Neurolinguistics: An Introduction

Language and the brain

Brain and the language

by Kenan Çetin

Animals and Human Language

Section 1

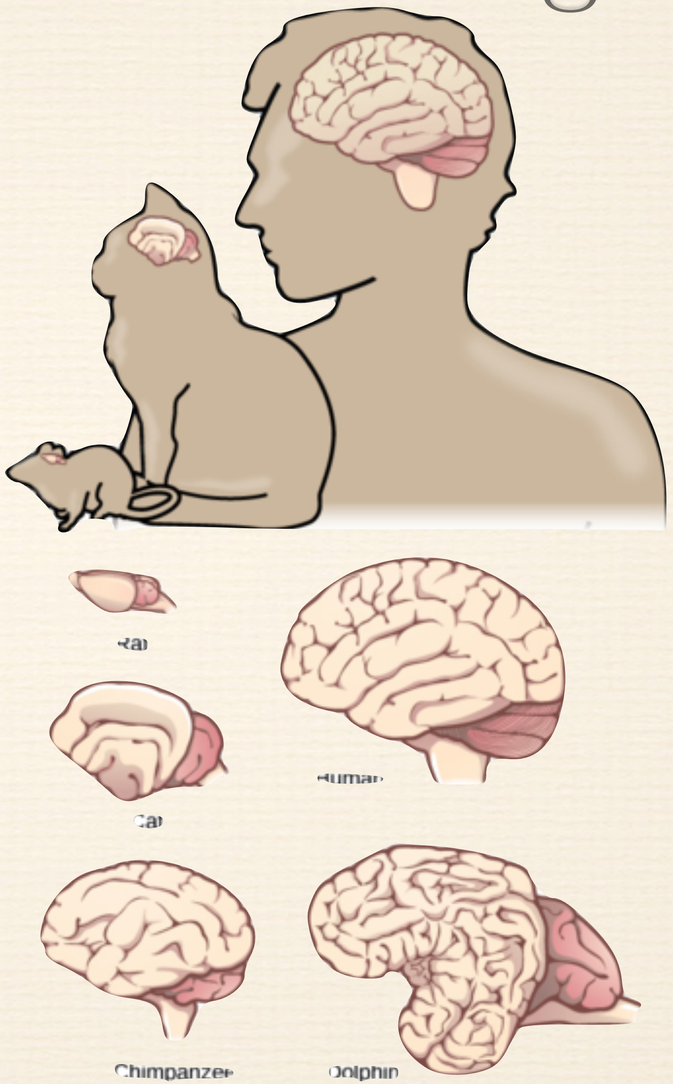
Language

Is it for only humans?

Can an ape ever learn to use language the way humans do?

