
tolerance
friends
empathy
enjoyment
influence
awareness
empowerment
pleasure
Why learn a
language
scope
employability
opportunities
insight
understanding
pride
adaptability
advantages

# LANGUAGE

## DEFINITION

System of communicating with others using sounds, symbols, and words to express a meaning, idea, or thought.

Very complex skill

- On average, each student knows aroung 80000 words (**huge involvment of long-term memory and also working memory**)
- **Abstract rules** (phonemes-morphemes-sentence-proposition..)

# LANGUAGE

## SPEAKING ≠ READING and WRITING

READING AND WRITING
We need explicit instructions to learn


SPEAKING
No specific instruction is needed

**TABLE 13.1** Aitchison's Ten Criteria for Language

| Feature | Definition | Example |
| --- | --- | --- |
| 1. Vocal-auditory canal | Use of vocalization to communicate | Speech and birdsong but not American Sign Language (ASL) or bee dances |

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| 9. Structure-dependence | Use of grammar, or structured "chunks" | Understanding that the "man in the hat" means the same as "he" |
| 10. Creativity | Ability to create novel utterances | Humans and possibly signing apes can say things they have never heard before |

# LANGUAGE

Of course also animals communicate each other.
Communication *per se* is not Language, anyway, because it does not include all abstract concepts and rules of human language

**3 types of ANIMAL COMMUNICATION**

- Simple vocalizations for rudimentary info (Danger! Go away!)
- Body movements (e.g., to communicate size and distance, see Waggle/bee dance)
- Complex sequences of behaviour/vocalizations (es. song birds)

# THE EVOLUTION OF LANGUAGE


## Are Nonhuman Animals Capable of Real Language?

*Thanks to words, we have been able to rise above the brutes; and thanks to language we have often sunk to the level of demons.*

Aldous Huxley

If we accept the notion that human language occurs as a result of some innate, genetically determined language-learning mechanism, it is also logical to think that such a system might have evolved according to Darwinian concepts, and that creatures other than humans might possess some language capabilities.

Many animals communicate with one another, often in complex ways. Communication, however, is not the same as language (Dronkers, Pinker, & Damasio, 2000). Some animals have a fairly inflexible group of calls used for functions such as signaling danger and identifying territories. Others use signals that communicate magnitude, as in the case of bee dances that indicate the location of food. Finally, animals communicate through sequences of behavior, as in the case of birdsong. These animal behaviors, although clearly used for communication, do not match the flexibility and creativity of human language as described by Aitchison (1983; see Table 13.1).

If we are to find an animal precursor to human language capability, the most logical place to start is with our nearest relatives, the great apes. In three species of great ape, Brodmann's area 44 (part of Broca's area) showed asymmetry between the left and right hemispheres similar to that typically seen in humans (Cantalupo & Hopkins, 2001). Although this doesn't prove that apes have the necessary brain structures for language production, it does suggest that human brain development for language is not completely unique. Other researchers point to the existence of mirror neurons in nonhuman primates as a possible precursor for human language (see Chapter 8). Mirror neurons are activated both when an animal performs an action and when it observes another animal perform an action (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Mirror neurons might have provided a mechanism allowing early humans to first gain an understanding of gestures, followed by language. The presence of mirror neurons in Broca's area in both apes and humans suggests a basis for the evolution of language (Corballis, 2004).

Researchers have attempted to teach human-like languages to apes. In 1931, Winthrop N. Kellogg and his wife adopted a baby chimpanzee named Gua, but their attempts to teach him human speech were unsuccessful. Efforts to teach apes sign language have been more promising. Allen and Beatrice Gardner (1969) taught

# LANGUAGE

## The evolution of language

Fossils do not “speak”….

