Protolanguage

Fitch 2010

See also Fitch 2006

Language-like behavior in animals

- Vervet monkeys' alarm calls.
- The dance of bees.

- Fitch will compare three approaches to the evolution of language:
  - Lexical protolanguage.
  - Gestural protolanguage.
  - Musical protolanguage.

Evolutionary forces (c.f. Fitch 2010)

- Natural Selection
  - Adaptation of organisms to their physical environment, in ways that aid individual survival.
  - Survival of the fittest.
- Sexual Selection
  - Bright plumage might make an individual more vulnerable to predators, but more attractive as a mate.
  - Selection due to competition within species for mates—reproductive success.
- Kin Selection
  - Organisms are more altruistic to their kin, which helps the family survive--and thus the individual's genetic material.
  - Wikipedia: Kin selection refers to apparent strategies in evolution that favor the reproductive success of an organism's relatives, even at a cost to the organism's own survival and reproduction.
- Group Selection
  - Wikipedia: In evolutionary biology, the idea that alleles can become fixed or spread in a population because of the benefits they bestow on groups, regardless of the allele's effect on the fitness of individuals within the group.
  - More controversial. Perhaps best explained as individual selection via kin selection as a mechanism.

Sexual selection: The peacock's tail

Lexical protolanguage

- A large learned vocabulary of words, but no syntax.

- E.g. Bickerton 1990, Jackendoff 2002.

- Rich conceptual structures and a basic symbolic capacity to match sounds with arbitrary referents were present before language.

- Both assume that all stages of language evolution were audio-vocal.

- Both assume that syntax came later:
  - Bickerton: catastrophically.
  - Jackendoff: gradually.

Table 12.1. Elements of Bickertonian lexical protolanguage

Present in lexical protolanguage:

(1) Vocal learning and expression via the auditory/vocal modality (signal)
(2) Lexical items (individual form–meaning mappings) (semantics)
(3) Motivation/Drive to share information (*Mitteilungsbedürfnis*)

Missing – Modern syntax:

(1) Grammatical items (function words and inflectional morphemes)
(2) Phrase structure
(3) Obligatory expression of argument structure
(4) Readily identifiable null elements
(5) Varied word orders for varied semantic pragmatic functions

- Bickerton: catastrophic emergence of syntax:
  - "The syntactic module consists not of an isolated brain area but rather of a particular type of nervous organization that permeate and interconnects those areas devoted to higher reasoning processes, concepts, and the lexicon, a type of organization that automatically sorts material into binary-branching tree structures."
  - Fitch: "Some continuously variable cellular trait (such as branching probability for neocortical pyramidal cells) is selected gradually to increase (either directly, because of increased storage capacity, or indirectly, by selection for a larger brain). Neurons become more branched, and in particular the density of (say) secondary dendritic branches increases. But at some point, the continuous variable of branching probability would lead to the appearance of tertiary branching: a qualitative change. Such a change could have major computational effects, effects permeating the entire neocortex, and yet be the result of continuous selection on a continuous trait."

- Jackendoff: Stages before protolanguage:
  - A one-word stage, lacking combinatoriality, where holistic utterances were mapped onto holistic meanings.
    - Interjections like *oops*, *tsk tsk* are a holdover.
  - The evolution of specialized innate "lexical acquisition tools" enabled large vocabularies.
    - Fitch: but dogs can use mutual exclusivity and fast mapping to learn vocabulary items.
  - A combinatorial phonology supported the development of large vocabularies.
- Lexical protolanguage with full vocal complexity and a large phonologically structured lexicon, used in a communicative context among adults members of some primitive hominid group.
- Jackendoff: Stages after protolanguage result in linguistic syntax.
  - Concatenation of words, use of word order to convey semantic roles, head structure, function words, syntactic categories, etc.

Problem with lexical protolanguage models

- Bickerton and Jackendoff propose that lexical protolanguage evolved for communication, supporting cooperation between members of the group through sharing information.

