Language in the Brain

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Examples: Frontal association cortex

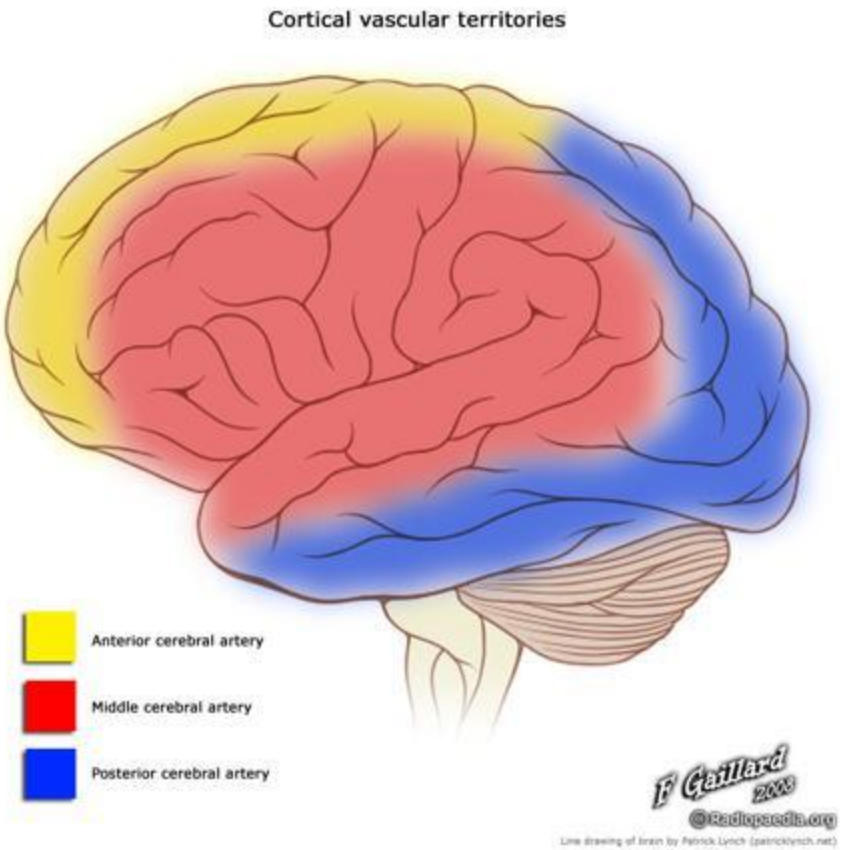
- Damage to the frontal lobe AND LIMBIC LOBE is often interpreted as a problem with the patient's "character"
- Diverse functions found in different areas of the frontal lobe, including planning, decision-making, abstract though, representation of self, and so on
- Phineas Gage is the classic example

Diseases of the cerebral cortex

- Vascular
- Tumor
- Developmental
- Degeneration
- Mental Illness

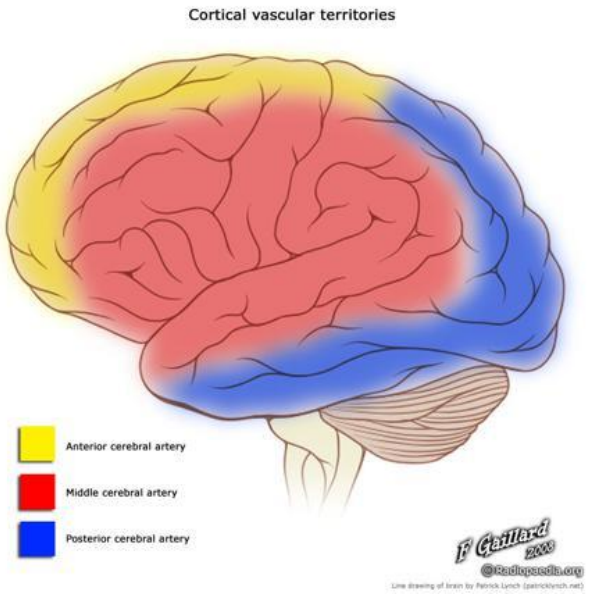
Vascular

- Three major sources of blood supply to the cerebral cortex:
  - Anterior cerebral artery (ACA)
  - Middle cerebral artery (MCA)
  - Posterior cerebral artery (PCA)



