

## Acoustics of Persian uvular lenition

Koorosh Ariyae and Alexei Kochetov (University of Toronto)

**Overview.** Stops are known to commonly undergo lenition (weakening in constriction degree) in a variety of word contexts. Yet, the precise factors contributing to it—whether production or perception—are still poorly understood<sup>[6,7,10]</sup>. Numerous cross-linguistic studies have examined positional effects on the lenition of labials, dentals/alveolars, and velars<sup>[9,10]</sup>, while susceptibility of uvulars to the process has not received as much attention. This paper presents an extensive acoustic analysis of the uvular /g/ in Spoken Persian (hereafter Persian), the sound that is known for its allophonic variation<sup>[1,11]</sup>, yet still phonetically understudied. The goal is to determine specific contexts of Persian uvular lenition and compare it to the cross-linguistic patterns.

**Methods.** Using an online experiment platform<sup>[14]</sup>, audio recordings were made of 14 speakers (7 females) of Persian producing various words with the uvular /g/ embedded in a carrier sentence. The consonant occurred in initial, final, medial intervocalic, and medial postconsonantal positions. To control for the constriction degree of the target consonant, words with /k/ and /h/ were included. Sentences were randomized and presented to participants 3 times, producing in total 168 tokens of /g/ (4 items×3 repetitions×14 speakers). Target and control consonants, and adjacent vowels were annotated in Praat<sup>[2]</sup>. Intensity (dB), a well-established acoustic correlate of constriction degree<sup>[3,4,5,8,13]</sup>, was extracted from the entire duration of annotated segments. Following previous work<sup>[3,5,8]</sup>, intensity ratio (intRatio) was calculated as consonant’s minimum intensity divided by the adjacent vowel’s maximum intensity. Higher values of intRatio correspond to louder and thus less constricted sounds. Values were further normalized across speakers using z-scores of individual productions and submitted to a Linear Mixed Effects model with the fixed effect Consonant.Position which included 4 positions for the target /g/ (#\_V, V\_#, V\_V, VC\_V) and 2 controls, /k/ and /h/, in initial position. **Results.** The results revealed significant differences across contexts (Consonant.Position;  $p < 0.001$ ), confirming the susceptibility of /g/ to lenition. Pairwise tests showed that the consonant was typically realized as a stop word-initially (with intRatio near-equal to /k/; i.e. [g]), as a fricative word-finally (i.e. [χ]~[ʁ]≈/h/), and as an approximant intervocalically (i.e. [ɣ] > /h/), as shown in Figure 1. Post-consonantally (after /t/), /g/ had values intermediate between stop- and fricative-like realizations (i.e. [g]~[χ]), being different from the word-final allophone ([χ]~[ʁ],  $p < 0.01$ ). **Discussion and conclusion.** The results show that the patterns of positional variation of the Persian /g/ confirm to cross-linguistic generalizations about lenition for other places. That is, lenition tends to occur in non-initial positions and most extensively intervocalically<sup>[4,12]</sup>. However, the Persian results differ from those for other languages (such as Italian, Murut, and Tümpisa Shoshone)<sup>[6]</sup> in the presence of lenition after an oral stop. The intermediate, stop- or fricative-like, realizations of /g/ in that context indicates that the preceding segment’s constriction blocks the process (cf. Catalan<sup>[10]</sup>), albeit part of the time.

These findings are best captured by the production-based model of lenition<sup>[10]</sup> arguing for the effects of position in the word and the preceding segment’s constriction degree. In sum, the results provide the first extensive acoustic investigation of the Persian /g/ realization across multiple contexts, extending cross-linguistic typology of lenition to uvulars, and providing some implications for theoretical approaches to the process.

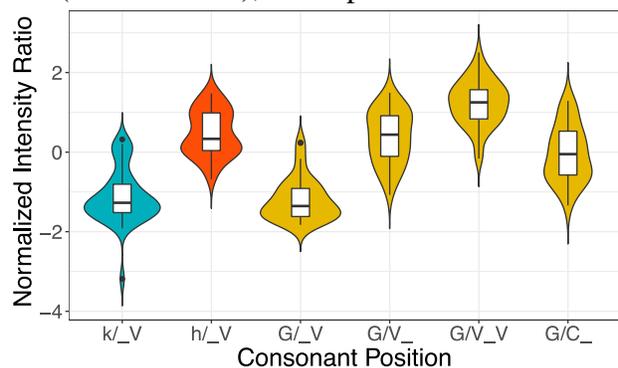


Figure 1: Intensity ratio across contexts

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