- But indiscriminate sharing with others is not an evolutionary stable strategy (ESS) because free riders who take but don't give would be better off than cooperators.

  – Since Dawkins & Krebs 1978, the traditional notion of animal communication as "Information sharing" has become generally suspect, and models where animals signal to manipulate others for their own selfish ends, are assumed today.

  – Solution: Kin selection and reciprocal altruism.

    • An individual can pay an immediate cost, benefiting another, if that other is related to it and thus shares some of its genetic code.

    • E.g. "Tit-for-tat" among nonkin: start out being cooperative but stop sharing if your partner cheats you first.

Some proposed solutions

- Dunbar 1996:
  - Grooming is a core mechanism for maintaining social groups, and individual selection drives the evolution of grooming in most primates.
    - As a group got large, complex vocalization arose as "vocal grooming", enabling an individual to "groom" multiple individuals simultaneously.
  - Gossip: a mechanism for generating reputations, based on sharing information about prospective partners among group members, provides a potent defense against free-riders.
- Fitch's criticisms:
  - Grooming generates endorphins and speech does not, but music does.
  - The use of gossip presupposes propositional meaning, so the emergence of propositional meaning is not accounted for.

Some proposed solutions

- Deacon 1997
  - Propositional meaning is "symbolic" (relying on relations between signals) rather than "indexical" (relying on relations between signals and referents).
  - Only humans have taken the leap from indices to symbols.
  - Humans have a long infancy and require a lot of fats and proteins—females must rely on male hunters to bring them meat.
  - It isn't evolutionarily advantageous to provide meat for another male's child, so monogamy emerged.
  - Only *unreal* or *invisible* referents would drive true symbolism, and "social contracts" like promises and commitments would have been the first symbols.
- Fitch's criticisms.
  - Humans commit adultery, and meat is shared among the group in hunting-gathering societies. Language does help stabilize groups, but this isn't enough to explain the emergence of propositional language.

Some proposed solutions

- Fitch 2004
  - The sharing of propositional information that language permits evolved, initially, in a context of transferring information from knowledgeable adults to their less-knowledgeable kin.
  - Supported by the speed and ease with which *children* learn language, and the frequency with which they use it with their parents.
  - State 1: kin selection for information exchange
    - Key insight: sharing with kin is *not* altruistic.
    - Kin selection has been used to explain bee communication since hivemates are related. Also animals are more likely to emit alarm calls for conveying information to kin than nonkin.
  - Stage 2: reciprocal altruism – no evolution needed
    - Once propositional language was off the ground, it was generalized to communication with non-kin, with gossip, social control and punishment playing their own role via cultural development.

Evolution of the signaling system

- The lexical protolanguage model presupposes a signaling system that would have had to evolve.

- Two main models:
  - Gestural protolanguage.
  - Musical protolanguage.

Gestural protolanguage

- The idea that a visual/manual communication system played a crucial intervening role in the evolution of our current vocally dominated system.

- Types of gestures:
  - Pantomime
  - Co-speech gestures
    - Deictic, Iconic, Emblematic, Beats, Metaphorical/lexical

- The earliest gestures substitute for words, but at the two-word stage they interact with words, and then accompany spoken language.

- Congenitally blind children gesture similarly to sighted children even when speaking to other blind children.

- Hewes 1973 proposed a gestural stage of hominid protolanguage.
  - Apes' natural, species-typical use of gestures is volitional and intentionally informative, and gestures are made with close attention to the intended receiver's state of attention.
    - Gesture, as a signaling system, thus provides a "line of least biological resistance" into intentional semanticity.
  - Humans can pantomime very successfully.
    - European explorers and native peoples.
    - "Home-sign systems of deaf children of hearing parents.
    - Children unlike chimps spontaneously use **declarative** pointing a way of eliciting attention to objects, not just **imperative** pointing.
- Fitch's criticism:
  - Given that sign languages are fully adequate languages, why would gestural protolanguage have evolved into spoken language?