Vascular

- Branches of the ACA, MCA, and PCA supply blood to different parts of the cerebral cortex
- Occlusions of some of these branches in ischemic strokes cause specific deficits in cortical functions that are normally carried out by the affected cortical regions



Vascular

- Ischemic stroke is the result of obstruction—most strokes are ischemic. Treatable with TPA (tissue plasminogen activator) within 3 hours
  - Thrombosis (clot)
  - Atherosclerosis (hardening of the arteries)

- Hemorrhagic stroke is the result of a blood vessel rupture. TPA will cause further bleeding.
  - Aneurysm (thin vessel wall)
  - Arteriovenous malformation (artery to vein shunt)

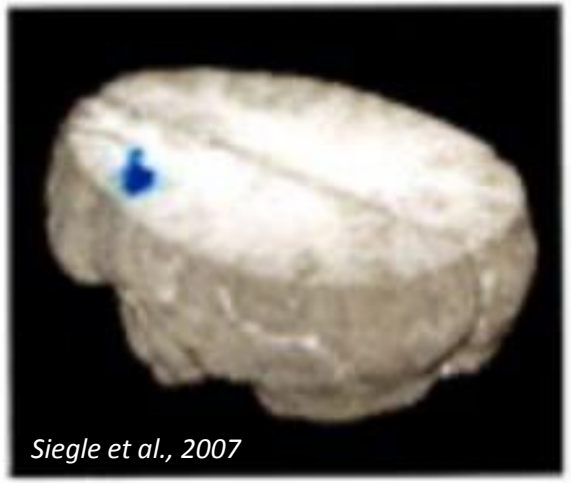
Developmental

- Up to 40% of children with drug-resistant epilepsy (chronic condition of recurrent seizures) have a cortical malformation.
- In many of these cases, seizures are caused by imbalance of excitation and inhibition (excitation > inhibition)
- Such imbalance can be due to deficient migration of excitatory neurons that then clump within the cortex, or reduced production of inhibitory interneurons during development

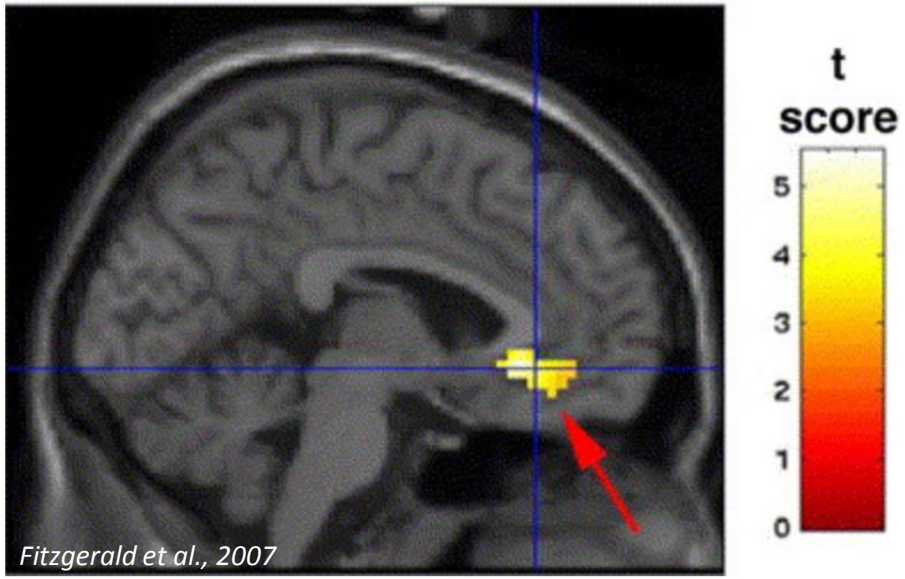
Mental Illness

- All mental illnesses seem to involve abnormalities in the cerebral cortex
- For example, depression is associated with reduced activation of the dorsolateral prefrontal cortex
- Obsessive-compulsive disorder is associated with overactivation of the anterior cingulate cortex
- These cortical abnormalities interact with subcortical deficits in unique ways across mental illnesses.

