

Week 7: The Emergence of Speech

Brain – REVIEW: Areas specialized for language processing:

- Allometrically increased **Wernickes** (Planum temporale); Lexicon for comprehension
- **Broca's** (Premotor) to plan grammatically organized articulation, linked to Mirror System devel
 - Appearance of new Basal Forebrain projection to arouse (sustain attention in) Brocas
- Significant increase in (white matter) connections – “**Arcuate Fasciculus**” - to/from Broca's
- **STS** (Superior Temporal Sulcus) for biological motion, including facial expression, lip reading
- **Basal Forebrain** – New arousal nucleus specialized to drive, sustain Broca's activity
- Lateralization
 - Humans lateralized to left hemisphere for speech: Left Wernickes asymmetrically enlarged
 - Left Brocas has priority of control over output (e.g. less lateralized, more likely to stutter)
 - Some suggestion that Acheulian tools were made by **Right Handers**, Mousterian certainly were
 - Perhaps right-handedness came first, then co-opted for vocal control??

Articulatory Apparatus

- The Larynx: Opening to trachea (to lungs) is above opening to esophagus in ape & human infant
 - But in adult human, trachea drops, so food entering esophagus can block airway
 - Thus, speech involved the high cost of choking!
- Hyoid Bone: Small, horseshoe-shaped bone in throat, anchors jaw, tongue & larynx muscles
 - Human's shaped somewhat differently from other primates, lies much higher in neck.
 - Neanderthal's shaped somewhat like humans, but possibly lower in neck (??)
 - Problematic as data, since a “floating” bone, so location not clear from fossils
- Thoracic spinal column: Narrower in *H. erectus* than in later *Homo* spp.
 - Presumably for greater enervation of the lungs for subtle controls on breathing
 - Poss adaptation for long-distance walk/running >> exaptation for breath control during speech?
 - Lake in Rift Valley (at times, largest on planet) >> breath control for swimming ?
- Basicranial flexure – base of skull, roof of mouth to Foramen Magnum (where cord enters brain)
 - Flexure makes for large, resonating chamber that increases range of sounds that can be made
 - Also relates to tongue position, which only in adult humans extends into throat
 - Slight in *H. erectus*, some in *H. neanderthalensis* & infant *H. sapiens*, great in H. sapiens adult
- Did Neanderthal speak? Perhaps speech impediments; Probably distinctly different from *H. sapiens*

Combinatorics

- Phonology: Primitives of Speech

- **Phonemes**: Sounds/Motoric movements of tongue, lips, teeth, breath that are basic units of speech
 - Speech errors reflect org of phonemes into syllables (e.g. **Spoonerisms**: well made>mell wade)
 - Note: Interpreting speech usually **multi-modal**: McGurk effect (hear “ba”, see “ga”, perceive “da”)
- **Prosody**: Emotional tone, emphasis, cadence (further developed in rhyme, song, etc)
 - Right hemisphere dominance (See lecture on Development & reading on “Motherese”) -

- Morphology: Packaging the Word

- **Morpheme** = minimal meaningful unit: e.g. Root word (“package”), Inflection (“-ed”, “pre-“), etc.
 - Made of combinations of (sometimes single) syllables, which can then be further combined

- Grammar: Organizing the Sentence

- Rules for combining morphemes into coherent strings = “complete idea” (= sentence)
- Rules include Word order, Parts of speech, Tense marking, Hierarchical phrase structure, etc
 - e.g. NP(Art,N), VP(V, NP(Art,N)) etc e.g. Word Order (Dog bites man, Man bites dog)
- Robust schematic scaffolding that prompts content & supports interpretation
 - e.g. “The boy saw the _____” “easily” “sang?” “brown?” “book?” (Must be a NOUN)
 - NOTE: Language trained animals can also learn what “type” of symbol required!
 - e.g. Chomsky's “Colorless green ideas sleep furiously” vs. “Green furiously ideas colorless sleep”
- So, speech is a serial interface for representing/communicating relations, and thus requires hierarchical organization, at multiple levels

- The Lexicon, Symbolic calls, refer to vast variety of people, places, things, aspects, events, ideas...

- Appearance of such symbols probably associated with BOOM in technological/cultural diversity
- Educated contemporary adults know 50,000+ words, so requires significant learning & memory

- RECALL: Prehistoric evidence for hier org: Hafted tools, embedded social tools, etc.
- If Neanderthal showed tool combinatorics, how about vocal??

Iconic to Symbolic Reference

- Reference (Point to, About something else)
 - **Iconic reference** = Signal bears resemblance to that to which it refers
 - e.g. Mimesis is using gesture, posture, vocalizations etc to refer to similar events
 - **Symbolic reference** = Arbitrary signal is unlike it's referent, refers per user agreement
 - e.g. "Big" is itself not big, "Infinitesimal" is itself not small
- Material evidence of prehistoric Reference is only found with *H sapiens* (from ~35,000YA)
 - Cave Art, Venus "icon" etc - Note how iconic! Still, they *are* representational (2D not 3D)
 - Neanderthal more limited; More advanced representational ability in (linguistic) *H. sapiens* ?
 - Earliest markings: ~9,000 YA "Tally marks" in stone; ~5,500 YA First writing (Hieroglyphics)
 - Note, still kind of "iconic" in 1:1 mapping from mark to referent, mixed w/conv symbols
- If Mimesis came first, how did we shift from Iconic to Symbolic??
- ??? Possibly...
 - As mimesis (including vocal) developed, use of some signals became conventionalized
 - e.g. "Ow" plus "Gurgle" => "owgurgle", now refers to fall into creek
 - i.e. **Omomotopia** morphs into more and more conventionalized forms
 - Growing dependence on reference (e.g. hearsay) selects for expanded vocal repertoire
 - e.g. **Expertise/Apprenticeship**, co-develop refinements in discrimination & practice
 - Includes generating terms to refer to those distinctions
 - e.g. See "**Professional Vision**" (*Gibson 1994*) develop in contemporary apprenticeships
 - Lear to see what matters thru attention-directing, domain-specific vocabulary
 - So as dependence on teaching increases, probably promoted lexical development
 - Plus, growing dependence on mimesis selects for improved narrative abilities
 - Growing dependence on narrative (scouts, gossip) provides organizational structure
 - As lexicon develops, such structure helps to schematically organize combinatorics
 - Provides fundamental schemes (wwwww) of Syntax*

* Syntax is a major focus of evolution of language models. A few seminal works include...

- Chomsky & the LAD (Language Acquisition Device): Proposed innate Universal Grammar:
 - Universality of some rules & "poverty of stimulus" suggests some of syntax "hard wired"
- Pinker 1994: *The Language Instinct*. Updated version of Chomsky's model
- Tomasello 1995: *Language is not an Instinct*: Instead, a learned, social collaboration
- Elman et al 1996: Connectionist models of syntactical learning: emerges from statistical regularities