International Conference of Students of Systematic Musicology (SysMus14)  
London, UK, 18-20 September 2014, <http://www.musicmindbrain.com/#!sysmus-2014/cfmp>

**Background.** Azerbaijani mugham reflects the innermost creative music identity of the Azerbaijani heritage through one of the most complex forms of communication, the voice. Traditional performances of vocal mugham require improvisatory skills, possession of an extraordinary vocal range, and the ability to recite extensive poetry (ghazal), which are set to specific melodic modes. This paper explores the acoustic features of mugham, and is a part of ongoing research that investigates vocal production, performance practice, and the cognitive perception of Azerbaijani vocal mugham. It originated as part of a Master's thesis, and hypothesizes that the singer's formant is present in the sound of bam (low register singing) and zil (high register singing) in vocal mugham. Despite the abundance of scholarly material focusing on mugham, little is known about the acoustic and physiologic properties of Azerbaijani vocal mugham, specifically how bam and zil are produced. This research fills the gap in understanding the vocal production, acoustic and physiologic aspects of this Ancient art form of vocal expression.

**Methods.** It uses the Long Term Average Spectrum (LTAS) to investigate acoustic parameters, looking for common factors in the distribution of energy across frequency spectrums. It analyses the sound produced by five professional female Azerbaijani Mugham singers between the ages of thirty and fifty. Each singer performed the same piece, entitled "Mirza Huseyn Segahi." Excerpts were spliced. Duration was relatively similar for each singer in bam and zil. Minor differences in duration were the result of different improvisatory elements used by the singers.

**Instrumentation.** The data gathered from each recording were analyzed using the Multi Speech Voice Analysis program (Kay-Pentax, Lincoln Park, NJ), Presser Voice Laboratory in order to investigate the contour of the acoustic spectrum. The analysis was performed on each singer's bam and zil singing samples, observing changes, or the lack of change, in the LTAS data. The LTAS data showed prominent peaks and valleys in five instances of bam for all five singers. It was possible to identify a singer's formant for all samples.

**Results.** Although, Azerbaijani vocal mugham singing is different from classical opera, the presence of singer's formant was also evident in the sound of bam and zil of vocal mugham. Preexisting scientific acoustic analysis has looked for a singer's formant in various vocal styles, such as folk singing, country singing, and opera singing. Scientists, Johan Sundberg, in his research, "The Source Spectrum in Professional Singing; Articulatory Interpretation of the Singing;" and in "Level and Center Frequency of the Singer's Formant," explains that singer's formant is a particular acoustic phenomenon that appears as a result of the lowering of the larynx that in turn creates the conditions for a clustering of the upper formants. Sundberg writes, that this acoustic phenomenon is a prominent sound energy peak, which occurs as a result of the clustering of the third, fourth, and fifth formants. The strong spectral peaks that are identified as a singer's formant appear in the upper part of the acoustic spectrum, between 2.5 and 3.3 kHz, depending upon voice classification.

**Conclusions.** Through the LTAS voice analysis, it was evident that Azerbaijani vocal mugham singers singing in bam and zil ranges employ the acoustic phenomenon of the singer's formant. The vocal ranges, bam and zil, are not to be equated with a traditional classical understanding of registers. They mainly describe vocal tessitura, referring to the high or low range within the compass of a singer's voice. However, the fact that the singer's formant is present in the sound of the singers, singing in the low range of bam and in the high range of zil indicates that the positioning of the larynx is stable and low. This results in the clustering of the third, fourth, and fifth formants, comprising of the singer's formant.

Keywords: Azerbaijani, mugham, singer's formant, bam, zil, voice science, acoustic parameters