Mental Illness



Siegle et al., 2007



Fitzgerald et al., 2007

Diseases of the cerebral cortex

- Vascular
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Language in the brain

- Aphasias and their associated brain regions
- Lateralization of language
- Language learning
- Evolution of language

Language is….

- *1. Localized*
- *2. Lateralized*

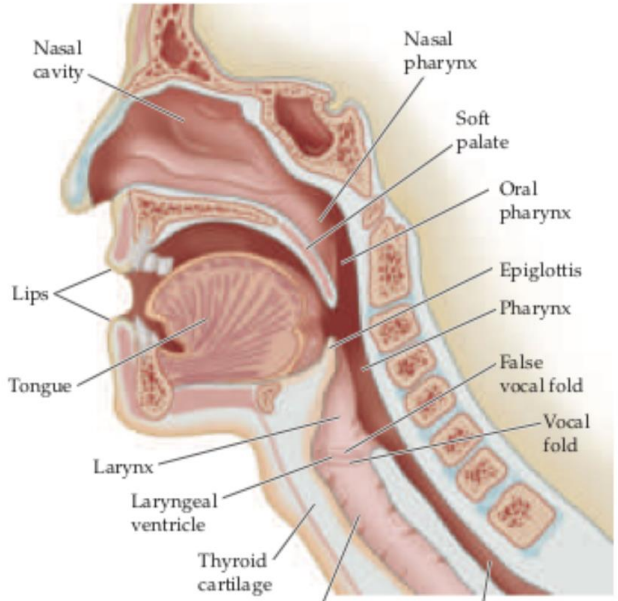
Our understanding of language is indebted to stroke patients

- Reminders: A stroke or loss of blood supply to the brain results in hypoxia
- A stroke results in death of brain tissue
- A stroke typically involves a smaller artery, and the region of the brain served by that artery is affected.
- Since different brain regions have different functions, the behavioral manifestation of the stroke depends on its location.

What is aphasia?

- Deficit in language comprehension or expression
- Caused mainly by stroke
- Distinct from dysarthria, which is a deficit in muscular control necessary to produce speech
- These different processes are sometimes referred

to as speech vs language



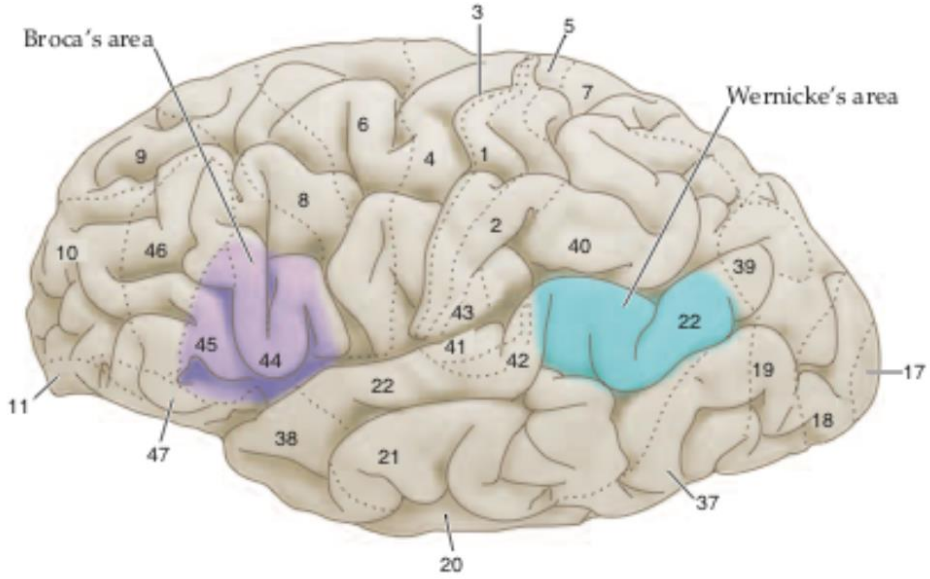
Neuroscience, Purves et al

Classifications of aphasia: Broca

- Loss of ability to produce meaningful language
- Still able to move the mouth and produce words
- Still able to comprehend language
- Associated with damage to the ventral posterior frontal lobe