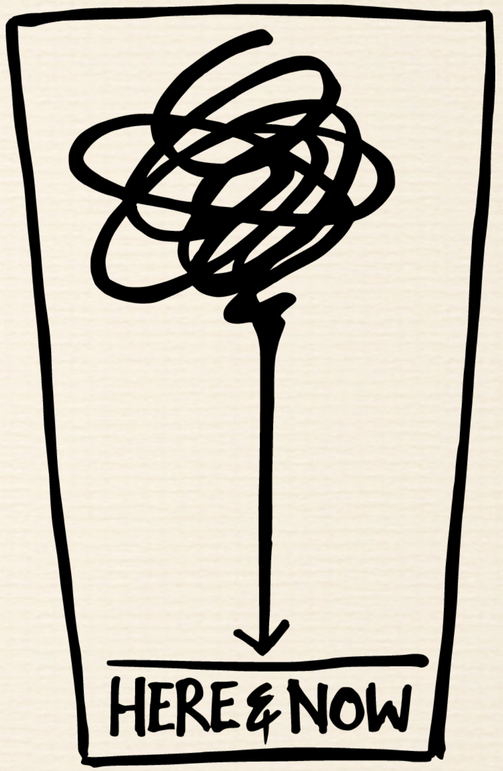
Properties of Human Language

- Displacement
- Arbitrariness
- Productivity
- Cultural Transmission
- Duality



Displacement

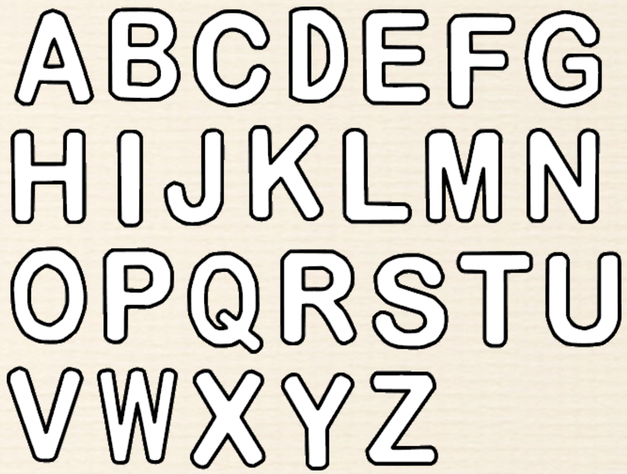
- Humans can refer to past and future
- Hypothetical talk and abstract concepts
  (fairies, after life, super heroes, fiction etc.)
- Exception of bees:
  Bees can communicate with each other to describe the location of nectars



Arbitrariness

- There is generally no connection between linguistic form and meaning
  e.g. the word dog does not look like a dog

- Animals have specific vocal or gestural forms for specific situations
  e.g. mating sounds



Productivity

- Humans can create new expressions and novel utterances by manipulating linguistic resources
- Animals can only use fixed signals such as barking, buzzing

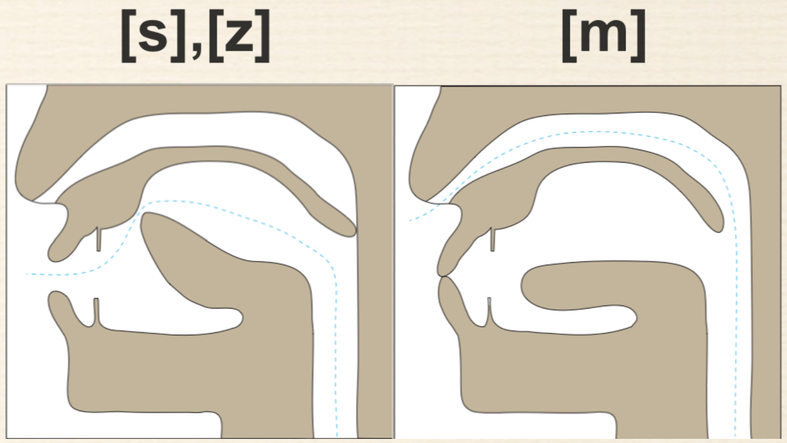
Cultural Transmission

- Passing the language from generations to generations
- Humans acquire a language in a culture with other speakers and not from parental genes whereas an animals will produce the same sound

Duality

- Two levels:
  distinct sounds: individual sounds; *n, b, and i*
  distinct meanings: particular combinations; *bin*

- Humans produce large number of sound combinations with a limited set of discrete sounds



GUA

Luella & Winthrop Kellogg

Comparative Psychologists

Indiana University

1931 & 9 months

VIKI

Keith & Catherine Hayes

Primate Biologists

Yerkes Laboratores of Primate Biology, Florida

1951 & 9 months

THE INTELLECTUAL DEVELOPMENT OF A HOME-RAISED CHIMPANZEE[1]

KEITH J. HAYES AND CATHERINE HAYES

Yerkes Laboratories of Primate Biology, Orange Park, Florida

(*Read October 27, 1950*)

THE anthropoid apes are of special interest to psychology because of their nearness to man on the phylogenetic scale. The degree of their similarity to man psychologically is rather uncertain, however, largely because the great majority of studies have utilized animals with very restricted backgrounds of experience. There is an ever-increasing body of evidence (e.g.: 1, 5, 6:296–299, 11) which indicates that the intellectual capacity of any animal—human or otherwise—depends not only on its hereditary endowment, but also, and to a considerable extent, on its psychological history. In view of such evidence, it seems unreasonable to suppose that an ape who has spent his whole life in a small, bare, laboratory cage could perform at his maximum potential level on intellectual tasks.