Gesture and mirror neurons

- Rizzolatti & Arbib 1998; Arbib 2002, 2005
- Mirror neurons are motor neurons which normally fire while the monkey performs an action, but also fire when the monkey *observes* that action performed by another.
  - Typically reaching and grasping actions of the hand, but also in grasping with the mouth.
- Might represent a shared primate mechanism that paved the way to a gestural protolanguage by providing a neural substrate for **parity** in gesture understanding.
  - Parity between acting and perceiving is a prerequisite of communication.
- Fitch: audio-motor neurons have also been discovered that fire when performing an action and when hearing the result; oral-action neurons have also been documented that respond to speech and music. This weakens the mirror neuron theory of gestural protolanguage.
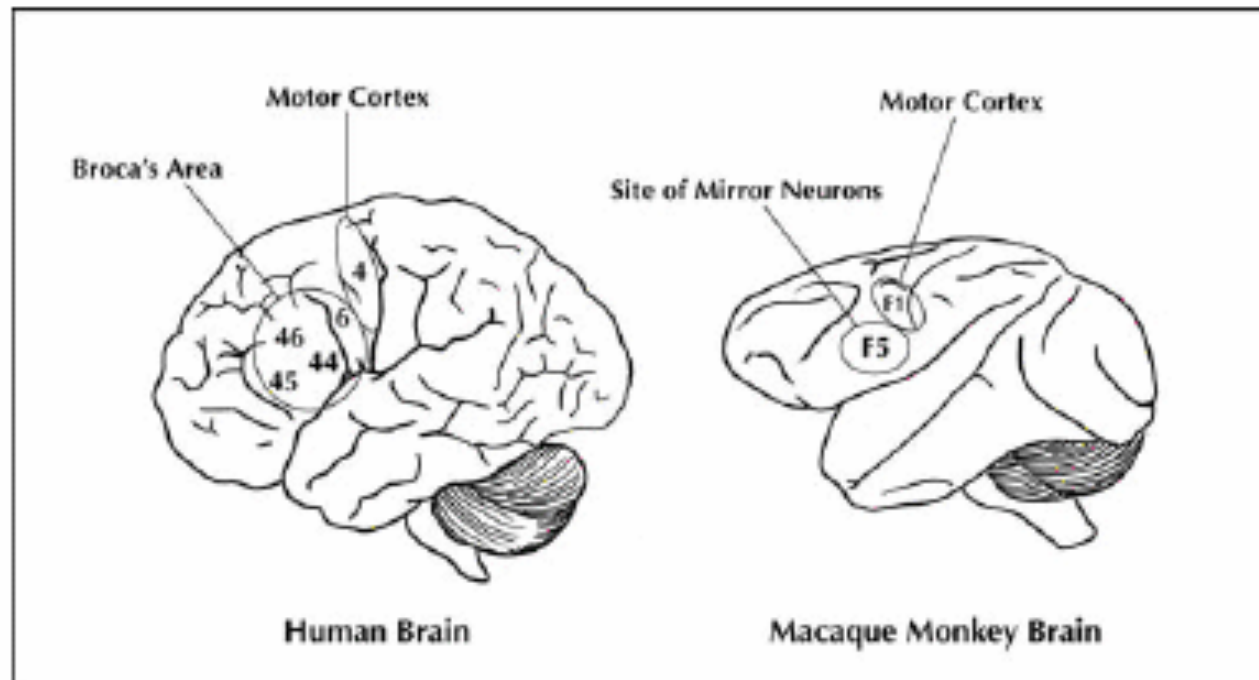
Figure 13.1 Mirror neurons in human and macaque brains – The diagram illustrates the similarity in location of the human Broca's area and area F5 in the macaque monkey, where motor neutrons are found.

Arbib first three stages, within primates, lead to our LCA with chimpanzees:

S1: grasping;
S2: mirror system for grasping;
S3: simple imitation (shared with chimpanzees but not macaques).

The following four stages are hypothesized in the evolution between the LCA and modern humans:

S4: complex imitation (beyond chimpanzees);
S5: protosign (key innovation: open repertoire);
S6: protospeech (key innovation: neocortical vocal control via collateralization);
S7: modern language.

