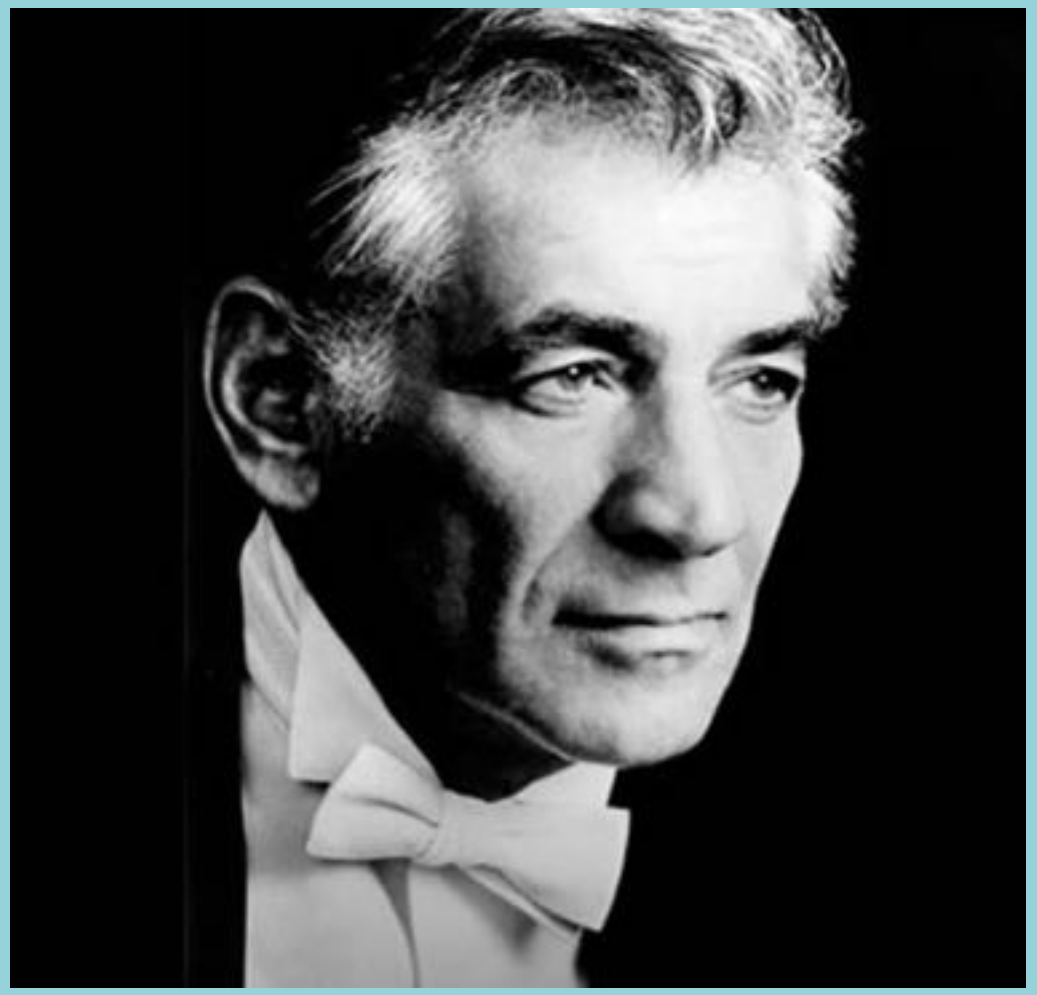
Music and the Mind

"Musical syntax," philosophical underpinnings of the Bernstein lectures, and evolution of musicality

Objectives

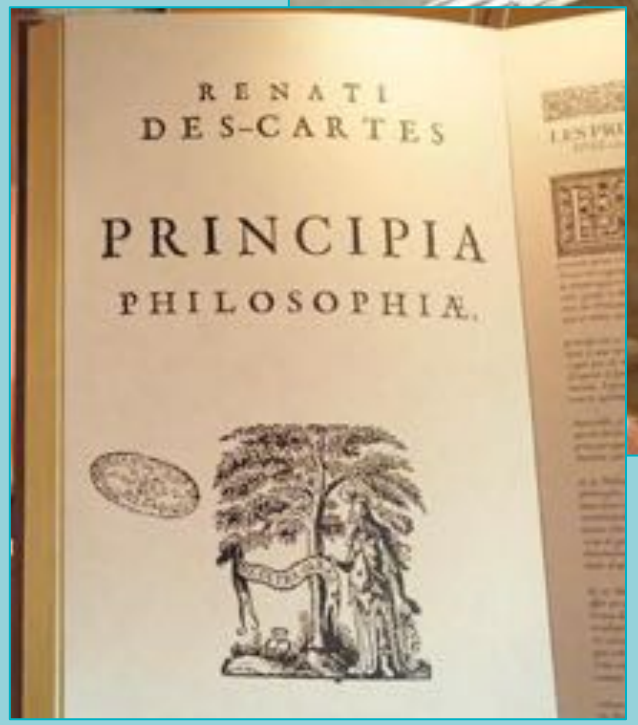
- Philosophical roots of Bernstein's Second Norton Lecture – "Syntax"
- The connection of language and music through the lens of Chomsky
- Extrapolating from speech to music with "transformational grammar"
- "Biomusicology," and the search for the evolutionary origins of music
- The "cocktail party effect" and how we listen to music
- Connecting the human voice to the evolution of musicality



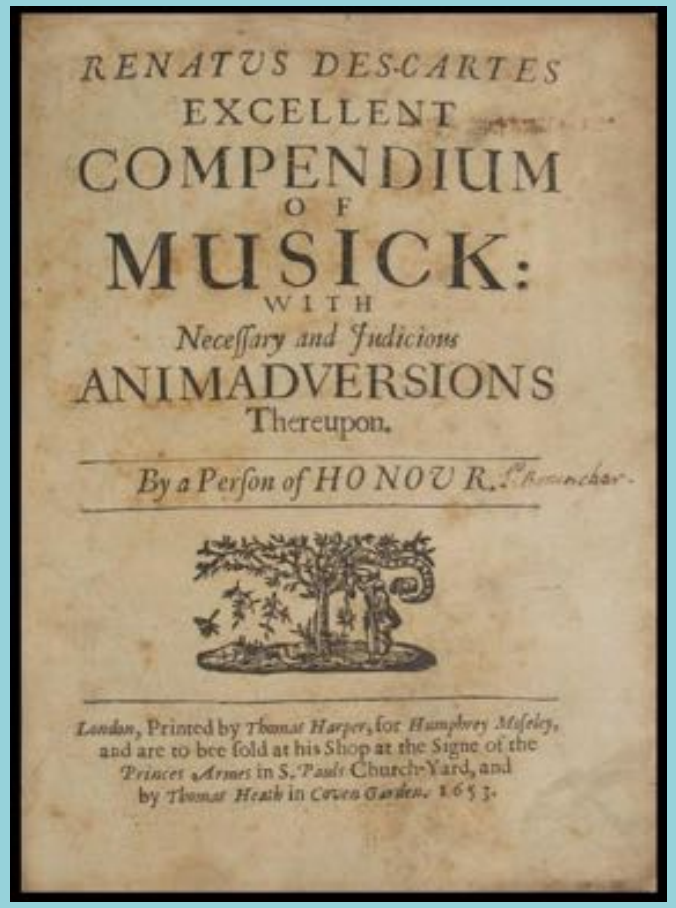
Leonard Bernstein's Second Norton Lecture

Cartesian dualism

- He marks the intellectual transition from the Middle Ages to the modern world
- “Father of modern philosophy" who invented analytic geometry
- Articulated a notion of brain vs mind
  - Mind is the seat of identity, emotion, belief, and soul
  - Brain is an instrument of the mind – moving muscles, stimulating breathing, sensing the world



Descartes and music


RENATUS DES-CARTES
EXCELLENT
COMPENDIUM
OF
MUSICK:
WITH
Necessary and Judicious
ANIMADVERSIONS
Thereupon.