In the present investigation, we are attempting to make a more satisfactory estimate of anthropoid intelligence by studying a young chimpanzee whose background of experience is very much like that of a human child. This type of project was suggested by Witmer (14) forty-one years *acquired*, more as the result of a gradual accumulation of knowledge from his continued experience in a physical and social environment? This problem has been studied within the human species, but such studies are burdened with a number of difficulties: both variables tend to be restricted in range, and they tend to be correlated. In the present study, we hope to get more clear-cut results by dealing with a greater range of the variables, and by keeping them unrelated. A chimpanzee raised as a child in a human home can be compared with normal human children, thus providing a large difference in heredity with constant environment. On the other hand, this same chimpanzee can be compared with its relatives who are raised in laboratory cages—constant heredity here being combined with a greater difference in environment that can be found within the human population.

Our subject, Viki, was adopted a few days after birth, and has now spent the first three years of her life in our home. She has been treated as nearly as possible like a human child, with a few

FIG. 3. We help her to say "mama," at fourteen months.

is superficially similar to babbling. It differs in that the sounds are produced entirely by mouth vibrations, without use of the larynx. Some of these sounds are roughly similar to certain human consonants, and since Viki readily imitates our production of them, we attempted to teach her to use them in words. By the time she was two-and-one-half years old she had learned to pronounce satisfactory approximations of the whispered words "papa" and "cup." We did not manipulate her mouth in teaching these words, but simply insisted that she copy our example of a certain combination of play sounds.

She did not use her three words meaningfully at first; but when we required her to employ them appropriately, she soon learned to address the proper experimenter as "mama" or "papa," and to say "cup" when she wanted something to drink. She sometimes confuses them, however—especially when we urge her to speak, or when she wants something very badly.

WASHOE

Beatrix & Alan Gardner

Pscyhobiologists

University of Nevada

1966

Washoe

- By 2007, Washoe knew 250 signs
- Washoe could produce combinations of signs such as “Give me sweet” and “ You me go out hurry”
- Her son, Loulis also learned sign language from Washoe

NIM CHIMPSKY

Herbert Terrace

Psychologist

Columbia University

1973

Nim Chimpsky

- Named after Noam Chomsky
- Nim was raised in a household
- Could use sign language
  "Stone smoke time now"
- Herbert Terrace concluded that Nim was only trained to imitate him to get rewards

KOKO

Francine Patterson

Pscyhologist

Stanford University

1972

Koko

- Koko new 1.000 signs and could understand spoken English
- It is claimed that he has an IQ between 70 to 95

KANZI

Sue Savage-Rumbaugh

Primatologist

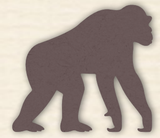
Georgia State University

1980-2003

Kanzi

https://www.youtube.com/watch?v=-CcVFjRPLLo&t

Why do you think humans have language and other animals do not?