- Video

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



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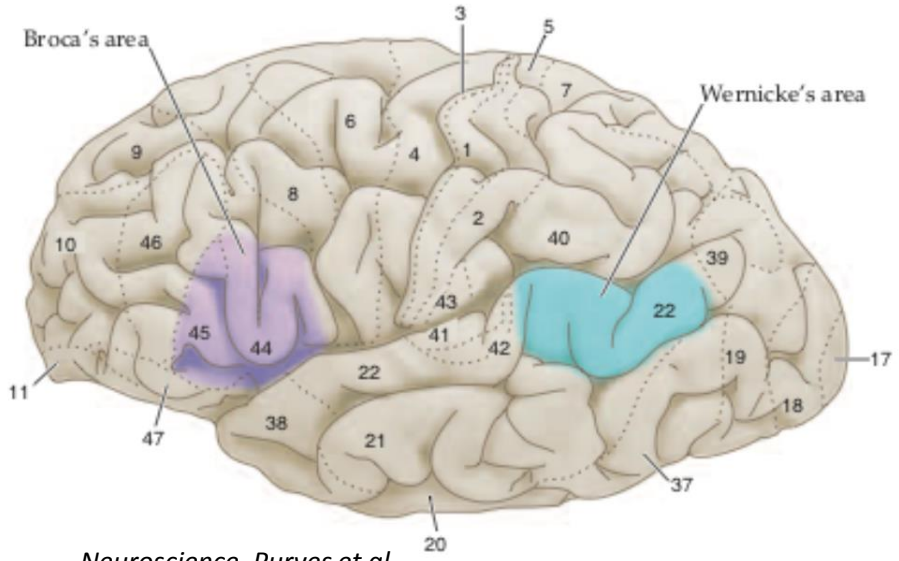
Classifications of aphasia: Wernicke

- Loss of ability to understand/comprehend language
- Still able to move the mouth and produce words
- Still able to produce technically grammatically correct sentences
- Associated with damage to the posterior and superior temporal lobe
- Video

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



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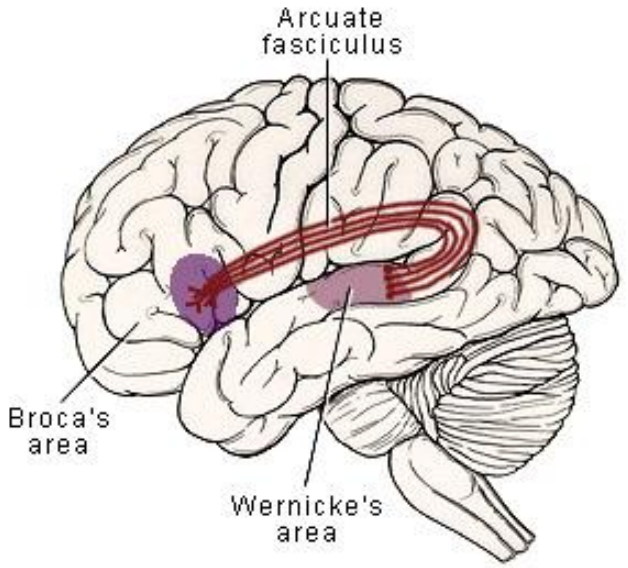
Classifications of aphasia: Conduction

- Unable to produce appropriate responses to communicative language
- Major impairment in ability to repeat words back
- Language is still comprehended
- Caused by damage to the white matter pathways connecting Broca's and Wernicke's areas, such as the arcua
- Video:

https://www.youtube.com/watch?v=G94TvTvjeeU



Language lateralization

- Language is typically lateralized to the left cerebral cortex
- Damage to the left side of the brain causes major language impairments. Damage to the right side of the brain does not.
- This includes ASL, even though receptive language is processed through visual, rather than auditory, pathways.