We can only get info about evolution of brain size, but no functional organization of hominiids’ brain

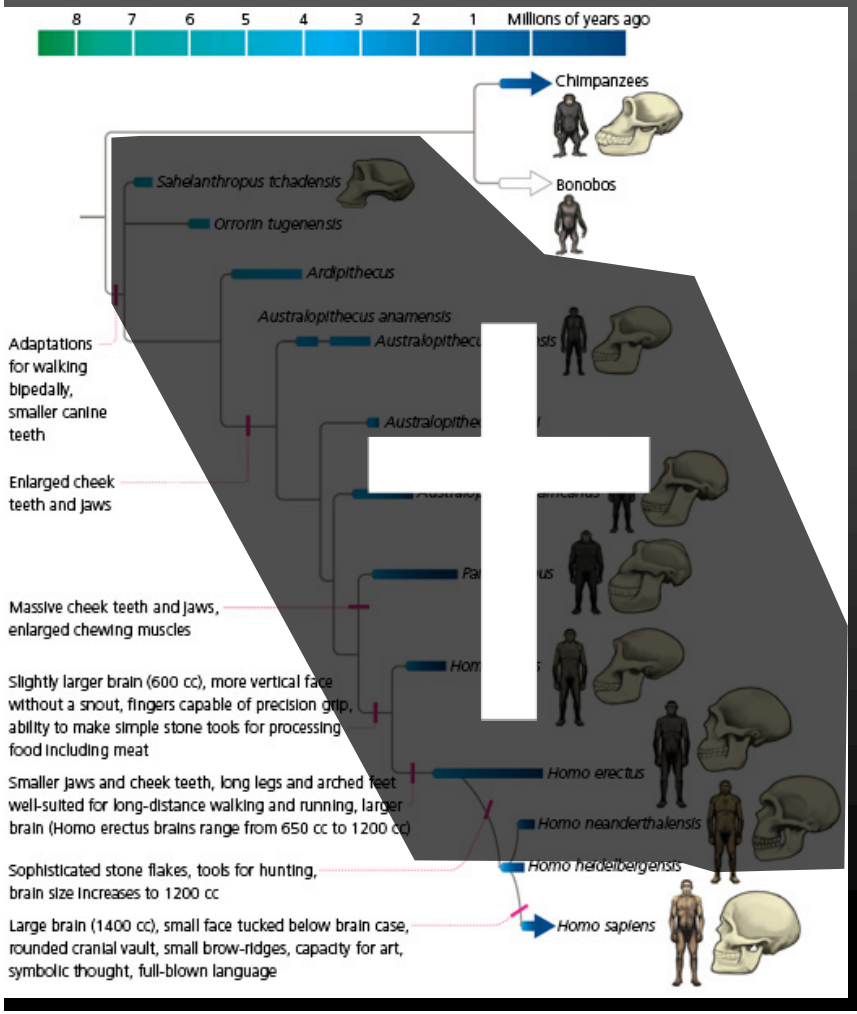
Some researchers believe that language emerged in *Homo abilis* (around 2 million years ago)

According to others, it would be more ancient..

# LANGUAGE

## The evolution of language

A way to test evolutionary origins of cognitive skills consists in comparing living organisms..




- If language evolved in “Homo” genus only, our closest relatives should NOT have any linguistic skill.
- If language evolved among primates (and then it became more specialized in hominiids), we should find rudiments of language also in apes.

# LANGUAGE

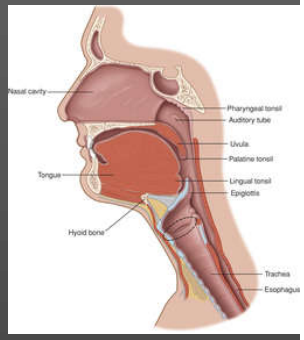
## The evolution of language

There are at least 2 main problems when we talk about the possibility to have language

### CENTRAL ISSUE

Do you have cognitve (abstract) skills to support language ?!?!

### PERIPHERAL ISSUE




Do you have peripheral anatomical structures to permit a wide range of vocalizations ?