Cognitive Tradeoff Hypothesis

Section 2

Cognitive Trade-off Hypothesis

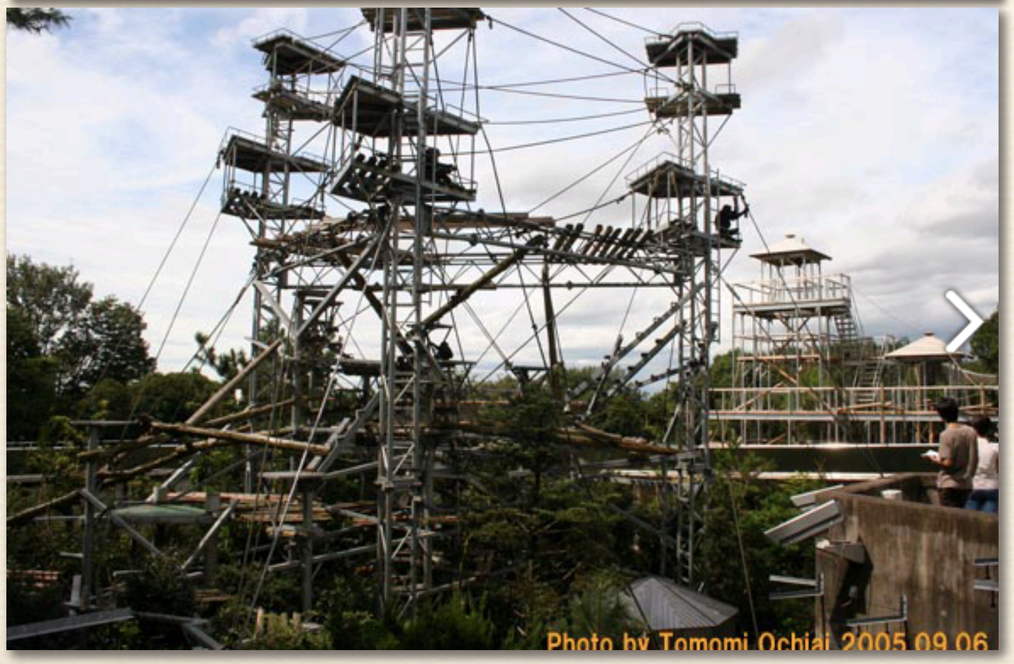
- Humans traded some aspects of cognitive development by re-purposing areas of the brain from short term memory to language development

Tetsuro Matsuzawa

Primatologist

Kyoto University

Primate Research Center



Cognitive Trade-off Hypothesis

https://www.youtube.com/watch?v=ktkjUjcZid0

Anim Cogn (2009) 12:405–407
DOI 10.1007/s10071-008-0206-8

SHORT COMMUNICATION

Memory for the order of briefly presented numerals in humans as a function of practice

Alan Silberberg · David Kearns

Received: 11 October 2008 / Revised: 29 October 2008 / Accepted: 14 December 2008 / Published online: 30 December 2008

ence in practice on their task: Ayumu had many sessions of practice on their task before terminal performances were measured; their human subjects had none. The present report shows that when two humans are given practice in the Inoue and Matsuzawa (2007) memory task, their accuracy levels match those of Ayumu.