By a Person of HONOUR.

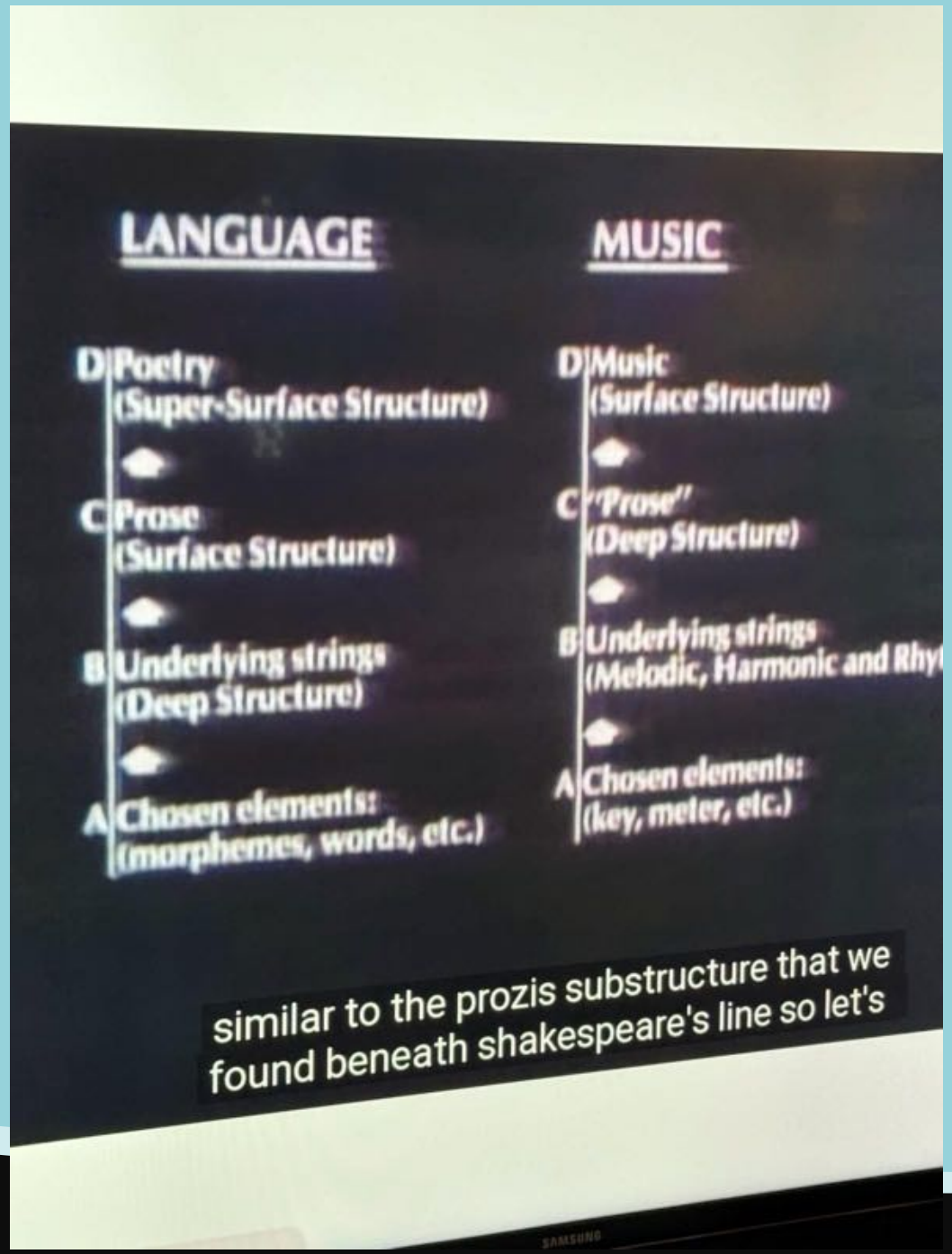
London, Printed by *Thomas Harper*, for *Humphrey Moseley*, and are to bee sold at his Shop at the Signe of the *Princes Armes* in S. *Pauls* Church-Yard, and by *Thomas Heath* in *Covent Garden*. 1653.

- Descartes' first book, at age 22: experiments on musical instruments with hypotheses about the nature of consonances and other problems in musical theory
- Study of the mathematical basis of music
- Application of empirical, deductive, and scientific approaches to the study of sensory perception
- Among the earliest attempts to define the dual relationship between the physical and psychological phenomena in music

- Rousseau considered music his primary vocation throughout his life. “Jean-Jacques was born for music,” he wrote in his *Dialogues*
- Initially written in 1754, sent to his publisher in 1763, and finally published posthumously in 1781
- Language developed in warm southern climates and then migrated north
- Language was initially musical and emotion-centric, rather than logic-based
- But the colder northern climate deprived language of its passion
- The full effect of particular music is restricted to cultural musico-linguistic communities: "The most beautiful songs, to our taste, will always only indifferently touch an ear that is not at all accustomed to them; it is a language for which one has to have the dictionary.”

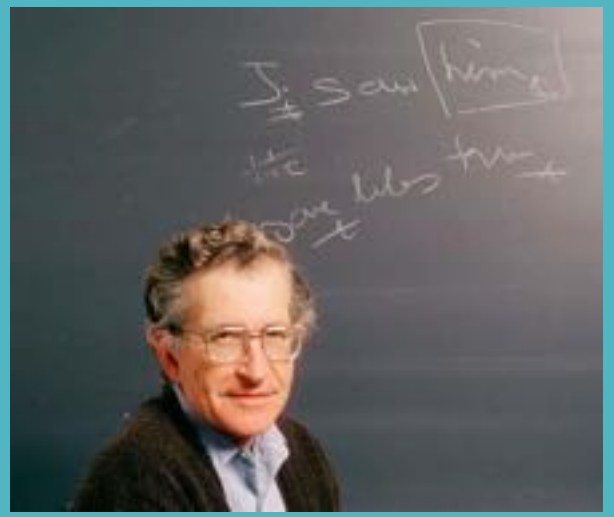
Parallels between language and music

- Finding equivalence between notes and letters, musical motives and words
- “Chords are like adjectives” – lending emotional context to melody/narrative
- Accompaniment, tempo, vamping constitute the verb of the musical idea
- “It is in the nature of music to be ongoing,” with only infrequent “punctuation” – “no pause for the period”
- Chomsky’s **“transformational grammar”**
  - Language organized on a surface level (form) and a deep level (meaning)
  - Innate capacity of the child to follow grammatical rules: “the combustion engines of language”



