

An acoustic comparison of Russian and English sibilant fricatives

Russian is known to have a 4-way place and secondary articulation contrast in voiceless sibilant fricatives, as, for example, in [sok] <сок> ‘juice’ vs. [s^lok] <цөк> ‘whipped’ vs. [ʂok] <шок> ‘shock’ vs. [ʃ^lok] <щөк> ‘cheeks (gen.)’ (Avanesov 1972; Timberlake 2004). These consonants have been previously noted to be different from the corresponding English fricatives /s/ and /ʃ/. The classical phonetic descriptive account of Russian sounds by Jones & Ward (1969; pp. 125-134) mentions that the Russian non-palatalized anterior /s/ has a “slightly lower pitch” compared to the English /s/, likely reflecting some constriction differences (laminal dental vs. apical alveolar) and presence or absence of secondary velarization. The Russian palatalized anterior /s^j/ is noted to be similar to the (British) English /s/ + /j/ sequence (as in *assume*), yet also showing some differences in “pitch” (higher than in English). The Russian /ʂ/, according to the authors, exhibits a “characteristic ‘dark’ or ‘hollow’ property”, an apparent result of the raised tongue tip, flattened tongue body, and rounded lips. This makes the sound particularly different from English /ʃ/, which has a “somewhat palatalized” quality resulting from a moderate raising of the tongue front. The degree of palatalization of the English /ʃ/, according to Jones & Ward (1969), however, is substantially smaller than for the strongly palatalized Russian /ʃ^j/. This auditorily-based comparison is undoubtedly useful for learners of Russian, yet it is not clear which specific acoustic properties these description represents. For example, Jones & Ward’s the non-standard use of the term ‘pitch’ could refer to differences in spectral means of fricative noise or differences in the formants of an adjacent vowel. Since the time of this work, acoustic properties of Russian fricatives have been examined in several studies (e.g. Derkach, Fant, & de Serpa-Leitao 1970; Purcell 1979), yet in considerably lesser detail than those of English fricatives (e.g. Jongman, Wayland, & Wong 2000). Moreover, none of the studies we know have explicitly compared the acoustics of Russian and English fricative contrasts (with the exception of a subset of fricatives in Zsiga 2000).

This paper attempts to fill this gap, by conducting an acoustic comparison of the Russian /s, s^j, ʃ, ʃ^j/ and the English /s, ʃ/ in word-initial position in a variety of vowel contexts. Words with these sounds were elicited from 10 Russian and 10 Canadian English native speakers, balanced for gender. The analysis was based on measurements of centre of gravity (COG) of fricative noise and the difference between the formants F2 and F1 (F2-F1) at the onset of the following vowel – the parameters known to distinguish place and secondary articulation differences. The results showed that COG values were overall similar for Russian and English anterior/posterior fricatives, with the exception of the lower COG for Russian /ʂ/ compared to English /ʃ/. Differences in F2-F1, in contrast, were very robust, with English fricatives showing on average intermediate values between the Russian palatalized and non-palatalized fricatives (see Figure 1). This suggests that secondary articulations in Russian - palatalization and velarization – serve to enhance the contrast in both anterior and posterior sibilant fricatives. This difference is acoustically manifested primarily on the following vowel (higher or lower F2-F1 difference), resulting in auditory differences with English fricatives observed by Jones & Ward (1969). A more detailed analysis of the fricatives by context showed that English /s/ and /ʃ/ were acoustically more similar to Russian palatalized consonants before high vowels /i/ and /u/, while being more similar to Russian non-palatalized fricatives before most other vowels. Overall, these differences suggest complex and context-dependent acoustic correspondences between the Russian 4-way and English 2-way sibilant fricative contrasts.

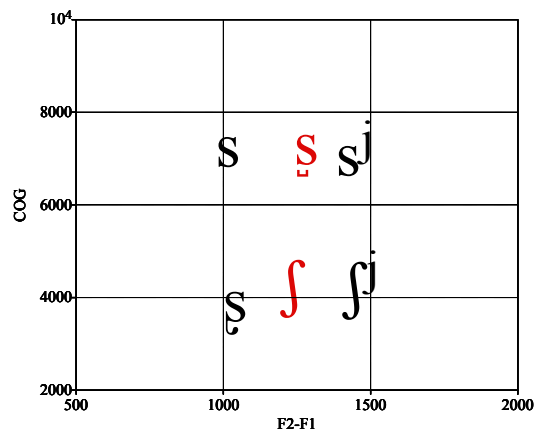


Figure 1. Mean COG and F2-F1 differences (Hz) for Russian /s, sʲ, ʂ, ʃʲ/ and English (/ʃ, ʃʲ/, red). Each symbol is centred at mean values averaged over 10 speakers and 5 vowel contexts.

References

- Avanesov, R. I. 1972. *Russkoe literaturnoe proiznoshenie* [Russian literary pronunciation] Moscow: Prosveshchenie.
- Derkach M., G. Fant, & A. de Serpa-Leitao. 1970. Phoneme coarticulation in Russian hard and soft VCV-utterances with voiceless fricatives. *Speech Research Quarterly Progress and Status Report (STL-QPSR)*, 2-3.
- Jones, D. & D. Ward. 1969. *The phonetics of Russian*. Cambridge: Cambridge University Press.
- Jongman, A., R. Wayland, & S. Wong. 2000. Acoustic characteristics of English fricatives. *Journal of the Acoustical Society of America* 108, 1252-1263.
- Purcell, E. T. 1979. Formant frequency patterns in Russian VCV utterances. *Journal of Acoustic Society of America* 66 (6), 1691-1702.
- Timberlake, A. 2004. *A reference grammar of Russian*. Cambridge: Cambridge University Press.
- Zsiga, E. C. 2000. Phonetic alignment constraints: Consonant overlap and palatalization in English and Russian. *Journal of Phonetics* 28 (1), 69-102.