# LANGUAGE

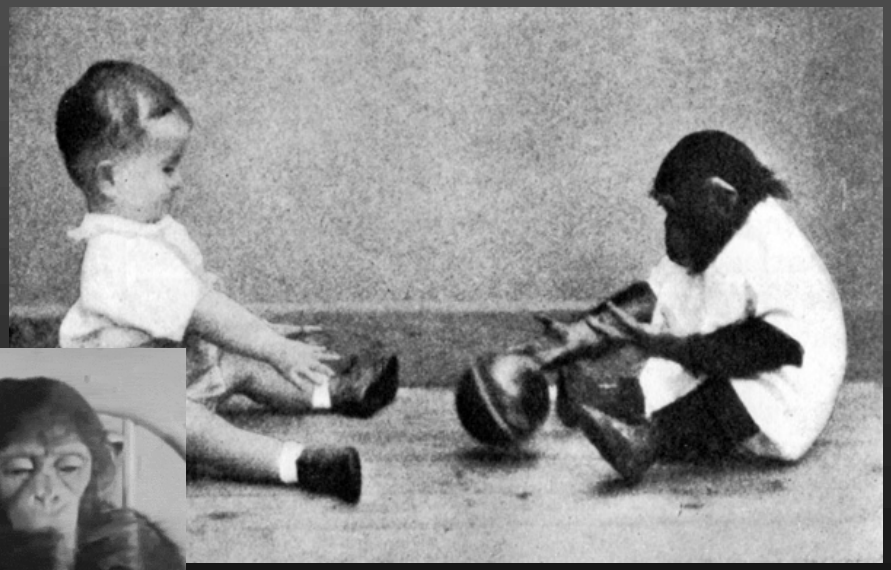
## First attempts

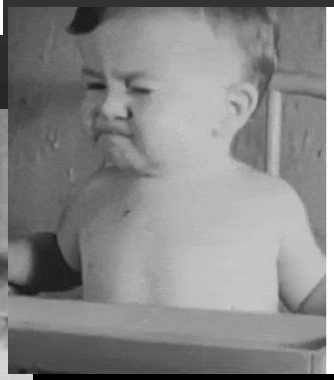
## Chimpanzees and verbal language

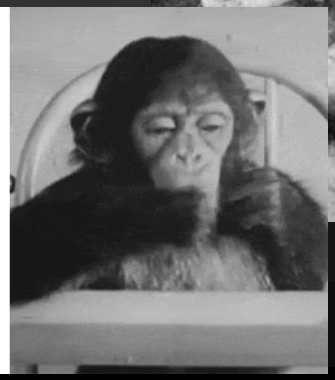
In 1931, Winthrop N. Kellogg and his wife adopted a baby chimpanzee named Gua. It was raised together with their son. In this way, Gua could have tried to learn language in a very 'natural' way.

Gua learned to understand different words (he could reply to verbal command by pointing).

However, their attempts to teach her human speech were unsuccessful (NO PRODUCTION)