- Collateralization
  - Mouth and hand control are accomplished by neighboring regions of the motor cortex.
  - Gestural control "collatoralized" speech control regions.
- Scaffolding
  - Speech accompanied and aided gesture, which in turn accompanied and aided expression through speech, and so on, resulting in spoken language.
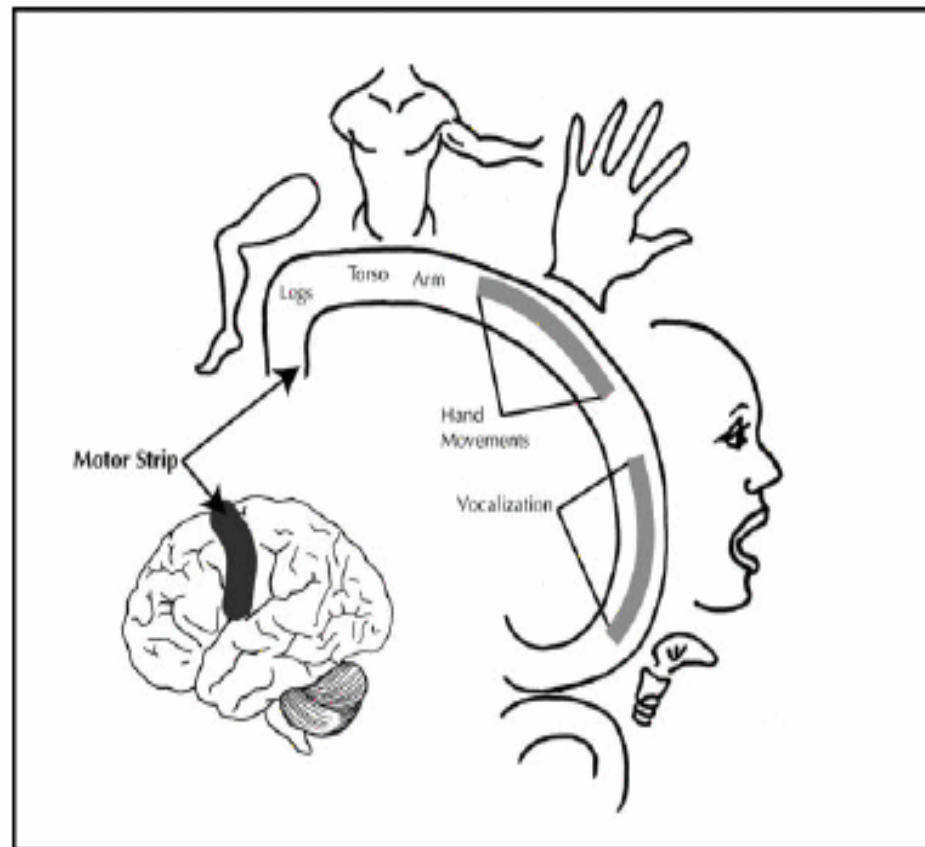
Figure 13.2 The motor "homunculus" – Control of contiguous body regions is mapped onto (mostly) contiguous regions of the motor strip in the frontal cortex. The hand area is directly beside the area controlling the facial and vocal musculature, which includes a large region that elicits vocalization when stimulated. This contiguity provides the spatial basis for Arbib's hypothesis that gestural control circuits "collateralized" speech control regions.

Musical protolanguage

- Lexical and gestural protolanguage hypotheses can't account for the role of vocal control in speech i.e. for our well-developed phonology.
- Phonology is arbitrary and generative (open-ended). These combine to give 'duality of patterning'—morphemes and words have meanings but their phonological components do not.
- A major problem for gestural theories is to explain how such a system evolved from an initially iconic, holistic, meaningful system.
- Bare phonology is a highly structured system. Why would an organism evolve such a system? Are there any parallels in nonlinguistic domains, or in other species?
- Music—non-lyrical song.