- The right hemisphere is not uninvolved in language: prosody and emotional components of language

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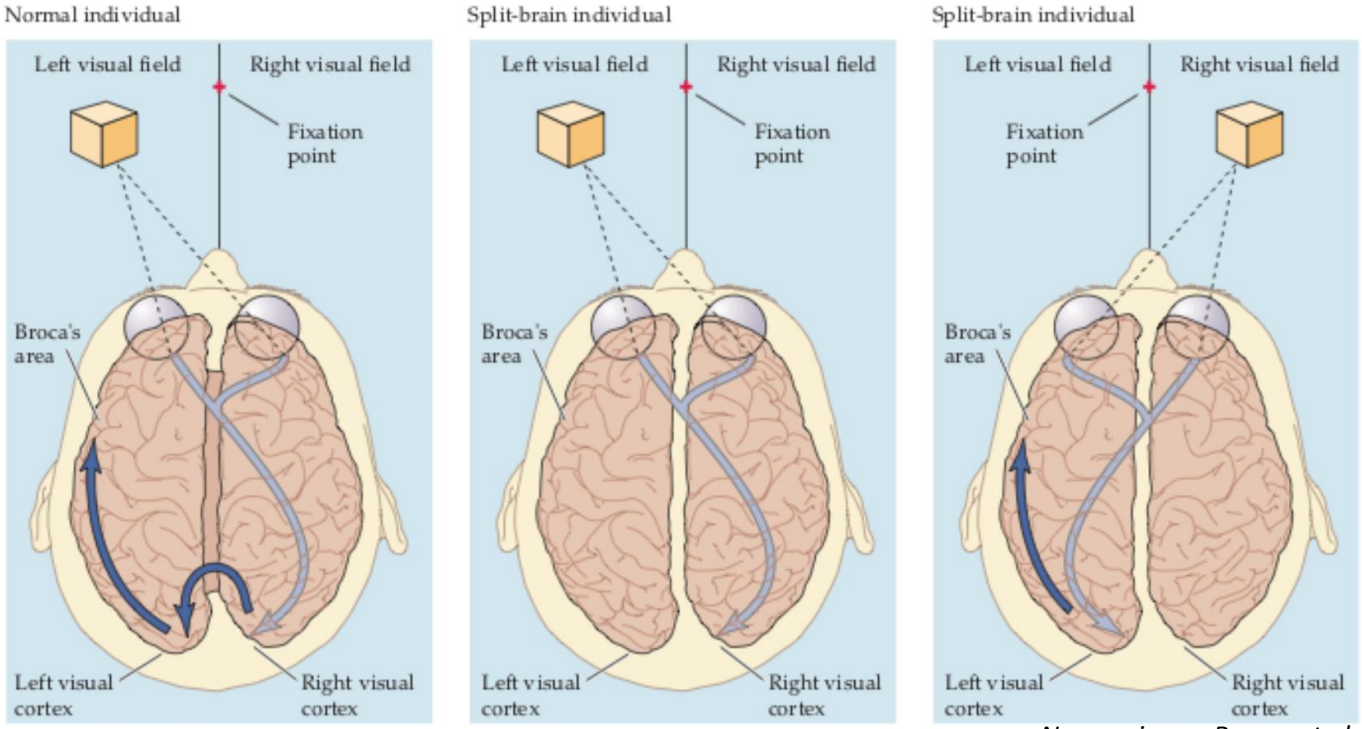
Language lateralization and split-brain patients

- With their left hemisphere, patients were able to name objects in right visual field.
- But with just the use of the right hemisphere, patients were unable to name objects in the left visual field!