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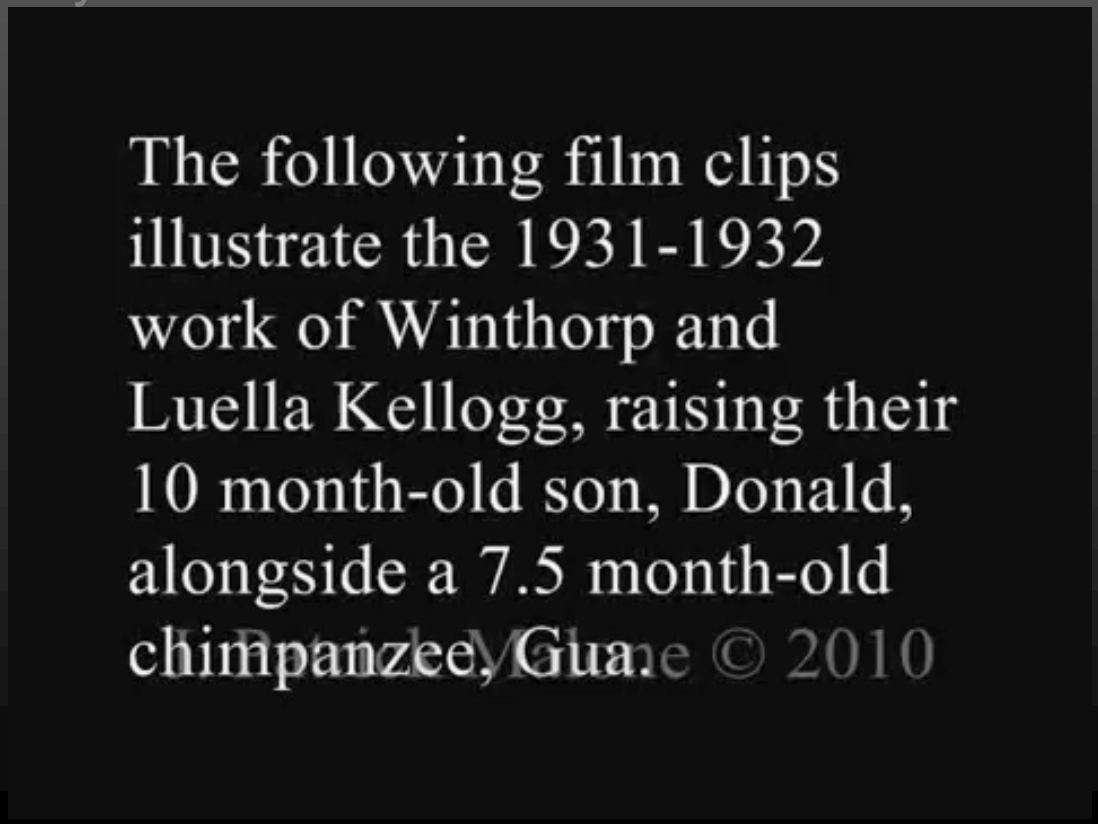

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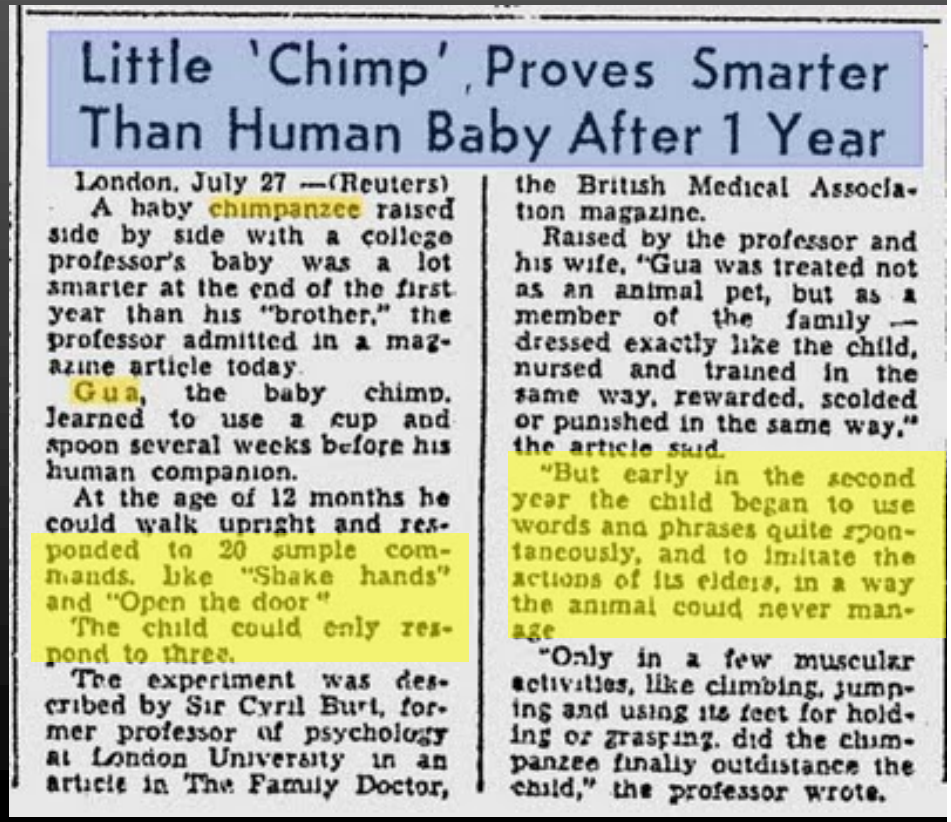