Language Areas in the Brain

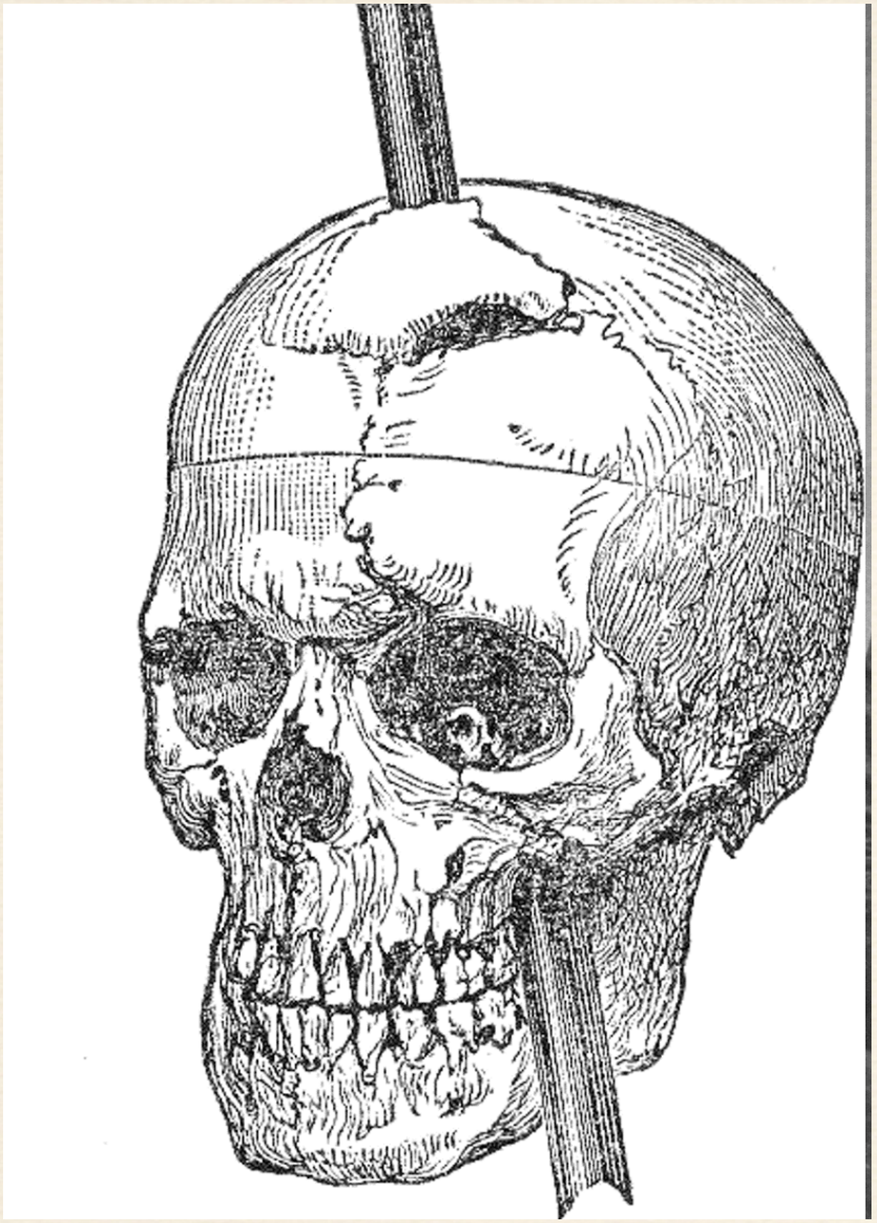
Section 3

How do you think the language is processed in a human's brain?
Is there a specific area for language?

