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Biomechanics, music, and speech: The coexistence of pitch, tone, and intonation in Yoruba speech. *

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Abstract

Lack of clear scientific foundation stifles advancements in all aspects of hearing research—music, speech, neurophysiology of hearing, and associated prosthetic devices. Musical pitch remains a scientific mystery. In Yoruba (a tone language), tone commutations provoke lexical contrasts, and pitch modulations produce intonation. Explaining the coexistence of pitch, tone, and intonation through f_0 has been wholly unrewarding. Why? A crippling error in the foundational Pythagorean string ratio theory of musical pitch intervals resulted in fundamental frequency (f_0) becoming the primary acoustic parameter in psychoacoustic investigations. However, f_0 is an intangible mathematical derivative, not directly accessible to listeners, and not invariant with pitch. The non-invariance problem has challenged the categorization of psychoacoustics as an auditory behavioural science. This paper proposes the way out of the impasse through biomechanical experiments. The data include human auditory responses to natural music and speech stimuli. The findings attribute f_0 features of tone to biomechanical laws of sound production, and to vagaries of technological artefacts for f_0 extraction; the f_0 features are shown to play no part in music and speech code perception. A biomechanical pitch scale demonstrates variability of pitch, tone, and intonation in Yoruba, without compromising speech intelligibility. It highlights perceptual *constancy* amid production and acoustic *variability*. To improve understanding of the auditory mechanism and enhance related technologies and prostheses, the findings compel shifting auditory research away from mathematical computations towards establishing biomechanical invariants that underly what we hear and how we hear. The concept of direct auditory perception without mediation is discussed.

*This paper is the application of tested mechanical principle in musical pitch production and perception@ to pitch, tone, and intonation in speech.

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