Noam Chomsky

- Universal grammar means that innate mental processes transform sounds and words into meaningful structures
- Grammar gives the mind its ability to combine phonemes into syntax, leading from words to clauses and sentences



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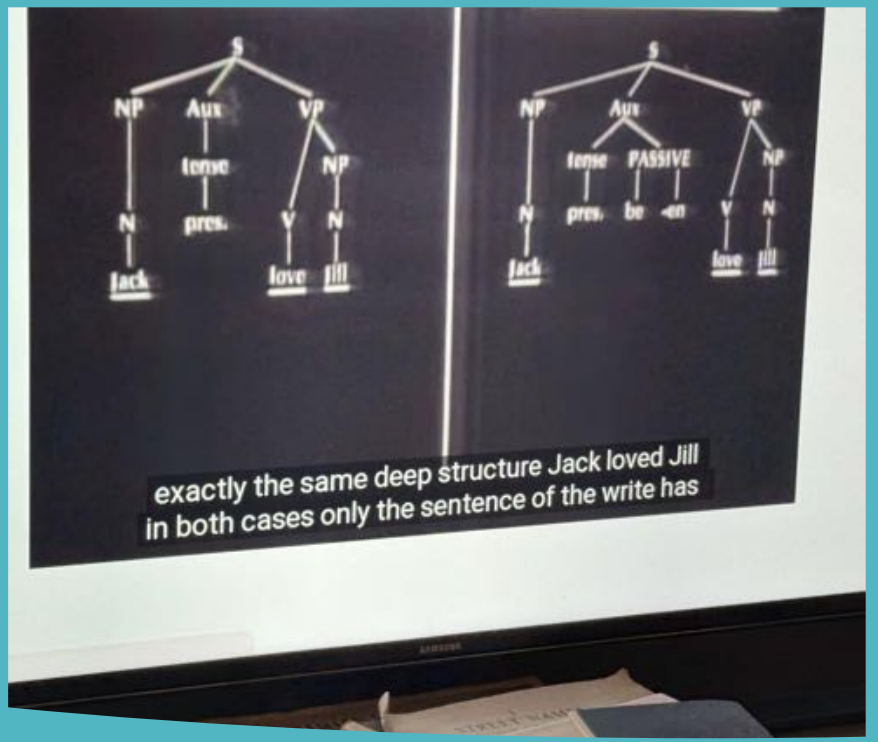
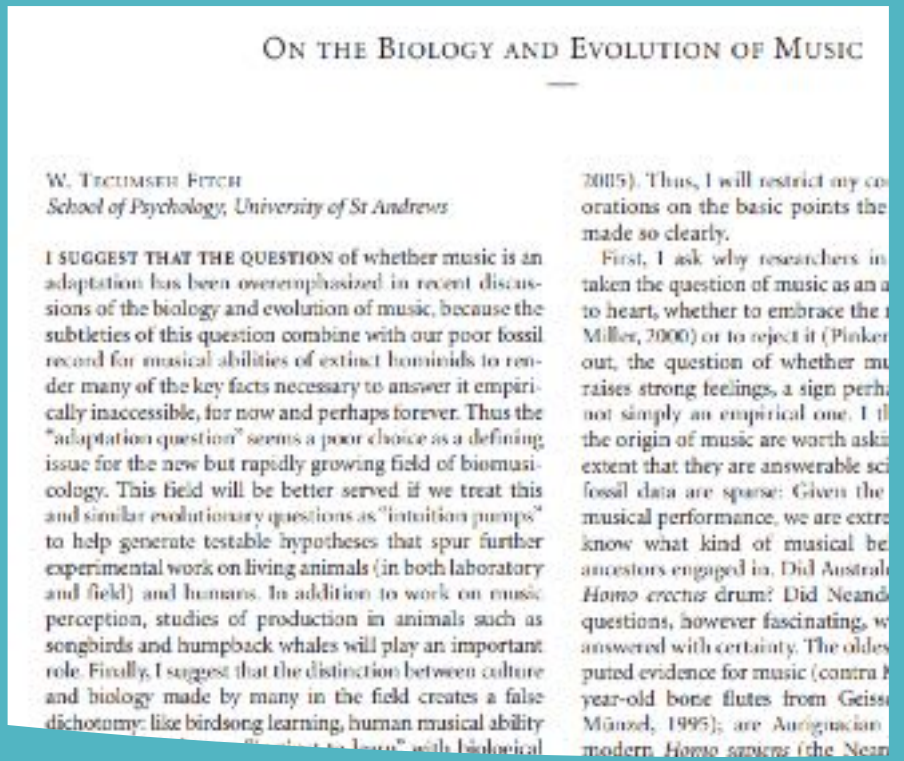
Transformational grammar

- Describes a transformational process from “deep structure” to “surface structure”
- He diagrams the sentence, "Jack loves Jill,” showing the underlying process for transforming deep structure into the spoken words
- He extends these analogies to music, taking "underlying strings“ (chord progressions, melodic motives) and combining them to create “surface structure” -- actual music!
- Through transposition, augmentation, deletion, and embedding, compositions are built within a set of intrinsic rules
- “Musical ambiguity” with regard to key and tempo play on our emotions and heighten expressivity



- Direct fossil data are sparse – extremely unlikely we'll ever know what kind of music our hominid ancestors made
- 36,000-year-old bone flutes from Geissenklösterle (Hahn & Münzel, 1995)
- Darwin: "modern music is a fossil of an earlier hominid communication system ("protolanguage")
- Not vestigial, because music still carries a physiological cost, plays an important role in human affairs like mating and socialization, and retains powerful effects on our behavior and physiology
- "If heritable and truly useless, musical behavior should be a target of selection to disappear, like a cave fish's eyes"
- Most inorganic sounds (falling trees or rocks, wind or water, vibrating natural objects) are not tonal (they do not contain integer harmonics)
- Natural sounds with harmonic structure are limited to animal vocalization
- Birds & marine mammals have convergently evolved behavior systems parallel to human song