Case of Phineas P. Gage

September, 1848

Cavendish, Vermont, USA

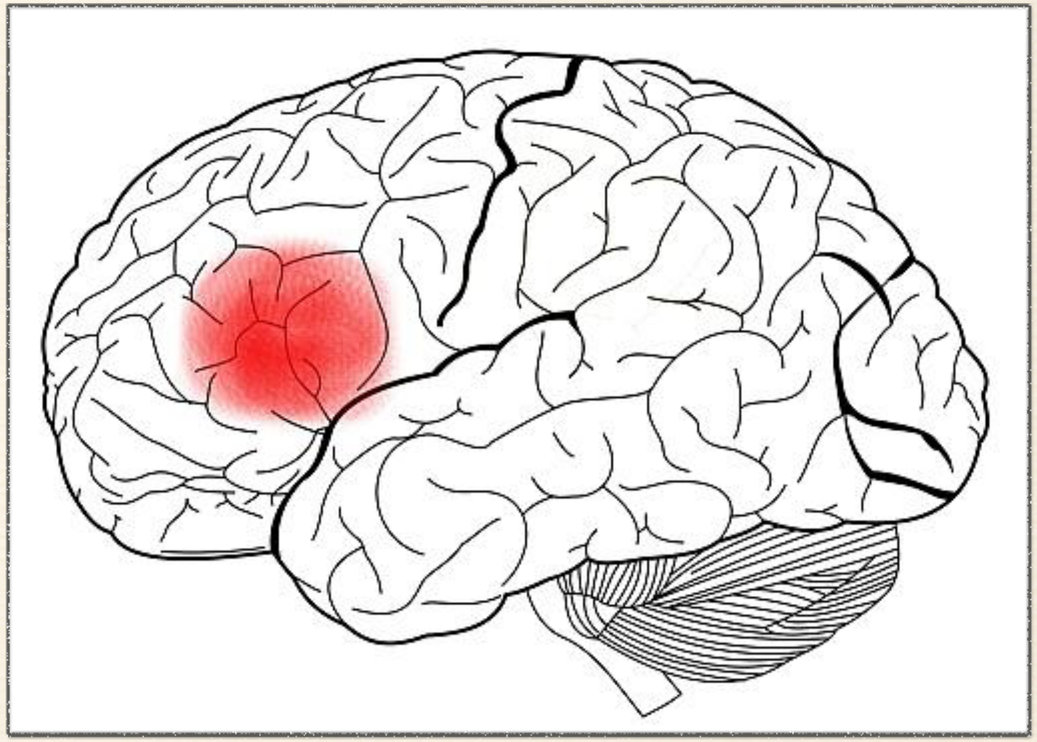


The four components

Broca's, Wernicke's, Motor Cortex & Arcuate Fasciculus

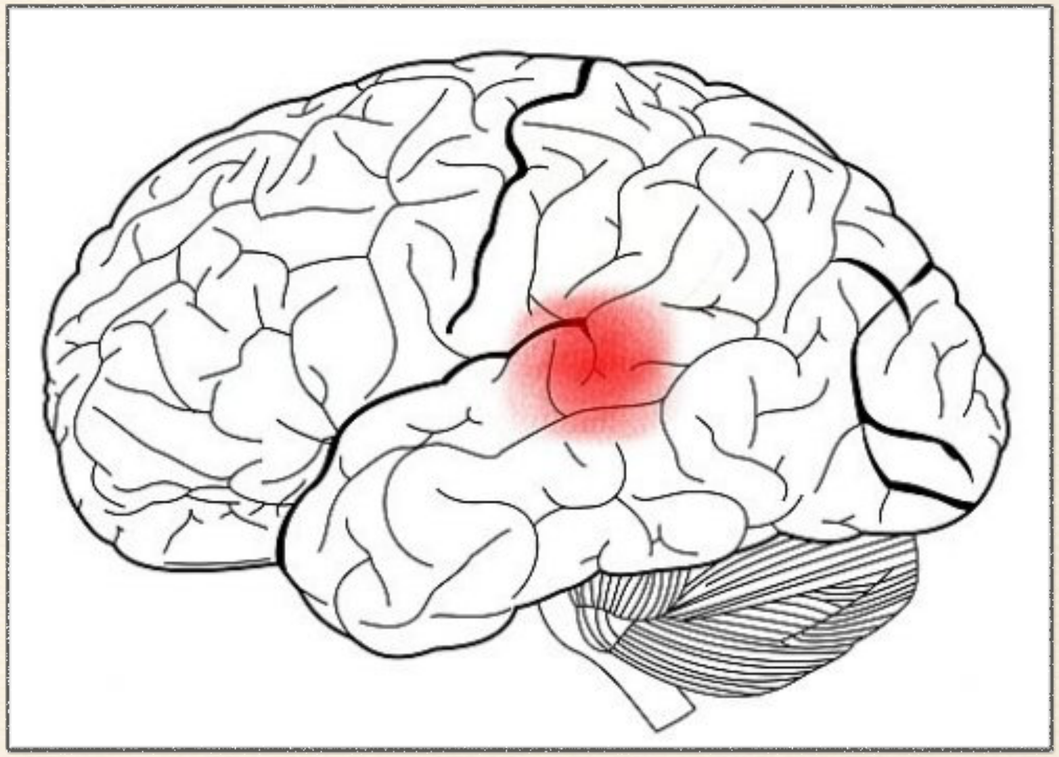
Broca's Area

- Named after Paul Broca, a French surgeon.
- Damage to this are results in difficulty in speech **production**.
- Located in the left hemisphere.