Table 14.1. Hockett's (1960) design features of language revisited

Design feature	Present in innate calls?	Present in music?
(1) Vocal auditory channel	yes	yes
(2) Broadcast transmission	yes	yes
(3) Rapid fading	yes	yes
(4) Interchangeability	yes	yes
(5) Total feedback	yes	yes
(6) Specialization	yes	yes
(7) Semanticity	?	no
(8) Arbitrariness	?	no
(9) Discreteness	no	**yes**
(10) **Displacement**	?	no
(11) **Productivity/Openness**	no	**yes**
(12) **Duality of patterning**	no	no
(13) **Cultural transmission**	no	**yes**

Design features of innate calls, music and language compared (see Introduction for details of each of Hockett's "design features"). Question marks for innate calls reflect the fact that some primate calls are "functionally referential" (e.g. alarm calls), but the existence of such calls in apes, and thus the LCA, remains unclear. The important differences between music and language on the one hand, and innate calls on the other, are that the former represent *discrete, generative* systems that are transmitted *culturally*, while innate calls are graded, closed systems transmitted genetically.

Darwin

- 1859. *The Origin of Species.*
- 1871. *The Descent of Man, and Selection in Relation to Sex.*
  - Tackled Language evolution.
  - Recognized that language is mental, learned although babbling indicates instinct to learn, has an analog in birdsong,
  - Three-stage scenario.
    1. Greater development of proto-human cognition.
    2. The evolution of vocal imitation (sexual selection), a musical stage.
    3. The association with meanings, e.g. through imitation of sounds of animals accompanied by gestures.

Prosodic protolanguage

- To avoid the connotation of discrete beats and frequencies, Fitch introduces the term "prosodic protolanguage".

- A vocal system that was learned (rather than innate) and generative, but in which discrete tones (scales) and beats (regular rhythms) need not have been present.

- However, because this involved movements of the vocal tract (e.g. tongue and lips) it would have had proto-syllables which by virtue of the shared mammalian system of categorical perception would constitute a form of "syllable discreteness."

  – Gives us proto-phonology.

  – Also gives us some aspects of proto-syntax: hierarchical phrases, and proto-lexicon as a list of tunes or "riffs".

  – Has emotional meaning but not propositional meaning.

Prosodic protolanguage and modern music

- The prosodic protolanguage could also be termed "protomusic", a hypothetical pre-musical precursor that existed in some extinct hominids.
  - Could have lacked instruments.
  - Lacked discrete pitches and regular beats.
  - More like "Motherese".
  - Would have been "repeatable" like music but not language except for formulaic utterances like greetings, ritualistic phrases etc. which could be a holdover.

Table 14.2. Design features of music

Design feature	Present in language?	Present in innate calls?
(1) Complexity	yes	no
(2) Generative	yes	no
(3) Culturally transmitted	yes	no
(4) Discrete pitches	no	no
(5) Isochronic	no	no
(6) Transposability	yes	?
(7) Performative context	no	no
(8) Repeatable (repertoire)	no	no
(9) Non-referentially expressive	no	yes

Proposed design features of human music (from Fitch, 2005c).

Adding meaning to prosodic protolanguage

- Jespersen 1922
  - "Language began with half-musical unanalyzed expressions for individual beings and solitary events."
    - Holistic.
  - A long analytic process spanning multiple generations resulted in the creation of modern language.

Modern versions of musical protolanguage theory

- Mithen 2005, *The Singing Neanderthals*: Hmmm model
  - <u>H</u>olistic, <u>m</u>anipulative, <u>m</u>ulti-<u>m</u>odal, <u>m</u>usical
- Brown 2000, "Musilanguage" model.
  - Fitch's criticizes:
    - Musilanguage conveyed referential meaning through tones like Vervet monkey signals.
    - Musilanguage had scales(discrete pitches).
    - The principle function was "group cooperation, coordination and cohesion" and group selection is needed to account for this.