Biomusicology



ON THE BIOLOGY AND EVOLUTION OF MUSIC

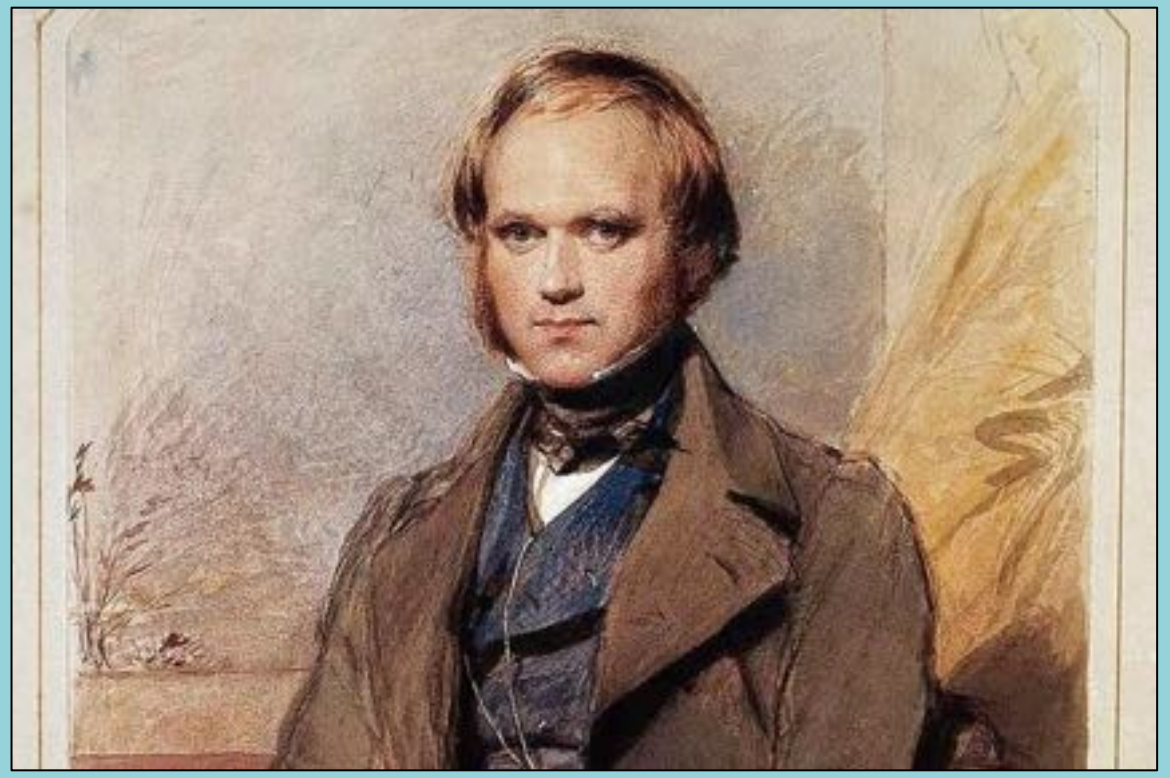
W. TECUMSEH FITCH
School of Psychology, University of St Andrews

I SUGGEST THAT THE QUESTION of whether music is an adaptation has been overemphasized in recent discussions of the biology and evolution of music, because the subtleties of this question combine with our poor fossil record for musical abilities of extinct hominids to render many of the key facts necessary to answer it empirically inaccessible, for now and perhaps forever. Thus the "adaptation question" seems a poor choice as a defining issue for the new but rapidly growing field of biomusicology. This field will be better served if we treat this and similar evolutionary questions as "intuition pumps" to help generate testable hypotheses that spur further experimental work on living animals (in both laboratory and field) and humans. In addition to work on music perception, studies of production in animals such as songbirds and humpback whales will play an important role. Finally, I suggest that the distinction between culture and biology made by many in the field creates a false dichotomy: like birdsong learning, human musical ability

Darwin on evolution of the music sense

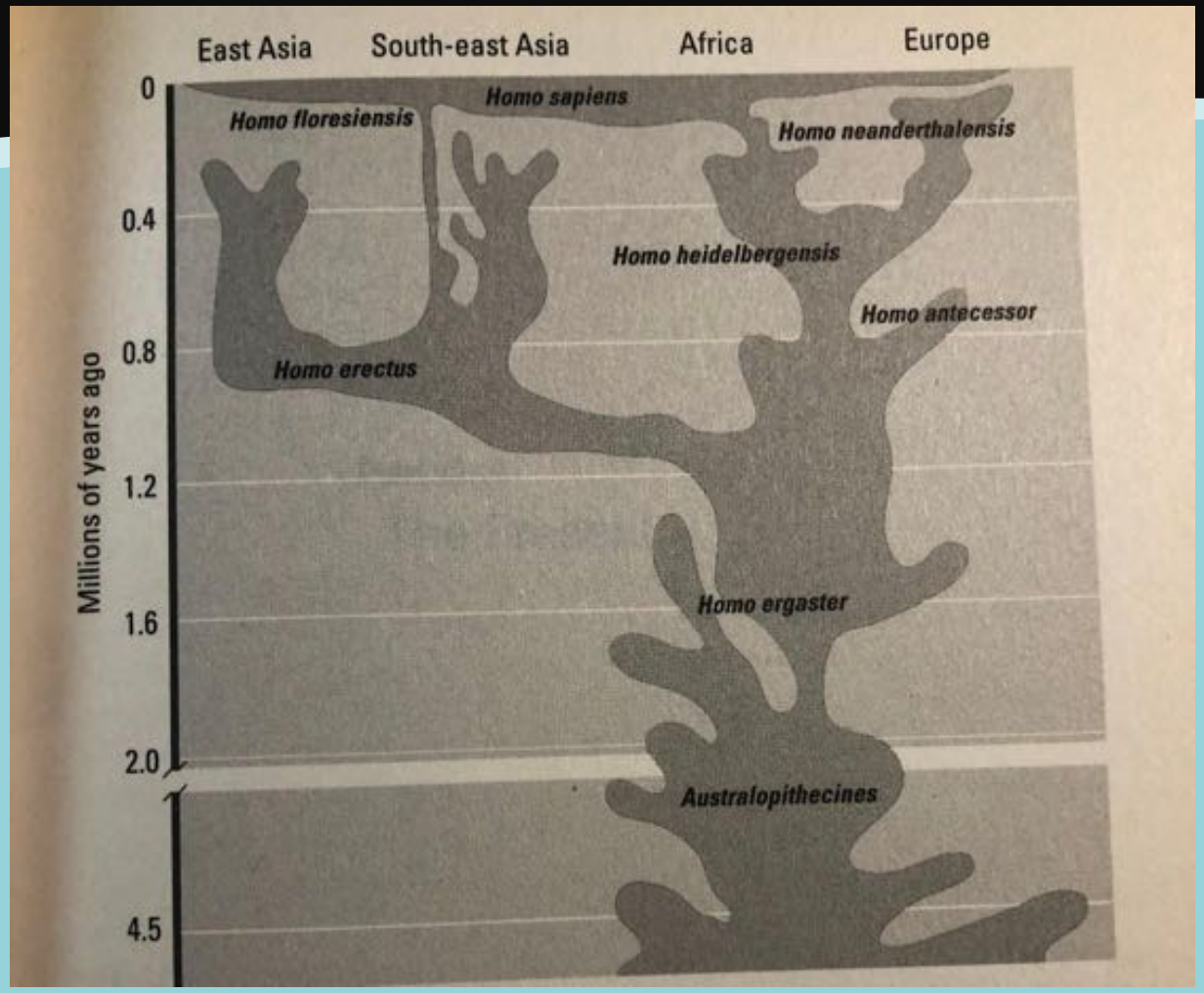
1. Music is an adaptive trait in mate attraction -- the strong emotional responses to music "become…intelligible if we may assume that musical tones and rhythm were used by the half-human progenitors of man, during the season of courtship, when animals of all kinds are excited by the strongest passions."