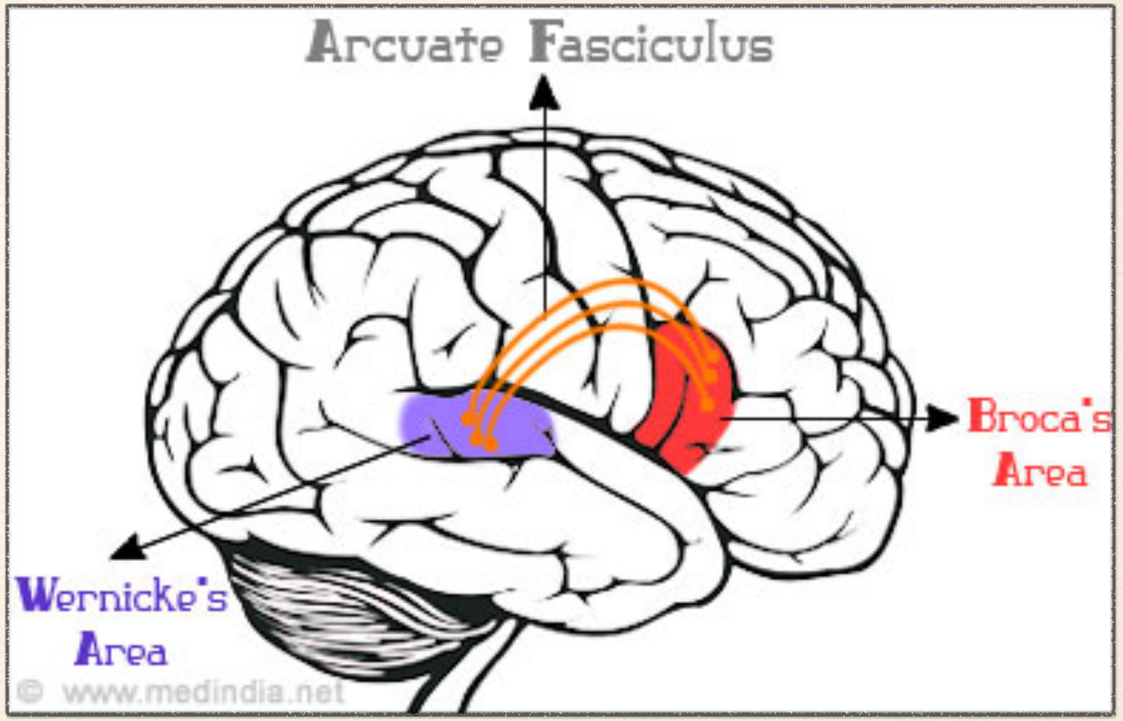
Wernicke's Area

- Named after Carl Wernicke, a German doctor.
- Damage to this are results in difficulty in **comprehension**.
- Located in the left hemisphere.



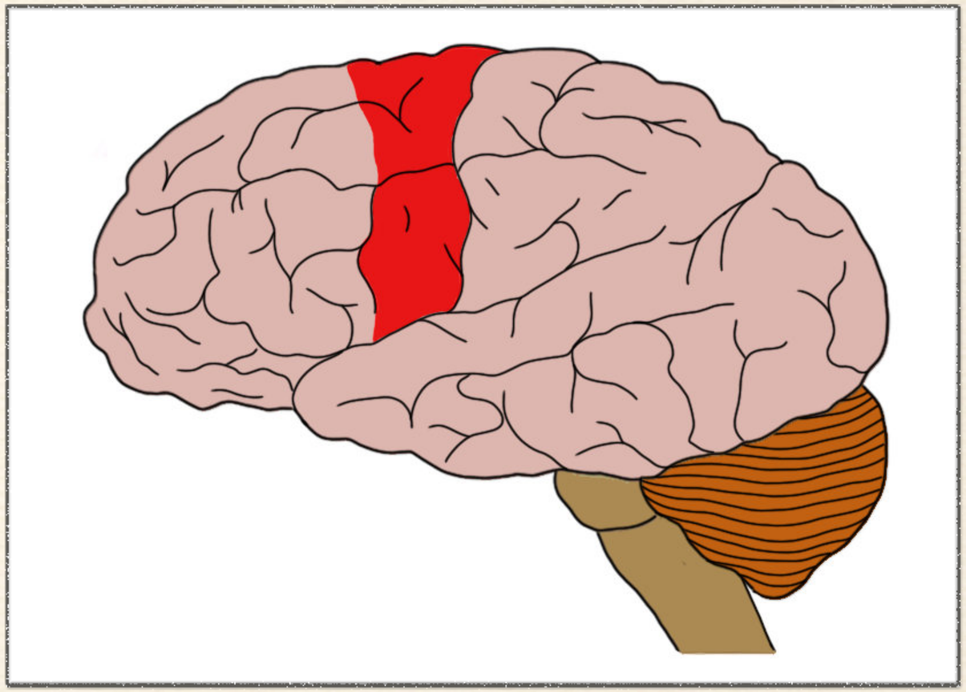
Arcuate Fasciculus

- Connects Broca's & Wernicke's areas
- Made of nerve fibers



Motor Cortex

- Generally controls the movement of the muscles
- The parts of motor cortex which are close to Broca's control the movement of jaw, tongue, and larynx



Localization View

The word is heard and comprehended via Wernicke's area.

