

**MUSCULAR TENSION AND ACOUSTIC PERCEPTION CONTRAST:
AN ARTICULATORY-PHONETIC ANALYSIS OF PLOSIVE AND
FRICATIVE CONSONANTS IN FOUR LANGUAGES**

Jabborov Sh.

Senior Lecturer

Karshi International University

Karshi, Uzbekistan

Abstract

This paper presents a cross-linguistic analysis of velar and uvular plosives and fricatives (/g/, /k/, /x/) in Uzbek, English, Mandarin Chinese, and Russian, focusing on the gap between IPA-based classification and real articulatory reality. It argues that traditional phonetic labeling often overlooks physiological factors such as muscular tension (fortis–lenis) and aerodynamic pressure (aspiration).

The study shows that Mandarin /g/ (pinyin *g*) and /h/ (pinyin *h*) are not primarily defined by voicing contrasts, but by aspiration and reduced articulatory tension, functioning as lax or “light” variants within the velar system rather than strictly voiceless equivalents.

Keywords: articulatory power, muscular tension, fortis, lenis, aspiration, velar, uvular, psychoacoustics, speech perception.

Аннотация

Данная работа представляет собой сопоставительный анализ велярных и увулярных взрывных и фрикативных согласных (/g/, /k/, /x/) в узбекском, английском, китайском (мандарин) и русском языках, с акцентом на различие между IPA-классификацией и реальной артикуляционной реализацией. В исследовании утверждается, что традиционная фонетическая классификация часто игнорирует физиологические факторы, такие как мышечное напряжение (fortis–lenis) и аэродинамическое давление (аспирация).

Исследование показывает, что мандаринские фонемы /g/ (пиньинь g) и /h/ (пиньинь h) определяются не столько признаками звонкости, сколько аспирацией и сниженной артикуляционной напряжённостью, функционируя как слабые («лёгкие») варианты велярной системы, а не как строго глухие эквиваленты.

Ключевые слова: артикуляционная сила, мышечное напряжение, fortis, lenis, аспирация, велярные, увулярные, психоакустика, восприятие речи.

INTRODUCTION

In modern comparative-typological linguistics, the structural mapping of an ethnic group's articulatory base remains a foundational area of inquiry. However, legacy acoustic blueprints codified by the International Phonetic Association (IPA) often fail to capture live speech perception and human psychoacoustic reality. [1]. Standard pedagogical resources routinely bifurcate the /g/–/k/, /d/–/t/, and /b/–/p/ structural pairs solely based on glottalization—whether the vocal folds vibrate—into “voiced” and “voiceless” consonants. In live cross-language communication, this rigid binary classification triggers profound phonological confusion.[2]

This study aims to re-evaluate the production mechanics of velar and uvular consonants across Uzbek, English, Mandarin Chinese, and Russian. By shifting the analytical lens from mechanical acoustics to physical muscular tension (*aerodynamic energy*), this paper exposes systemic classification flaws in academic phonetics and proposes an updated model for applied cross-linguistic analysis.

THEORETICAL FRAMEWORK AND ARTICULATORY MECHANISMS

The Cross-Linguistic Hierarchy of the /g/ Phoneme and the Critique of the “Voiced” Myth

Standard pedagogical sources typically represent the Uzbek, English, and Russian /g/ with the same IPA symbol [g], but this masks important articulatory differences in muscular effort and airflow.

The Uzbek /g/ functions as a strong (fortis) plosive. It is produced with a firm dorsum–velum closure, creating high intraoral pressure, followed by a forceful, fully voiced release with strong vocal fold vibration. This results in a comparatively tense, “anchored” sound.

In contrast, the English /g/ is generally a weak (lenis) articulation. As described by Roach, it often undergoes partial devoicing depending on position and speech speed, with reduced muscular tension and lower perceptual force, making it sound softer or less prominent to non-native listeners.

Mandarin Pinyin /g/ presents a different issue: although often transcribed as [k] in IPA due to its voiceless nature, this is misleading in functional terms. Its distinction from /k/ is not based on voicing but aspiration. Thus, Mandarin /g/ is better understood as an unaspirated voiceless plosive. As Duanmu notes, using a standard voiceless [k] can cause meaning confusion (e.g., 高 “gāo” vs 烤 “kǎo”), since aspiration is the critical contrastive feature.

Overall, the Mandarin “g” is not simply a voiceless [k], but an unaspirated, lax voiceless stop, and treating all three languages under a single [g] symbol obscures key phonetic and phonological distinctions.

The /x/ and /h/ Continuum: The “Single Palate, Lax Articulation” Phenomenon

A parallel oversimplification occurs in the treatment of Chinese /h/, often equated in Western manuals with the English glottal [h]. However, this ignores its closer relation to velar–uvular friction involving the same articulatory zone as Uzbek [x] [8].

The vocal tract allows a shared velar/uvular friction space where output is shaped mainly by **muscular tension** rather than fixed position. Uzbek /x/ uses high tension and strong constriction, producing intense acoustic friction. In contrast, Chinese /h/ uses a more relaxed configuration, with a wider constriction and smoother, weaker airflow, yielding a softer fricative.

Thus, Chinese /h/ is better interpreted as a **lax, reduced form of velar friction**, rather than a pure glottal [h]. Mispronouncing it as English [h] removes its velar acoustic character (e.g., *Hǎo*). This supports Chomsky and Halle's feature-based view, where **tension (tense vs. lax)** is a key determinant of phonetic realization, more informative than rigid categorical labels.

RESULTS AND DISCUSSION

A voicing-only model is insufficient to describe /g/ across languages; a more accurate account considers **subglottal pressure, muscular tension, and aerodynamic release**.

- **Uzbek (Maximum Fortis):** /g/ is produced with strong velar closure and high muscular tension, creating high pressure and a forceful explosive release.
- **Russian (Palatalized System):** /g/ varies contextually: firm velar before back vowels and palatalized /gi/ before front vowels, producing a more softened articulation.
- **English (Lenis System):** /g/ is a weak stop with reduced tension and pressure, often partially devoiced in fast speech, resulting in a softer percept.
- **Mandarin (Unaspirated System):** /g/ is voiceless and unaspirated ([k]-like), distinguished from /k/ by aspiration rather than voicing, producing a light, non-explosive articulation.

Overall, the languages differ in phonetic strategy: Uzbek emphasizes force, Russian shows contextual variation, English reduces articulatory energy, and Mandarin relies on aspiration contrasts rather than voicing.

CONCLUSION

The acoustic perception of English and Chinese **G** sounds as “softer and lighter” than the Uzbek counterpart is a measurable physiological fact. This behavior is dictated by **low muscular tension (lenis)** and the elimination of post-release air-blasts, rather than strict glottal voicing.

The initial consonant in the Mandarin word Gāo is phonologically an **unaspirated, voiceless lax G**. Instructing students to pronounce it as a hard “K” is an academic failure that induces semantic errors (e.g., mishearing it as Kǎo).

The Chinese **H** is not a glottal aspirate, but an anatomical equivalent of the Uzbek **X**, executed with a relaxed tongue profile. It is a lower-tension modification of the same physical coordinate.

Implementing this updated articulatory-tension model within standardized language curriculums offers a concrete, scientifically sound method to eliminate persistent native-language accents.

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