2. Darwin's theory related to phylogeny: "The perception, if not the enjoyment, of musical cadences and of rhythm is probably common to all animals, and no doubt depends on the common physiological nature of their nervous systems" (*Descent of Man*, 1871) – birdsong, rhythmic patterning in nature.



Synchronized action (Darwin)

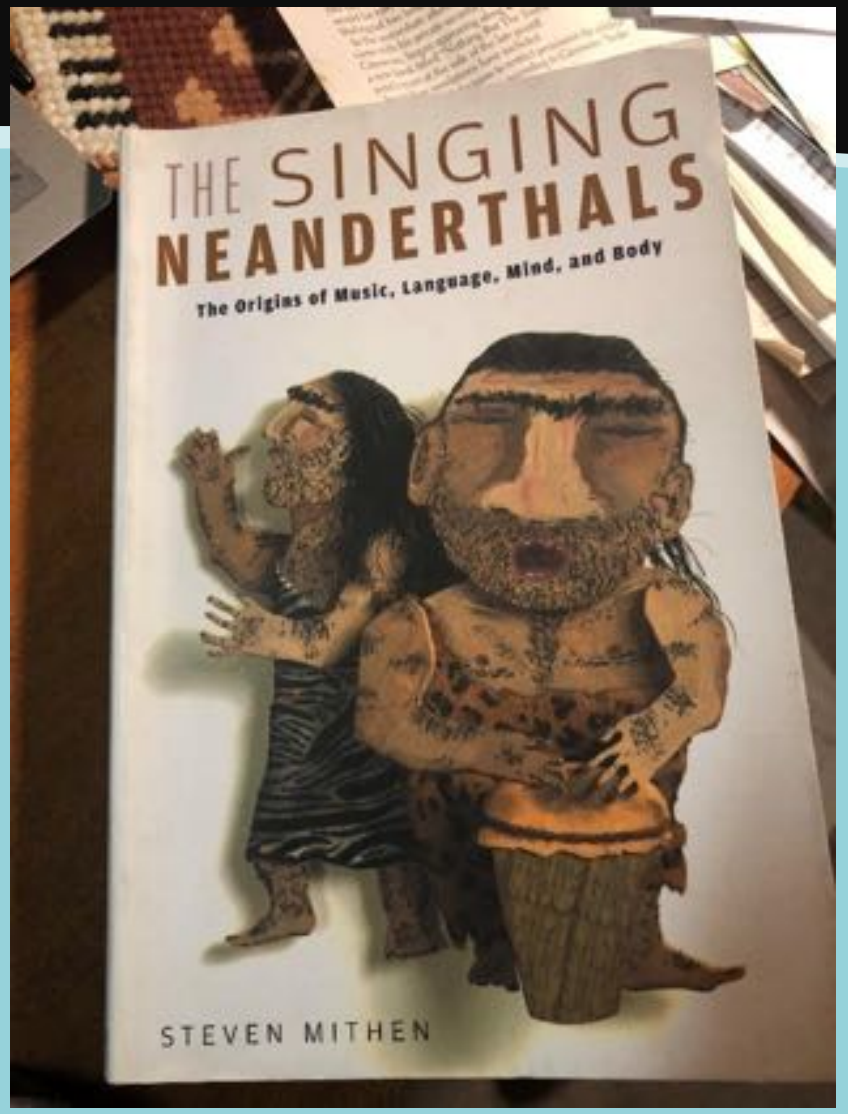
- Appreciated that horses and cattle respond in characteristic ways to threats
- Normally produce haphazard sounds (mooing, clucking) when not in danger -- Signals to group members that they are among their kin
- Animals noticing danger stop moving, stop verbalizing, and look in the direction of the danger
- Others quickly follow: soon all are silent and scanning for possible danger.



- Human/Neanderthal split 300k-500k years ago
- Evolved separately in Africa (*Homo sapiens*) and Europe (*Neanderthals)*
- Neanderthal brains were large (1300-1600cc); Humans are 1200-1700cc
- The 1st hyoid bone from a pre-modern human excavated 1983 in Kebara Israel was similar to humans
- Hypoglossal canal and phrenic nerve canal dimensions comparable

Steven Mithen

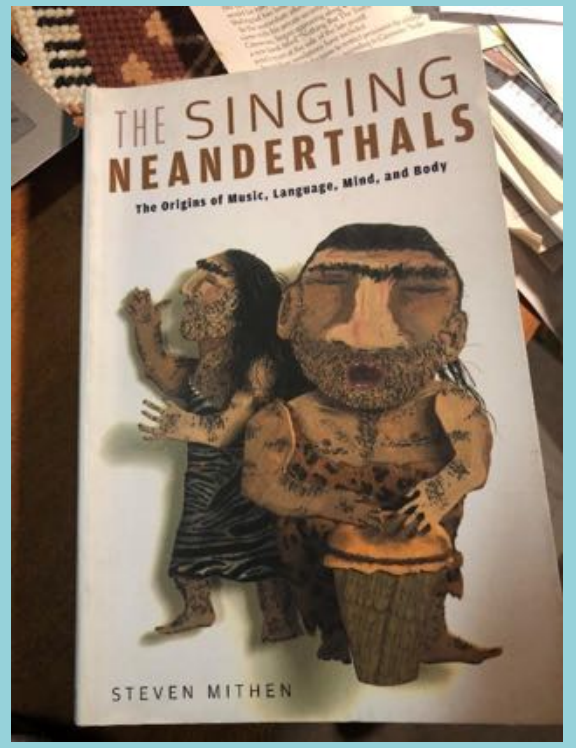
- Joint music-making facilitates cooperative behavior – shared emotional state
- Neanderthals had a "Holistic, manipulative, multi-modal, musical, and mimetic" means of communication (Hmmmmm)
- "Language effectively delivered the capacity for metaphor to the human mind that underlies art, science and religion. Cognitive fluidity also enabled the construction of complex artefacts and the extension of the mind and body into material culture. As such it provided the possibility of musical instruments and an immense elaboration of hominin musical abilities."

