

Acoustic Determinism in Single-Hole Cylindrical Flutes: Evidence That Musical Scales Emerge from Instrument Geometry Rather Than Cultural Transmission

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Abstract

This paper proposes that several of the world's most widespread musical scales arise naturally from the acoustic physics of simple bilabial end-blown cylindrical flutes with a single tone hole. Through hands-on construction and performance of one-hole flutes made from uniform cylindrical tubing, the author demonstrates that placing a hole at a minor second interval above the fundamental, combined with the overtone series, generates the Freygish (Hijaz) scale. A hole at a major second generates a pentatonic scale in the more accessible registers, and a Lydian Dominant scale when played into the higher, more demanding partials. When the end-covering technique of overtone flutes is combined with the single-hole technique, additional scale systems emerge from the same instrument. These findings suggest that culturally diverse scale systems may share a common origin not in theory, cultural exchange, or aesthetic preference, but in the physical constraints of elementary wind instrument construction. The implications extend to ethnomusicology, organology, and the origins of tonal music.

Keywords: *acoustic determinism, overtone series, cylindrical flute, bilabial embouchure, Freygish scale, Hijaz, pentatonic, Lydian Dominant, organology, ethnomusicology, musical origins*

1. Preliminary Note

This document serves as an initial disclosure to establish intellectual priority for the observations and theoretical framework described herein. A full paper with detailed acoustic measurements, diagrams of instrument construction, and audio-visual documentation of the demonstrated scales is forthcoming. The author has over 35 years of experience constructing and performing on experimental wind instruments, including extensive work with bilabial and interdental embouchure techniques on cylindrical flutes.

2. Core Observation

When a single tone hole is placed at specific intervals above the fundamental pitch of a simple cylindrical tube played with a bilabial end-blown embouchure, the interaction between the two available fundamental pitches (hole open and hole closed) and the naturally occurring overtone series of each produces coherent, recognizable musical scale systems without any additional design intervention. The tube geometry and the physics of the overtone series determine the resulting scale.

Specifically: a hole placed at a minor second above the fundamental generates the pitches of the Freygish (Hijaz) scale. A hole placed at a major second above the fundamental generates a pentatonic scale in the lower, more accessible registers, and a Lydian Dominant scale when the player ascends into the higher partials. Furthermore, when the end-covering technique familiar from overtone flute traditions is combined with the single-hole technique on the same instrument, additional scale systems emerge from a single tube.

3. Implications

These observations suggest that musical scales found across diverse and geographically isolated cultures may not have originated through cultural transmission or independent theoretical development, but rather through the shared physical constraints of elementary instrument construction. Any culture that constructed a simple cylindrical tube with one hole would have encountered these same scale systems as an inevitable consequence of acoustic physics. The scales were not invented; they were discovered through the act of building and playing.

4. Contact

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