Language and Brain Evolution

- Definition of Language
- Do Animals Have Language?
- Primates Can Learn Sign Languages
- Unique Position of the Human Larynx
- Advantages of Having Language
- Dramatic Encephalization in Hominin Evolution
  - Plasticity in Response to Injury and New Tasks
  - Lateralization, Handedness, and Sequencing
  - Possible Ultimate Causes of Encephalization
  - Paedomorphosis as a Proximate Cause
- Human Characteristics Are Mutually Reinforcing
Figure 7.1: Vervet monkeys give specific alarm calls at the sighting of their main predators: leopards, eagles, and snakes. The responding monkeys’ escape behaviors differ accordingly.
Figure S7.a: Vervet monkeys give specific alarm calls at the sighting of different predators: leopards (top), eagles (middle), and snakes (bottom). The responding monkeys’ escape behavior differs accordingly.

*From Seyfarth and Cheney (1992)*

How would you test whether the monkeys respond only to the call or to the call plus other situational stimuli?
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Figure S7.b:

An educational psychologist teaches a juvenile chimpanzee ("Washoe") to use the American sign language symbol for "hat".

*From* Turnbaugh *et al.* (1993)
Figure S7.c: Kanzi, a bonobo, is trained by primatologist Sue Savage-Rumbaugh to recognize English words spoken to him over headphones. He responds by choosing a previously learned symbol from an array of tiles (lexigrams).

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Larynx and supralaryngeal space.

The supralaryngeal space (SLS) modulates the sound generated by the vocal folds in the larynx. The SLS also enhances human speech by allowing the tongue to produce certain consonants. However, the extended common passageway for air and food also creates a hazard of choking.

From Sataloff (1992)
The larynx (voice box) forms the upper end of the trachea (windpipe) at the base of the tongue. The epiglottis stands open vertically during breathing. During swallowing, it closes down horizontally, thus preventing food and drink to enter the trachea.

From Sataloff (1992)
Figure S7.d: Chimpanzee head shown in dorsolateral view. The high position of the larynx allows the animal to breathe air and drink liquids simultaneously.

Air from the nasal cavity (blue) passes behind the epiglottis into the larynx while liquid from the mouth (red) runs around the larynx into the esophagus.

Human babies, but not adults, have the same capability due to a short supralaryngeal space.

*After Ciochon and Fleagle (1993), p. 58*
Figure 7.2: Supralaryngeal space (SLS) in humans and chimpanzees.

In humans, the low position of the larynx does not allow the epiglottis to lock behind the soft palate.

Their large SLS exacerbates the problems of crossing pathways for air and food, and the hazard of choking. However, the long SLS facilitates spoken language.
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Increasing brain size from *Australopithecus afarensis* (left) to *Homo erectus* (center) to modern *Homo sapiens*.

*Photo by Kevin O’Farrell, CONCEPTS.*
Encephalization is characteristic of hominin evolution. Note dramatic increase of brain size in humans and their ancestors but not in apes.

From Lewin (1993a) p. 171
Figure 7.f: The human cerebral cortex, if flattened, would cover four letter-sized pages of paper. A chimpanzee’s cortex would cover one page, a monkey’s would cover a postcard, and a rat’s would cover a postage stamp.

*From Calvin* (Scient. Amer. Oct. 1994, p. 102)
Figure 7.3: Map of the human cerebral cortex, shown in left lateral aspect. Frontal, parietal, occipital, and temporal lobes are demarcated, in part, by two grooves, the central sulcus and lateral sulcus.

Areas involved in language and facial movements are marked red. They include Broca’s area (in frontal lobe) and Wernicke’s area (in temporal lobe).
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Figure 7.3: Map of the human cerebral cortex, shown in left lateral aspect. Frontal, parietal, occipital, and temporal lobes are demarcated, in part, by two grooves, the central sulcus and lateral sulcus.

Areas involved in language and facial movements (marked red) are lateralized to the left in most people. They include Broca’s area (in frontal lobe) and Wernicke’s area (in temporal lobe).
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Proximate and Ultimate Causes

**Ultimate Cause**
- e.g. territoriality

**More Fertile Offspring**

**Heritable Trait**
- e.g. birdsong

**Proximate Cause**
- e.g. hormone

**Proximate and Ultimate Causes**
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Figure 7.4: Baby chimp (a) and adult chimp (b, not to scale). In the adult chimp, face and body have grown much more than the braincase.

Figure 7.5: Brain weight plotted versus body weight. Straight inclines represent periods of proportional growth. This period lasts the longest for the human.

From Gould (1977)
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Figure 7.6: Human Characteristics Are Mutually Reinforcing

- Bipedalism
- Precision grip, Tool making
- Encephalization
- Language, Art
- Communal Cooperation
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