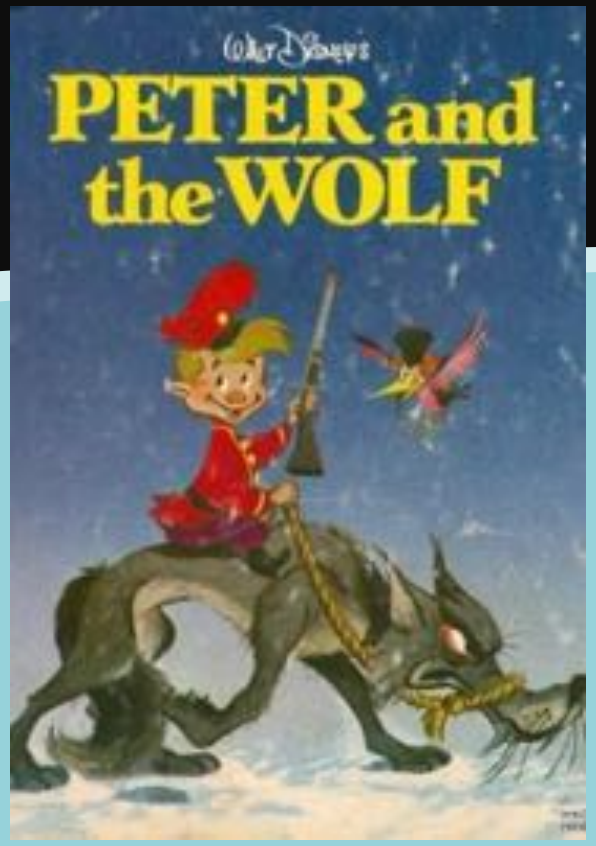


Music as protolanguage

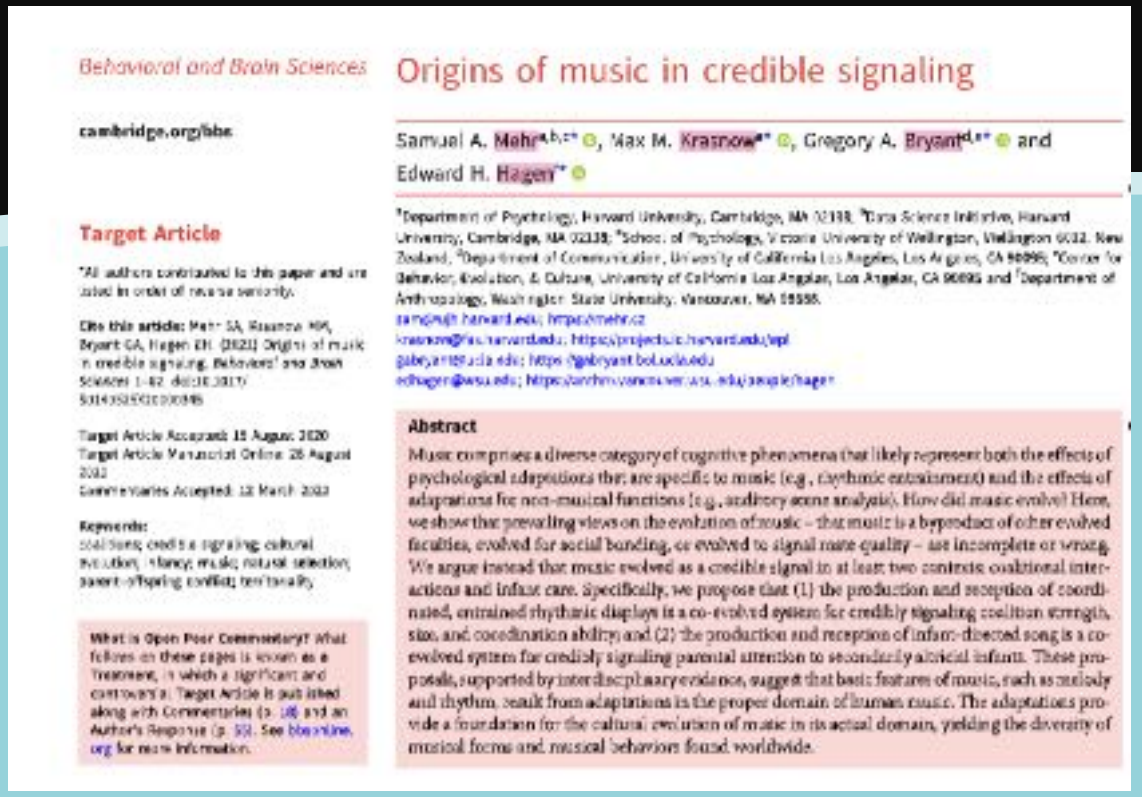
“Mithen argues that musicality is a fundamental part of being human, that this capacity is of great antiquity, and that a holistic protolanguage of musical emotive expression predates language and was an essential precursor to it.”

- Bickerton & Jackendoff -- words came before grammar, and it is the evolution of syntax that differentiates the vocal communication system of Homo sapiens from all of those that went before
- Wray & Arbib -- pre-modern communication was constituted by ‘holistic’ phrases, each of which had a unique meaning and which could not be broken down into meaningful constituent parts





Mithen's idea of **"holistic utterances"**



Behavioral and Brain Sciences

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Target Article

Origins of music in credible signaling

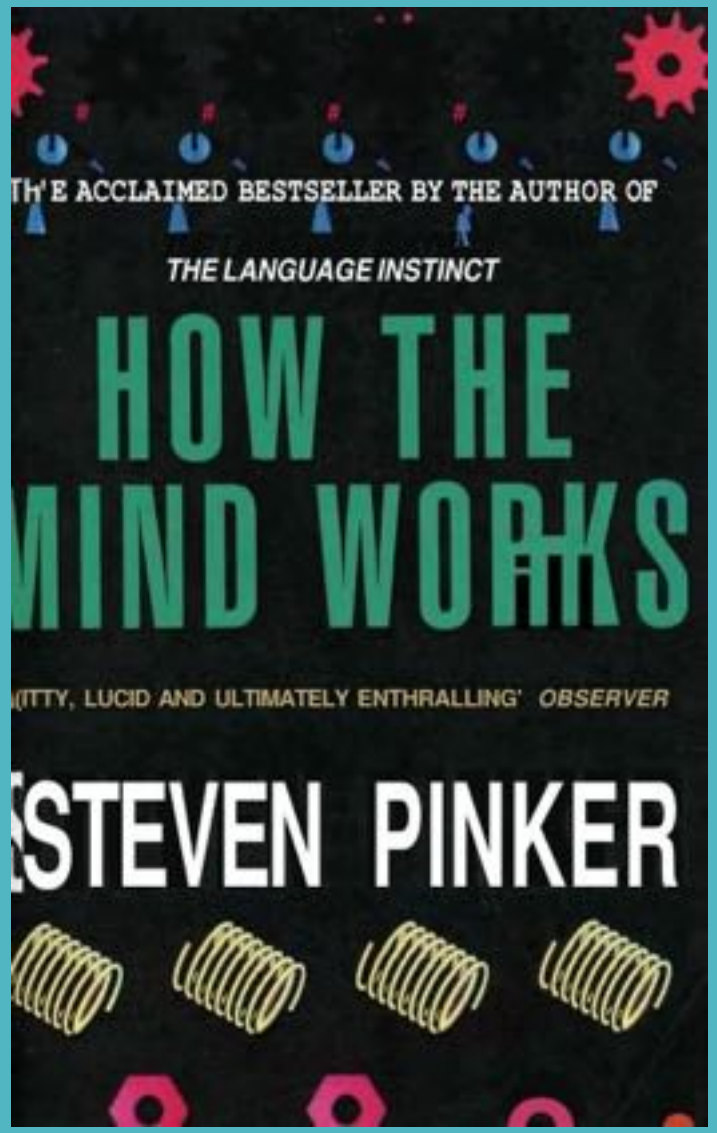
Samuel A. Mehr, Max M. Krasnow, Gregory A. Bryant and Edward H. Hagen