More plausible evolutionary mechanisms

- Sexual selection (Darwin).
  - But the existence of musical abilities (song) in human babies and adult females raises a major objection against any model that exclusively relies on sexual selection.
  - Although there is more and more evidence for song in female birds, especially in the tropics where there is male-female duetting.
  - Thus, an early musical protolanguage stage could be driven by sexual selection on males, while later stages involved a shift to selection on both sexes.
  - When males are involved in child rearing, females too will have to compete for mates, and hence sing.
  - Thus, sexual selection could have driven the evolution of song in both sexes, even if it may be inadequate to drive the cooperative semantic aspects of language.

More plausible evolutionary mechanisms

- Kin selection
  - Dissanayake, Trehub,Trainor, Falk
    - Music is immensely important to women in raising infants.
    - Lullabies and play songs, modulating infant arousal, strengthening the mother/infant bond, socializing the infant.
    - Child-directed speech and child-directed music is universal.
  - With bipedalism and upright stance, carrying the infant would become a problem.
    - Singing to the infant would permit the mother to put the infant down when foraging.
  - Fathers also sing to their babies, and male as well as females babies are sung to.
  - The "insight" that leads to semantics could have been made by children.

Wray's 1998 model of holistic protolanguage.

- Pre-existence of a complex, culturally transmitted bare phonology + holistic mapping to meanings
  - *Abcadabra, gesundheit, how do you do?*
  - Such holistic meanings are still in use today.
- Analytic syntax came second, and derives not from the need for communication (for which the holistic meanings suffice) but from its use in thought.
  - Thus agreeing with Chomsky.
- She didn't consider the role of music or song.
- Tallerman 2007 criticized Wray's model, but Fitch defends it.
  - Tallerman is skeptical about the ability of children to analytically discover words in their parents' holistic messages.
  - Would children's over-regularizations be enough to convert a holistic protolanguage into a synthetic one?

Kirby's 2000 computer simulations of holistic/analytic transitions

- A community of agents produce random but complex multisyllabic utterances heard by others.

- Hearers learn these utterances by rote and produce them themselves later.

- Holistic meanings are mapped onto whole complex signals and there are no words.

- Gradual, staggered agent death and replacement, no rewards are given for accurate communication.

- Over many generations, the agents converge on a syntactic, analytic language, applying pre-existing *conceptual* primitives onto chunks of signals.

- In the privacy of its own simulated mind, each agent attempts to streamline its lexicon, storing partial semantic/ phonology matches that happen by chance as a means of of optimizing storage and retrieval.

- Ultimately this produces a population-wide modern lexicon that associates *phonological words*, rather than whole utterances, with meanings.

- The process driving this cultural convergence is a simple frequency-based learning bias.

- Once one agent has made an analytic "mistake" it tends to produce that string more often.

- Subsequent agents remember this more regular aspect of the developing proto-lexicon because they hear it more frequently.

- This cultural evolution process reliably drives a random holistic system to become a compositional one, in all runs of the simulation.

Fitch's Multi-Stage Model

1. Phonology first.

   - Sexual and kin selection.

   - Bare phonology.

2. Arbitrary holistic meaning.

   - Kin selection.

   - Association with context-bound entities: activities, repeated events, rituals, individuals.

   - Musical protolanguage was a manipulative, emotionally grounded vocal communication system, not a vehicle for the unlimited expression of thought.

3. Analytic meaning.
   - The linked wholes were gradually broken down into parts.
   - Language became a vehicle for thought to be expressed.
   - No genetic changes required.

4. Modern language – genetic fixation of the analytic urge.
   - Kin selection.
   - Pressure for rapid analytic learning by children became strong.
   - Drove the last spurt to our modern state where language is mostly composed of atomic meaning units (morphemes or true words).

NH: Final thoughts

- Music also evolved.
  - Discrete pitches and scale structure as well as isochrony perhaps emerged through experimentation with instruments like flutes and drums.
  - Some kind of genetic adaptation to music also occurred along with cultural evolution.
  - When recursion became fully functional in language, perhaps it was exploited in music.
- The musical protolanguage idea also explains why the distributed music and language processing systems in the brain overlap.