**Little 'Chimp' Proves Smarter Than Human Baby After 1 Year**

London, July 27 —(Reuters)— A baby chimpanzee raised side by side with a college professor's baby was a lot smarter at the end of the first year than his "brother," the professor admitted in a magazine article today.

Gua, the baby chimp, learned to use a cup and spoon several weeks before his human companion.

At the age of 12 months he could walk upright and responded to 20 simple commands, like "Shake hands" and "Open the door."

The child could only respond to three.

The experiment was described by Sir Cyril Burt, former professor of psychology at London University in an article in The Family Doctor, the British Medical Association magazine.

Raised by the professor and his wife, "Gua was treated not as an animal pet, but as a member of the family — dressed exactly like the child, nursed and trained in the same way, rewarded, scolded or punished in the same way," the article said.

"But early in the second year the child began to use words and phrases quite spontaneously, and to imitate the actions of its elders, in a way the animal could never manage.

"Only in a few muscular activities, like climbing, jumping and using its feet for holding or grasping, did the chimpanzee finally outdistance the child," the professor wrote.

# LANGUAGE

## First attempts

## Chimpanzees and verbal language

Researchers try to replicate the experiment with another chimpanzee

After 6 years of education, he was able to produce only 4 words:

1. *Mum*
2. *Dad*
3. *Cup*
4. *On*

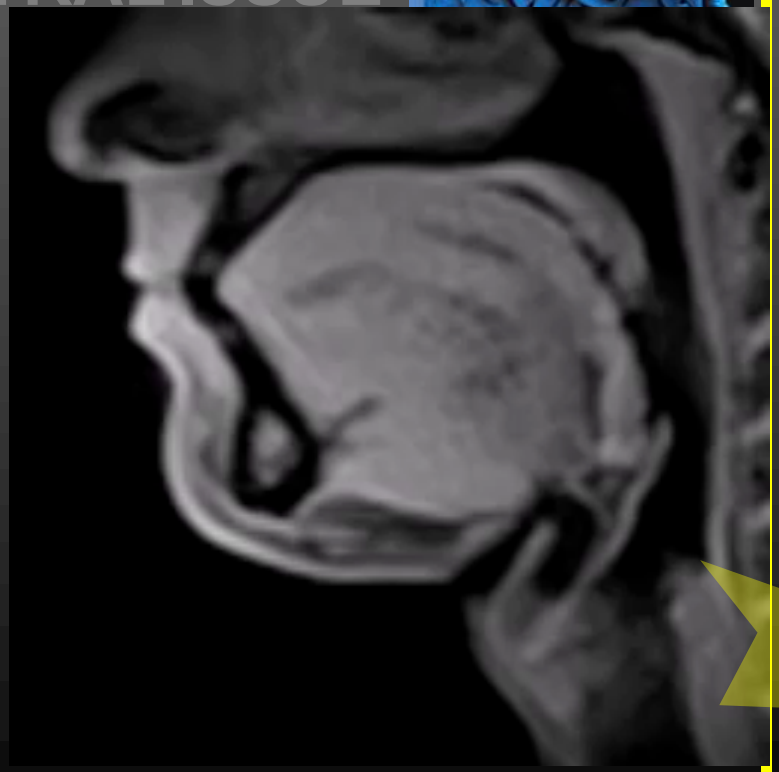
These words were pronounced with a very low pitch.

