Montreal Summer School: 
**Language Evolution:**

**Darwin’s Model of Language Evolution**

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All Animals Communicate...

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But Other Animals Do Not Have Language

Meaning: They Cannot Express All That They Can Think.

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Simplest Model of Language

**Minimal** Model of Human Language.  
(More may be required!)

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Animal Communication Schematic

**Simple Mapping**

*Innate* Capacity to Express a Subset of Concepts

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So What Can Animals Teach Us about language?

A Lot!
Bio-Linguistics: Building Bridges between Biology & Linguistics


Faculty of Language, Broad Sense:
ALL mechanisms involved in language

Faculty of Language, Narrow Sense:

Hauser, Chomsky and Fitch (2002) Science: Evolution of the Language Faculty

Multiple Necessary Components of Language

“Signal”
(Complex Signals: Vocal Control & Learning)

“Syntax”
(Compositional, Hierarchical, Processing)

“Semantics”
(Intent to Communicate, Pragmatics)

Timing of Different Mechanisms:
The Key Difference Between Models

Predictions:

Lexical:

Speech, Semantics, Syntax

Gestural:

Semantics, Syntax, Speech

Musical:

Syntax, Semantics

Multiple Transitionary Stages Required: “Protolanguages”

Modern H. sapiens

??

Vocal Learning?
Semantics?
Syntax?

LCA

??

Since our divergence from the Last Common Ancestor we share with chimpanzees (6-7 million years), multiple “key innovations”

Darwin’s Hypothesis for The Evolution of Language

A big problem after publication of the Origin of Species in 1859
Slow Acceptance of Darwin’s Ideas

- Evolution itself almost instantaneous
- But Natural Selection as a driving force long ignored (problem of blending inheritance)
- Sexual Selection: dismissed by many until the 1960’s
- Musical Protolanguage: still widely overlooked

Impossibility of Language Evolution as a strong argument against Darwin’s theory of evolution

Darwin’s Puzzle: The Function of Music

- Darwin (1871) “Descent of Man”: “human musical ability” must be ranked amongst the most mysterious with which he is endowed”
  “As neither the enjoyment nor the capacity of producing musical notes are faculties of the least use to man in reference to his daily habits of life”

Solution? Music as an earlier stage of human communication, and a “preadaptation” to language:

Vocal imitation, was used largely “in producing true musical cadences, that is in singing”.

Music as a “living fossil” - a rudiment or vestige of an earlier functional trait.

Darwin’s 1871 Model: Musical Protolanguage

Song First - Vocal Control
Early, Driven by Sexual Selection (on bird song analogy)

Semantics - Propositional
Meaning late

What is to be explained?

Language is “an instinctive tendency to acquire an art”

Birdsong is “in many ways the closest analogy”
Similarities: Bird Song & Human Speech

- Instinctive calls exist in both groups;
- An instinct to sing/speak exists in both;
- But structure of song itself is learned;
- Subsong parallel to human babbling
- Learning leads to cultural transmission
- And this leads to regional dialects

Stage 1: Singing Meaningless but Complex, Learned Phrases

Darwin concluded from “widely spread analogy” that this stage driven by sexual selection

“Prosodic Protolanguage”: Comparative Method applied to Song & Speech

Language \[\text{Prosodic/Mimetic Vocal Communication}\] Music

Scat singing: Sarah Vaughan

Stage 2: Meaning acquired via Imitation and Onomatopoeia

An innovation of some particularly “wise ape-like animal”

Stage 3:
Early system feeds back on brain to generate greater intelligence

Language "reacted on the mind by enabling and encouraging it to carry on long trains of thought" which "can no more be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or algebra"

How to Add Meaning to Music?

Holistic Protolanguage

1. First utterances phonologically complex, but signify whole propositions
2. Fractionation into words comes later, building on pre-existing conceptual primitives

Linguist Otto Jespersen (also Alison Wray, Simon Kirby, Michael Arbib)
Darwin’s Model from a Modern Perspective

Testing Multiple Models of Protolanguage

Why We Need a Broad Comparative Database

Homology - Descended From Common Ancestor

Convergence - Separate, Parallel Evolution

Vocal Production - Testing Hypotheses about Vocal Control and Vocal Learning

Core Fact: Apes cannot “ape” speech

Furness, 1916
Yerkes, 1929
Hayes, 1951
Kellog, 1968
Gardner, 1969

But Many Birds Can: Italian-Speaking Mynah Bird

Vocal Imitation in Seals

Hoover, a talking seal
What Key Components of Speech Production Differentiate Humans from other Primates?

