Title
Entropy-Based Critical Points in Overtone Interaction Predict Cross-Cultural Pitch Stabilization in Maqam and Raga Performance

Author
James Dennis, Lecturer of Music Theory
Texas State University
jcd131@txstate.edu

Abstract
Why do musicians stabilize on certain pitches in performance? Conventional tuning systems (e.g., equal temperament or just intonation) offer symbolic ideals, but do not explain how pitch targets emerge in real-world performance across cultures. We propose a perceptual model grounded in overtone interaction and information theory. For each pitch in a 0–1200¢ continuum, we compute the Shannon entropy of its overtone interaction vector (OIV), a representation of how the first 12 harmonics of that pitch interact with those of a fixed tonal reference. This results in a continuous entropy curve over pitch space. From this curve, we extract 72 candidate perceptual attractors by considering minima, maxima, and discontinuities of the first and second derivatives. These points are hypothesized to act as stable perceptual targets in human intonation. To test the model, we extracted 92 KDE pitch peaks from 18 professional recordings (12 Arabic maqamat, 6 Indian ragas). Of these, 82 fell within ±7 cents of predicted attractors. A Monte Carlo simulation with 1 million random trials yielded $p = 0.0003$ ($z \approx 3.4$), confirming the result as highly significant. By contrast, Partch's 43-tone just intonation scale accounted for only 50 matches ($p \approx 0.1745$), indicating no significant alignment. We argue that pitch stabilization across musical cultures reflects acoustic entropy structure, not symbolic tuning ideals. This model offers a computational and perceptually grounded account of cross-cultural tonality.

Preferred format: Oral presentation.

References

Balzano, G. J. (1980). The group-theoretic description of 12-fold and microtonal pitch systems. Computer Music Journal, 4(4), 66–84.

Cheveigné, A. de. (2005). Pitch perception models. In Pitch: Neural coding and perception (pp. 169–233). Springer.

Huron, D. (2001). Tone and voice: A derivation of the rules of voice-leading from perceptual principles. Music Perception, 19(1), 1–64.

Lerdahl, F., & Jackendoff, R. (1983). A Generative Theory of Tonal Music. MIT Press.

McAdams, S., & Bigand, E. (1993). Thinking in Sound: The Cognitive Psychology of Human Audition. Oxford University Press.

Partch, H. (1974). Genesis of a Music (2nd ed.). Da Capo Press.

Sethares, W. A. (2005). Tuning, Timbre, Spectrum, Scale (2nd ed.). Springer.

Sundberg, J. (1977). The acoustics of the singing voice. Scientific American, 236(3), 82–91.

Temperley, D. (2001). The Cognition of Basic Musical Structures. MIT Press.

Vassilakis, P. N. (2001). Perceptual and physical properties of amplitude fluctuation and their musical significance. Ph.D. dissertation, UCLA.

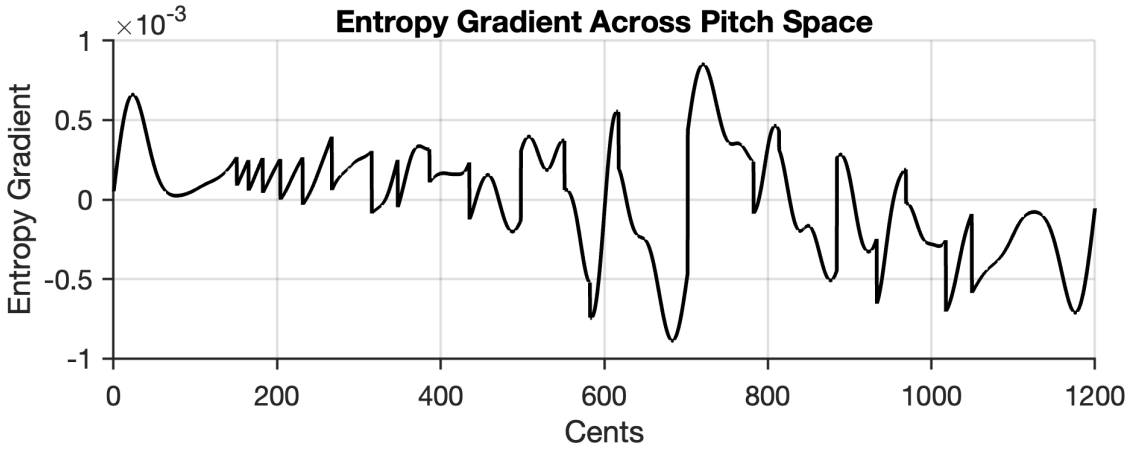

Figure 1. *Gradient of entropy computed from overtone interaction vectors using 12 harmonic partials per pitch. The curve spans the 0–1200¢ pitch continuum at 0.1¢ resolution. Candidate perceptual attractors are defined as minima, maxima, and discontinuities of the first and second derivatives of entropy.*