# LANGUAGE

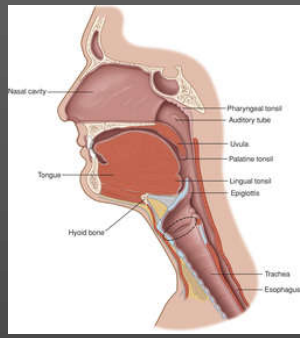
## The evolution of language

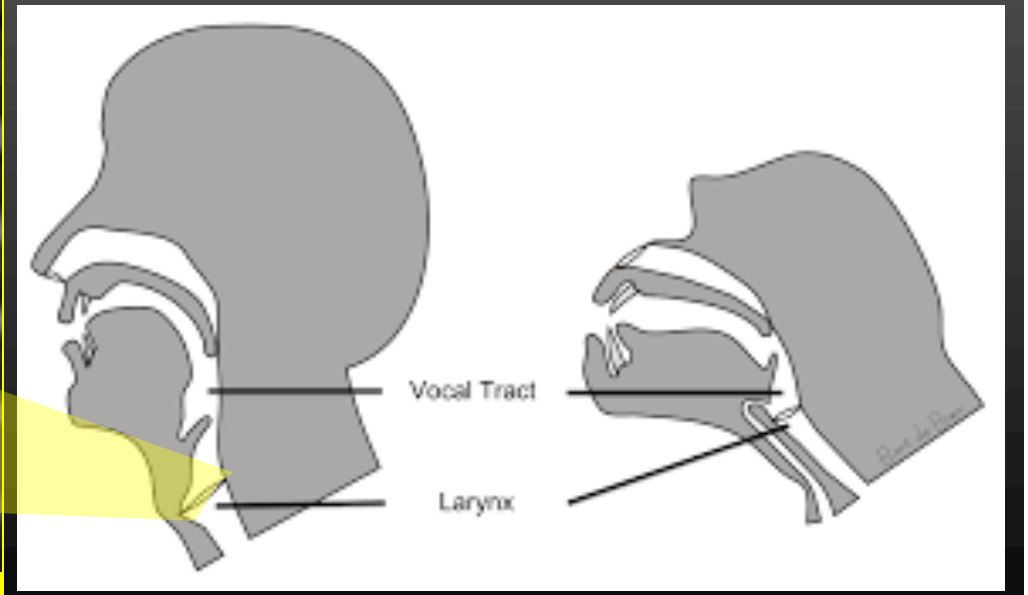
There are at least 2 main problems when we talk about the possibility to have language