- Vocal Anatomy?
- Neural & Cognitive Mechanisms?

The Descent of the Larynx: Why?

Lieberman et al. 1969:
Descended larynx and tongue -> greater variety of vocal tract shapes -> greater variety of speech sounds

Plausible. But what about animals?

X-ray Cineradiography of Vocalizing Mammals (w/ A. W. Crompton)

Larynx Lowers in All Mammals Thus far Examined.


Conclusion: At Any Point in Human Evolution, Vocal Tract was Flexible Enough for Speech

Hominin Vocal Dynamics: Reconstructed Using Comparative Data
Key Differential Components of Speech & Language are Neural Mechanisms

II. The Central Nervous System

The Kuypers/Jürgens Hypothesis

Jürgens, Uwe (2002). Neural pathways underlying vocal control. *Neuroscience & Biobehavioral Reviews, 26*: 235


Why? Cortico-Vocal Connections in Mammals

Kuypers, H (1958) Brain, 81, 364-388.

Are Direct Connections Crucial?

Correlation does not demonstrate causality: Can we test the Kuypers/Jürgens Hypothesis?

Comparative data, and convergent evolution, become crucial

DIRECT Cortico-Motor Connections in Humans. But NONE to larynx in other Primates

Vocal Imitation: Convergently Evolved in Many Clades

Now, *Broad* Comparative Method Required
Bird Vocal Source is Syrinx, not Larynx - But Basic Prediction Upheld

Why did Musical Protolanguage evolve?

Darwin was confident it was Sexual Selection:
‘musical notes and rhythm were first acquired by the male or female progenitors of mankind for the sake of charming the opposite sex’

Sexual Selection and Animal Song

Mostly males who sing, during mating season. But female song exists (both alone and duets) in birds - thus caution is required.

Sexual Selection signals: Bird and whale songs - complex nonhuman vocalizations

Best Documented Function of Song: Mother Infant Communication

Lullabies and Play Songs: Universal Aspect of Mother/Infant Interactions: Sandra Trehub & Laurel Trainor
Why us and not others?
Ape Demographics & Language Evolution

Extended Childcare? Sharing knowledge with kin extremely valuable.
When? Homo erectus the first hominid to emerge from Africa into highly varied habitats.
Or did semantic language wait for Homo sapiens?

Conclusion:
Testing Models of Language Evolution with “Cognitive Archaeology”
Molecular Biology Leads the Way

FOXP2 - Ancient transcription factor

FOXP2 and Vocal Control
Affected KE family members

• Vocal imitation requires uniquely flexible vocal control: one factor is the FOX-P2 gene
• A human-specific mutation in this ancient gene appears to be a key mutation supporting advanced oral-motor control in humans.

FoxP2 - An ancient transcription factor, but different between humans and other apes


Dating the FoxP2 mutation: Estimate “Selective Sweep” only 200,000 years ago

Cognitive Archaeology with Genes: As more language-related genes are found, we can date selective sweep for each and finally discover order of appearance of different language modules. Crucial Point is not exact time (vague) but ordering in time.

Conclusions

- Multi-component model of language
- Multiple Models of “Protolanguage”
- Testing using convergent data from animal studies, neuroscience, evolutionary theory and genetics
- Demands that students who will make a big contribution to these questions must master multiple fields!


Thank You!

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Alfred Russell Wallace

Natural selection cannot explain the evolution of the human mind.

The Descended Human Larynx

Orangutan Chimpanzee Human

Human Speech Production

Multiple Models of “Protolanguage”

- **Lexical** Protolanguage - (Bickerton, Jackendoff): Words first, syntax last
- **Gestural** Protolanguage - (Hewes, Arbib): Gestural signs first, then syntax, speech last
- **Holistic** Protolanguage- (Jespersen, Wray): Sentences first, words/grammar last
- **Musical** Protolanguage - (Darwin, Mithen): Vocal control first, meaning last

When did music evolve?

Music does not fossilize - But instruments can!
Geissenklösterle flutes (Cro-magnon): 37,000 yrs old
Divje Baba: Neanderthal fossil “flute”, 40,000?