This signal is then transferred via the arcuate fasciculus to Broca's area where preparations are made to produce it.

A signal is then sent to part of the motor cortex to physically articulate the word.

Aphasia

- “an impairment of language function due to localized brain damage that leads to difficulty in understanding and/or producing linguistic forms.”
- The most common cause is a stroke

Broca's Aphasia

- Reduced amount of speech, distorted articulation, slow and effortful speech. Impairment in fluency.
- Speech is usually made of lexical morphemes (nouns and verbs)
  I eggs and eat and drink coffee breakfast
- Speech usually has long pauses

https://www.youtube.com/watch?v=JWC-cVQmEmY&t

Wernicke's Aphasia

- Involves auditory comprehension and impairment in accuracy, not fluency.
  I can't talk all of the things I do, and part of the part I can go alright, but I can't tell from other people.

- Difficulty in finding the correct word

https://www.youtube.com/watch?v=3oef68YabD0

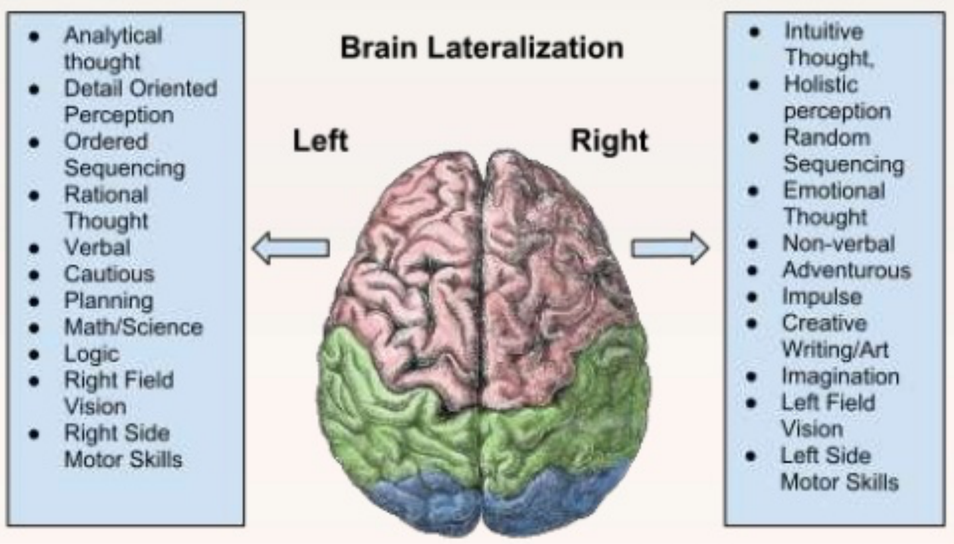
The Critical Period Hypothesis

Section 4

What is the difference between the language learning/acquisition process of a 5-year-old and a 45-year-old?

Lateralization & TCP

- Apraxia: “difficulty in performing movements with either side of the body when asked to do so, but not when performing them spontaneously”
- Apraxia is almost always associated with left-hemisphere damage



- Left hemisphere: dominant
  Right hemisphere: minor
- Lateralization starts in early childhood, concedes with the time a child acquires a language

Neuroplasticity

- Our brains are the most”plastic” when we are young, it also continues in adults

- The brain is most ready to receive input and learn a particular language. This is sometimes called the “sensitive period” for language acquisition, but is more generally known as the **critical period**.

“Backwards Brain Bicycle”

https://www.youtube.com/watch?v=MFzDaBzBlL0