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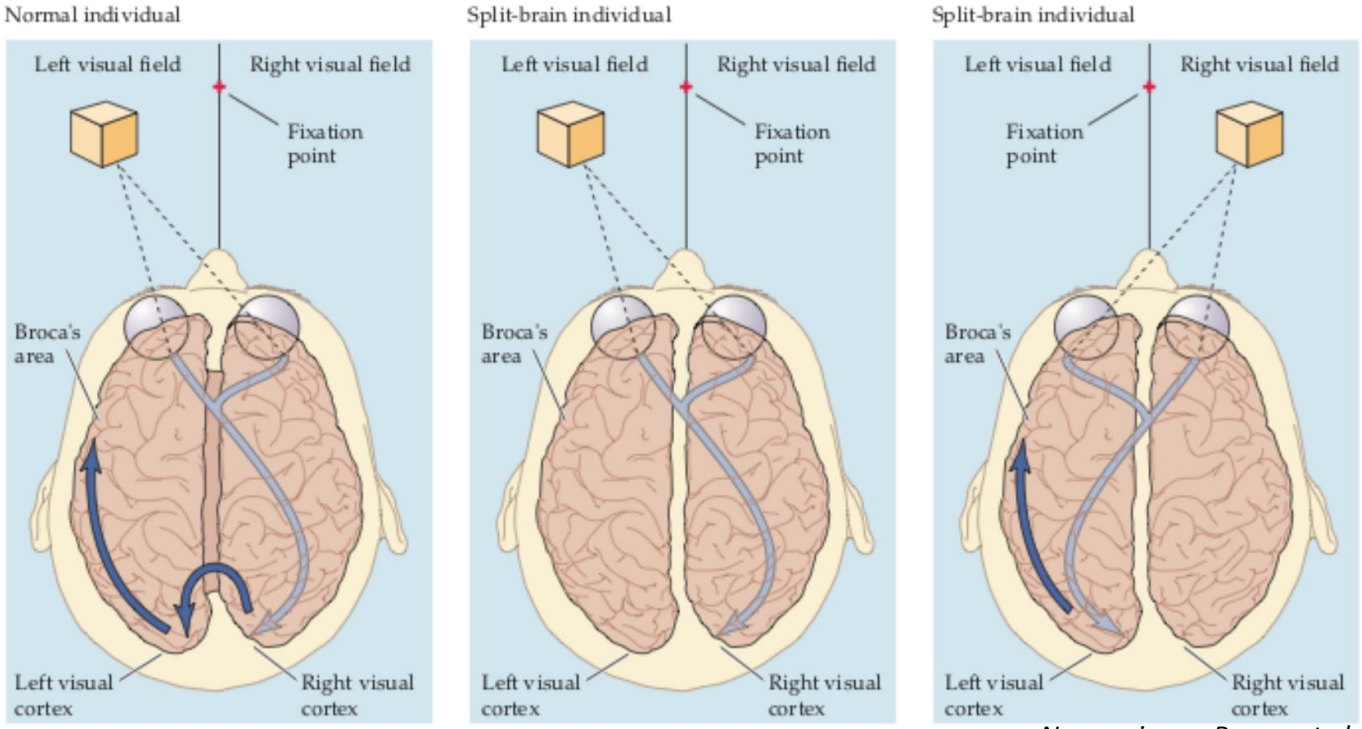
Language lateralization and split-brain patients

- A very small number of patients have had their corpus callosum severed because of intractable epilepsy
- For these patients, visual stimuli in the right occipital lobe cannot be transferred to the left language areas, and vice versa



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Language acquisition

- Hypothesis: Exposure to language, whether a first language or second (or third, fourth….) during the first few years of life (ranging from 0 to 5-12 years) is necessary to develop fluency: critical period
  - Similar to critical periods for visual acuity
- Evidence: Neglected and abused children without language exposure until post-puberty do not become fluent. Profoundly deaf individuals not exposed to sign language until post-puberty are not fluent even after decades of use (cutoffs around 5 years old and 12 years old). Ease of second+ language acquisition much easier at younger ages.

