REVIEW OF MARK CHANGIZI'S *HARNESSED*

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A recent study used DNA evidence to show that the spotted coat pattern on horses depicted in a 25,000 year old cave painting in France is consistent with a horse genotype found in Paleolithic France [1]. This finding suggests that the painting is a naturalistic depiction, and casts doubt on previous interpretations of the spots as being hallucinated in shamanistic ritual or an early example of "art for art's sake." More broadly, this finding supports the view, held since the ancient Greeks, that much of human culture aims to imitate nature.

In *Harnessed: How Language and Music Mimicked Nature and Transformed Ape to Man* (BenBella Books, 242 pages), Mark Changizi describes why and how he thinks speech and music evolved to "sound like nature." The opening pages reject often-cited hallmarks of Darwinian selection in spoken language and music-making — cultural universality, complexity, effortless and rapid development in infants, and specialized brain areas — on the grounds that our only recently acquired capacity to read shares most of these same hallmarks (p. 3). The central claim is that, by sounding like nature, speech and music "harness" evolutionarily ancient auditory "what" and "where" mechanisms for recognizing and tracking auditory sources and events. As the author puts it: "By mimicking nature, language and music could be effortlessly absorbed by our ancient brains, which did *not* evolve to process language and music. In this way, culture figured out how to trick nonlinguistic, nonmusical ape brains into becoming master communicators and music connoisseurs" (p.11).

So, how do speech and music sound like nature? Changizi — a science writer and Director of Human Cognition at the 2AI lab — is not referring merely to scattered instances of onomatopoeia in speech (e.g., the word "buzz") or programme music (e.g., the nightingale in Beethoven's Sixth Symphony). Instead, he is referring to two particular classes of sound regularities (or what J. J. Gibson called "invariants") that arise from lawful physical events, are stable across habitats and over evolutionary time, and are implicitly known to the listener. In a nutshell, he argues that "speech sounds like solid-object physical events" and "music sounds like people moving." Most of the book is spent detailing these regularities and testing the hypothesis that if language and music evolved to mimic them, then these same regularities should be reflected in statistical trends in language and music corpora.

For example, in Chapter 2, Changizi proposes three basic types of sounds arising from the interaction between solid objects: "hits" (impact sounds), "slides" arising from friction (broadband noise), and "rings" (vibration). Hits, slides, and rings, according to the author, correspond to "the principal three classes of phonemes in human speech" (p.39): plosives, fricatives, and sonorants, respectively.[1] He points out that "the events in our mouths that make the sounds of speech are events involving airflow, not hits, slides, or rings at all. Airflow events in our mouths mimic hits, slides, and rings, the constituents of solid-object physical events" (p. 42). Chapter 2 ends with data showing substantial overlap between the frequency distributions of hits, slides, and their combinations in videos of naturalistic settings (YouTube videos of people cooking, family gatherings, etc.) and the distribution of their corresponding phonemes in a sample of words from eighteen languages.

The case for music sounding "like people moving" spans chapter 3 (on rhythm), chapter 4 (on melody), and an Encore section that follows the Conclusion. The link drawn between the musical "beat" and the sound of human footsteps is substantiated by the proximity of the mean musical tempo to the mean pace of human gait (the Italian medium tempo directive *andante* means "at a walking pace") and similarities between *ritardando* (slowing down at the end of a musical phrase) and deceleration patterns in human locomotion [2]. Uncited in *Harnessed* but potentially relevant are findings [3] that expressive timing variation in music performance contains long range dependencies (*1/f* noise) characteristic of timing variability in human gait [4].

The book's proposed link between pitch perception and sound localization also has some basis beyond the widespread (although not culturally universal [5]) tendency to describe pitch changes in terms of "upwards" and "downwards" movement. For example, interactive effects of space- and pitch-varying sequences on auditory perception have been observed [6], and such sequences activate highly similar brain networks [7]. The book shows that faster tempo piano melodies have a wider *tessitura* or pitch range (pp. 220-222), implying composers' implicit recognition that faster moving objects traverse longer distances. This finding is consistent with studies showing that more widely-spaced tone sequences affect tempo judgment [8] and are reproduced more quickly and with faster finger movements [9-10].

Where I think *Harnessed* falters is in its insistence on a physical basis for the perceptual link between pitch and movement in space. (There is no such basis, for example, for perceptual interactions between numbers and space in common circuits in the parietal lobe [11].) An early suggestion that musical tones engage the vestibular system, eliciting a "corresponding movement experience" in the listener [12], has found little physiological support [13]. Here Changizi implausibly proposes that melodies exaggerate tiny Doppler shifts (beyond conscious detection) that arise from moving human bodies changing direction in space relative to the listener (p. 179). The preponderance of arch-shaped melodic contours in music [14] are thus argued (pp. 170-173) to mimic a typical human "encounter" of veering toward the listener (upshifting) and then away (downshifting). But a more parsimonious account for melodic arch in both human and bird song implicates vocal constraints on the control of subglottal airflow [15]. Moreover, it is difficult to imagine what Doppler-shifted "encounter" might explain other melodic universals not discussed in *Harnessed*, such as the tendency for a large melodic leap to be followed by a smaller leap in the opposite direction (pitch-skip reversal) [16].

Some words of warning: *Harnessed* is not a scholarly book in that it contains fewer citations, references, and endnotes than there are in this review, and no index. Few additional avenues are provided to the non-specialist reader, who may also be thwarted by the book's avoidance of certain established, searchable terms (e.g., declination, speech prosody, pitch proximity, and meter). Music cognition researchers and psychoacousticians may be dissatisfied by the book's isolation from contextual evidence in the scientific literature, and the informally presented data sometimes raise more questions than answers.[2] Still, Changizi's speculative hypothesis is engagingly presented, clearly laid out, and richly detailed. I hope to see aspects of it more rigorously tested and refined in the future.

Notes

1. To my knowledge (I am not a phonetician), Changizi's "principal three classes" are his own. Phonemes are generally classified by features such as manner of articulation. Thus, sonorants (speech sounds produced with continuous airflow) are contrasted with obstruents (speech sounds produced with obstructed airflow), which include both plosives and fricatives.
2. For example, it is claimed that the plot on p. 218 shows a flat distribution of notes across the tessitura for a sample of 10,000 musical themes, which contrasts with other reports of a Gaussian distribution [15-16]. However, there is clearly a "bump" in the middle quintile, the prominence of which is obscured by the scale of the y-axis.

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