Abstract

Music comprises a diverse category of cognitive phenomena that likely represent both the effects of psychological adaptations that are specific to music (e.g., rhythmic entrainment) and the effects of adaptations for non-musical functions (e.g., auditory scene analysis). How did music evolve? Here, we show that prevailing views on the evolution of music – that music is a byproduct of other evolved faculties, evolved for social bonding, or evolved to signal mate quality – are incomplete or wrong. We argue instead that music evolved as a credible signal in at least two contexts: coalitional interactions and infant care. Specifically, we propose that (1) the production and reception of coordinated, entrained rhythmic displays is a co-evolved system for credibly signaling coalition strength, size, and coordination ability; and (2) the production and reception of infant-directed song is a co-evolved system for credibly signaling parental attention to secondarily altricial infants. These proposals, supported by interdisciplinary evidence, suggest that basic features of music, such as melody and rhythm, result from adaptations in the proper domain of human music. The adaptations provide a foundation for the cultural evolution of music in its actual domain, yielding the diversity of musical forms and musical behaviors found worldwide.

- Like grooming in non-human primates, larger human groups required more efficient mechanisms (ie laughter & music) -- Dunbar
- Increased social bonding
- Musicality arising from adaptations in credible signaling is a set of building blocks for cultural evolution
- A credible signal of coalition strength, size, and coordination ability
- Infant-directed song is a co-evolved system for signaling parental attention

- “A pure pleasure technology, a cocktail of recreational drugs that we ingest through the ear to stimulate a mass of pleasure circuits at once”
- “As far as biological cause and effect are concerned, music is useless.”
  - No signs of design for long life, grandchildren, or accurate perception & prediction of the world
  - “Music could vanish from our species and the rest of our lifestyle would be virtually unchanged”
- “Auditory cheesecake” – a frill, a hedonic diversion easily dispensed?
- Crafted to tickle six of our mental faculties:
  - Language
  - Auditory scene analysis
  - Emotional calls
  - Habitat selection
  - Motor control
  - Something else



Music as a coevolved system for social bonding

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Abstract

Why do humans make music? Theories of the evolution of musicality have focused mainly on the value of music for specific adaptive contexts such as mate selection, parental care, coalition signaling, and group cohesion. Synthesizing and extending previous proposals, we argue that social bonding is an overarching function that unifies all of these theories, and that musicality enabled social bonding at larger scales than grooming and other bonding mechanisms available in ancestral primate societies. We combine cross-disciplinary evidence from archeology, anthropology, biology, musicology, psychology, and neuroscience into a unified framework that accounts for the biological and cultural evolution of music. We argue that the evolution of musicality involves gene–culture coevolution, through which proto-musical behaviors that initially arose and spread as cultural inventions had feedback effects on biological evolution because of their impact on social bonding. We emphasize the deep links between production, perception, prediction, and social reward arising from repetition, synchronization, and harmonization of rhythms and pitches, and summarize empirical evidence for these links at the levels of brain networks, physiological mechanisms, and behaviors across cultures and across species. Finally, we address potential criticisms and make testable predictions for future research, including neurobiological bases of musicality and relationships between human music, language, animal song, and other domains. The music and social bonding hypothesis provides the most comprehensive theory to date of the biological and cultural evolution of music.

- Human musicality is a coevolved system for social bonding
- “Such bonds are psychologically & biologically central to survival and reproduction”
- Synchronizing and harmonizing the moods, emotions, actions, or perspectives of two or more individuals
- The “invention” of music is an iterated process where different proto-musical components of musicality arose over an extended period as behavioral innovations that generated new cognitive and social niches for subsequent biological adaptations “in a virtuous spiral”

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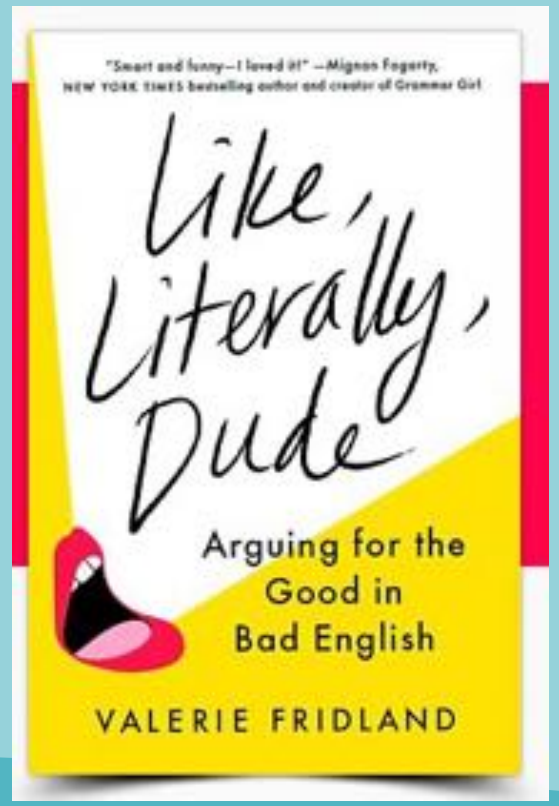
National Endowment for the Humanities fellowship:
"I Hate When You Say That! Exploring the rise, reign and significant cultural value of our most pilloried linguistic quirks."



The cocktail party effect

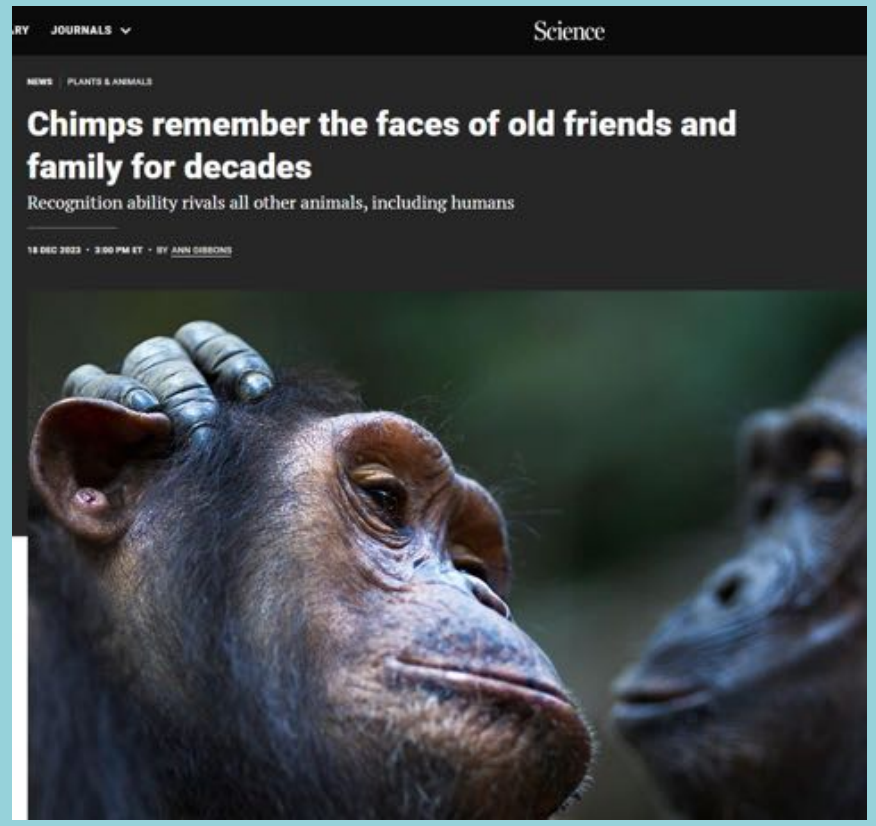
- Sound meets the eardrum, and mechanical energy is converted to electrical energy
- A process of **“auditory scene analysis”** ensues – integrated vs segregated (one sound or many sounds)
- Based on pitch & timbre, and previous familiarity, the brain assigns each sound to a suspected source
- Sounds in time are clustered together in **auditory streams**
- The ability to focus on one auditory stream represents **“the cocktail party effect”** *Colin Cherry (1953)*