Language acquisition

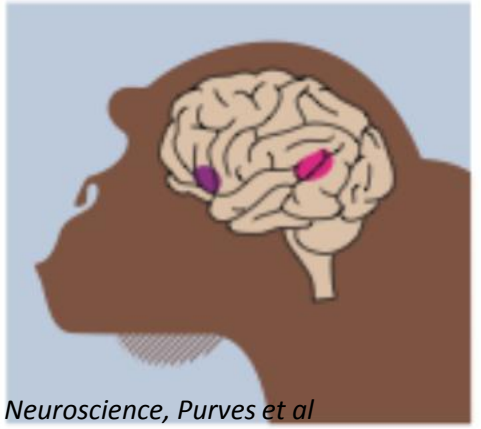
- Infants are sensitive to a wide range of phonemes (distinct sounds)
- Much of this sensitivity is lost as a particular language is learned.
- We are not born with a propensity to learn a particular language, but to language acquisition itself

The evolution of language

- A gene important for language: FOXP2
  - It is present in other species
  - Relevant for development across many organs
  - Always also relevant to vocalizations
- Discovered through the KE family, afflicted to different degrees by verbal dyspraxia
  - Autosomal dominant inheritance

The evolution of language

- What about nonhuman animals? Do they have language?
- Several experiments raising nonhuman animals, especially apes, in a human environment. Speech is an issue: they do not have the vocal apparatus that humans have.
- Washoe was taught ASL. Eventually learned 160 signs. (by comparison, a 4 year old has ~3000 words)



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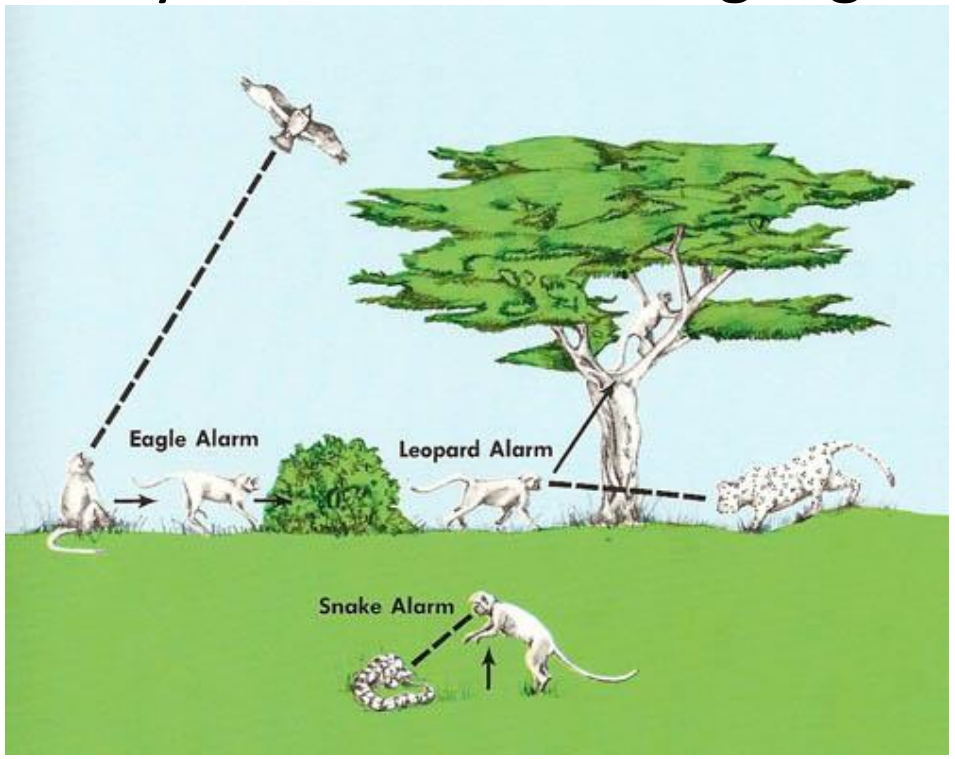
The evolution of language

- What about nonhuman animals? Do they have language?
- What about testing vocalizations nonhuman animals do use to figure out how similar they are to human language?



http://www.daviddarling.info/childrens_encyclopedia/Speak_Chimpanzee_Chapter2.html

The evolution of language

- What about nonhuman animals? Do they have language?

"If a lion could talk, we would not understand him."--Wittgenstein

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