The cocktail party effect

- Attentional focus is much easier when listening with two ears – localizing the origin
- The auditory system can localize at least 2 sources and assign correct characteristics simultaneously -- extracting the signals from a mixture of interfering sound sources
- **Sensory memory** assigns a preliminary importance (**“salience”**) to particular stimuli
- Prioritizing one voice allows tuning out the others – ie. **selective attention**
- Also allows detection of important words in unattended stimuli (e.g. hearing one’s own name, or taboo words)

Frazer Harrison/Getty Images

- Recognition of familiar people is based on 3 types of information
  - Visual: face recognition
  - Auditory: voice recognition (e.g. on the phone)
  - Linguistic: name recognition (e.g. in an email)
- Brain damage can selectively impair each
- Recognition involves comparing a given face/voice/name with all known faces, voices, or names
- A feeling of familiarity unlocks the production of an endogenous opioid reaction
- Convergence of modality-specific information into a person-identity node that allows retrieval of recalled biographical information (relationship, profession, etc)
- Finally, retrieval of the phonologic memory of the person's name



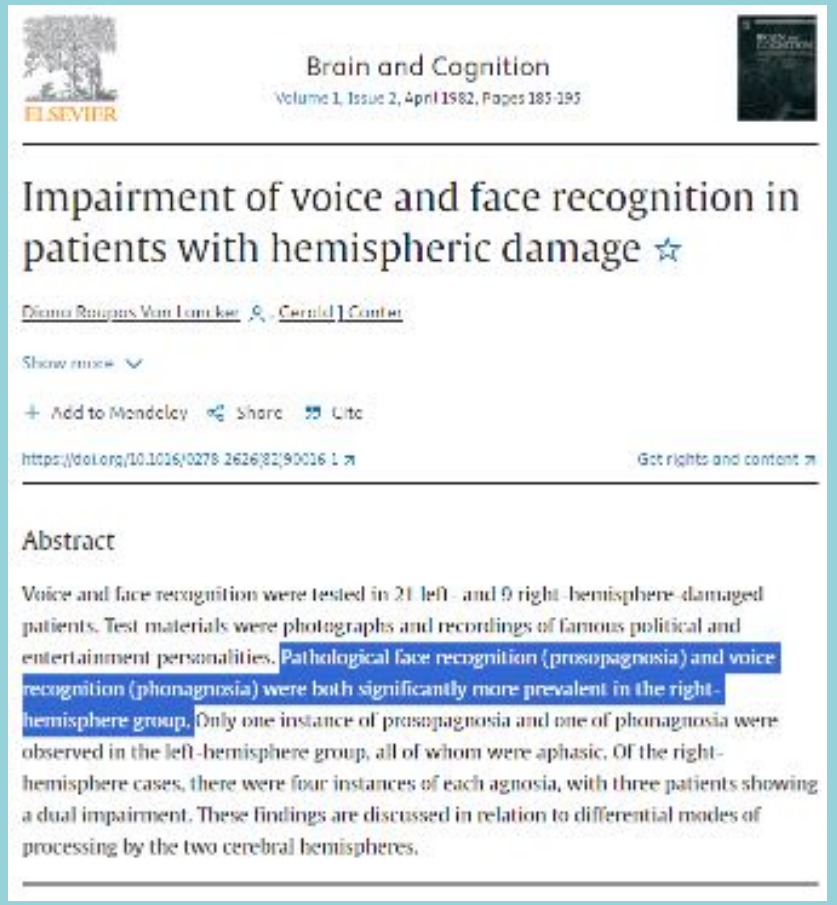
Auditory processing disorders

- Neurodevelopmental disorders affecting the way one's brain processes sounds
- Normal hearing, but difficulty interpreting the sound (eg speech)
- Common disorders in children, especially boys, and particularly in kids with autism
- Difficulty hearing in noisy places; difficulty with comprehension; overlap with ADHD

DuxX/Getty Images

Phonagnosia vs prosopagnosia

- Normal people recognize faces faster than voices
- Damage to the right anterior temporal lobe more likely to compromise face recognition
- Left temporal lobe atrophy compromises name recognition
- Voice recognition disorders mostly due to right temporal lesions, like face recognition
- Possible to distinguish unfamiliar voices in people who don't recognize famous voices
- Face and voice recognition disorders tend to co-occur, but have distinct anatomic centering:
  - Face recognition → right fusiform gyrus (FG)
  - Voice recognition → right superior temporal gyrus (STG)



Brain and Cognition
Volume 1, Issue 2, April 1982, Pages 185-195

Impairment of voice and face recognition in patients with hemispheric damage ☆

Diana Ruggiero Van Lancker, Gerald J. Canter

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Abstract

Voice and face recognition were tested in 21 left- and 9 right-hemisphere-damaged patients. Test materials were photographs and recordings of famous political and entertainment personalities. Pathological face recognition (prosopagnosia) and voice recognition (phonagnosia) were both significantly more prevalent in the right-hemisphere group. Only one instance of prosopagnosia and one of phonagnosia were observed in the left-hemisphere group, all of whom were aphasic. Of the right-hemisphere cases, there were four instances of each agnosia, with three patients showing a dual impairment. These findings are discussed in relation to differential modes of processing by the two cerebral hemispheres.

Guido Gainotti, Neuropsychologia, 49;2011:2273-2282

Summary

- Philosophical roots of Bernstein's Second Norton Lecture – "Syntax"
- The connection of language and music through the lens of Chomsky
- Extrapolating from speech to music with "transformational grammar"
- "Biomusicology," and the search for the evolutionary origins of music: from Darwin (*Descent of Man*) to Mithen (*The Singing Neanderthals*) to Pinker (*How the Brain Works*)
- The "cocktail party effect" and how we listen to music
- Connecting the human voice to the evolution of musicality