**CENTRAL ISSUE**

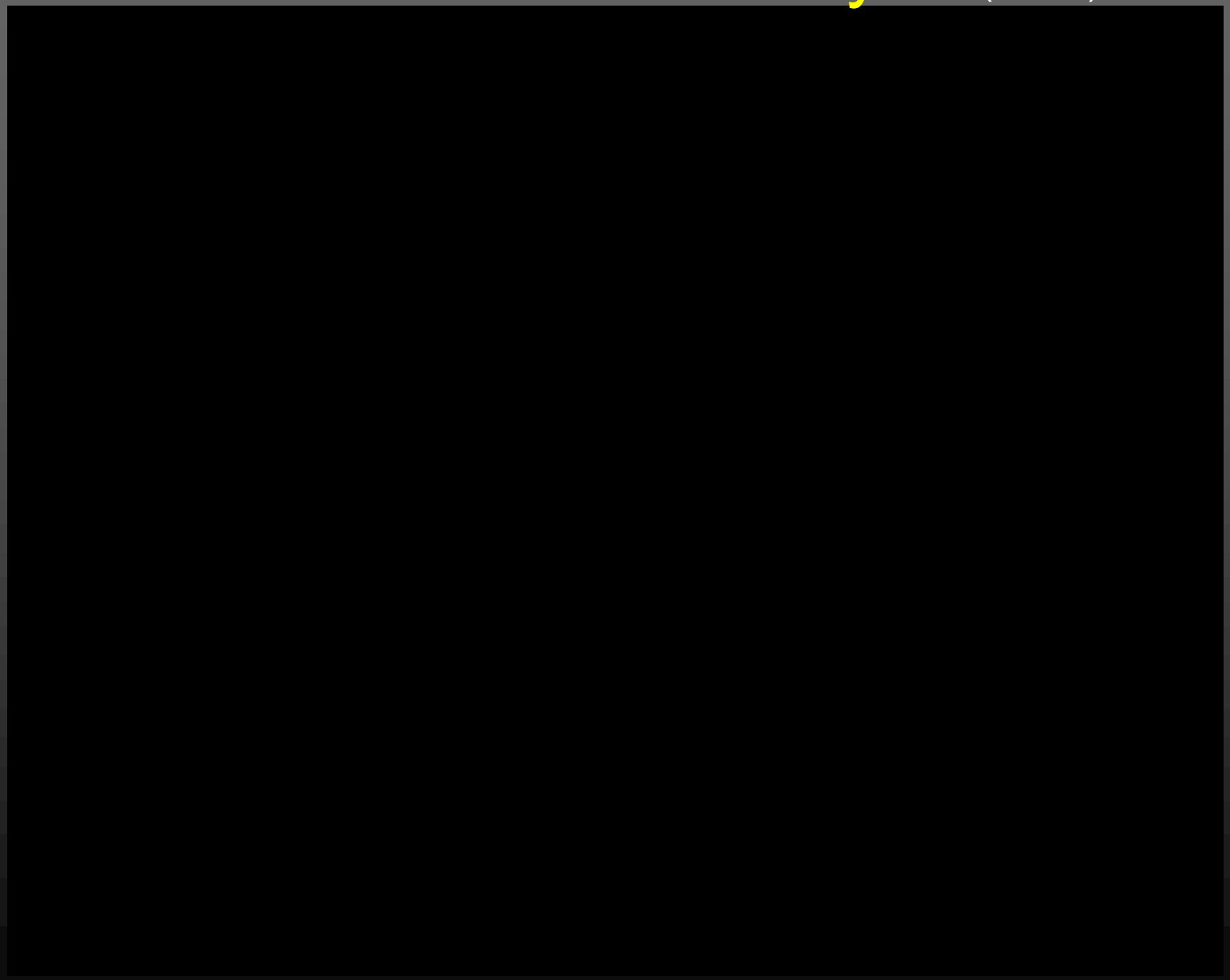


**PERIPHERAL ISSUE**





# The Descendant of larynx (1:25-)



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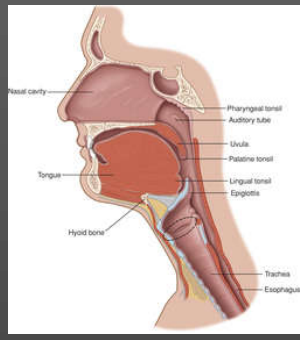



Do you have peripheral anatomical structures to permit a wide range of vocalizations ?

# LANGUAGE

## Chimpanzees and language

We need to find out alternative (non-vocal) languages..

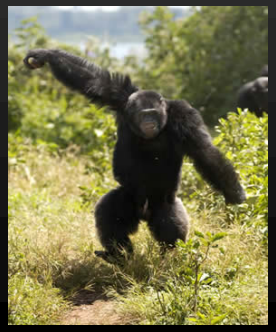
In nature (Kortlandt, 1968) they often communicate each other by gestures… the same action is sometimes represented differently in different groups of the forest.

1) Palm like this!


GO AWAY !

2) Movement arm from below to above;

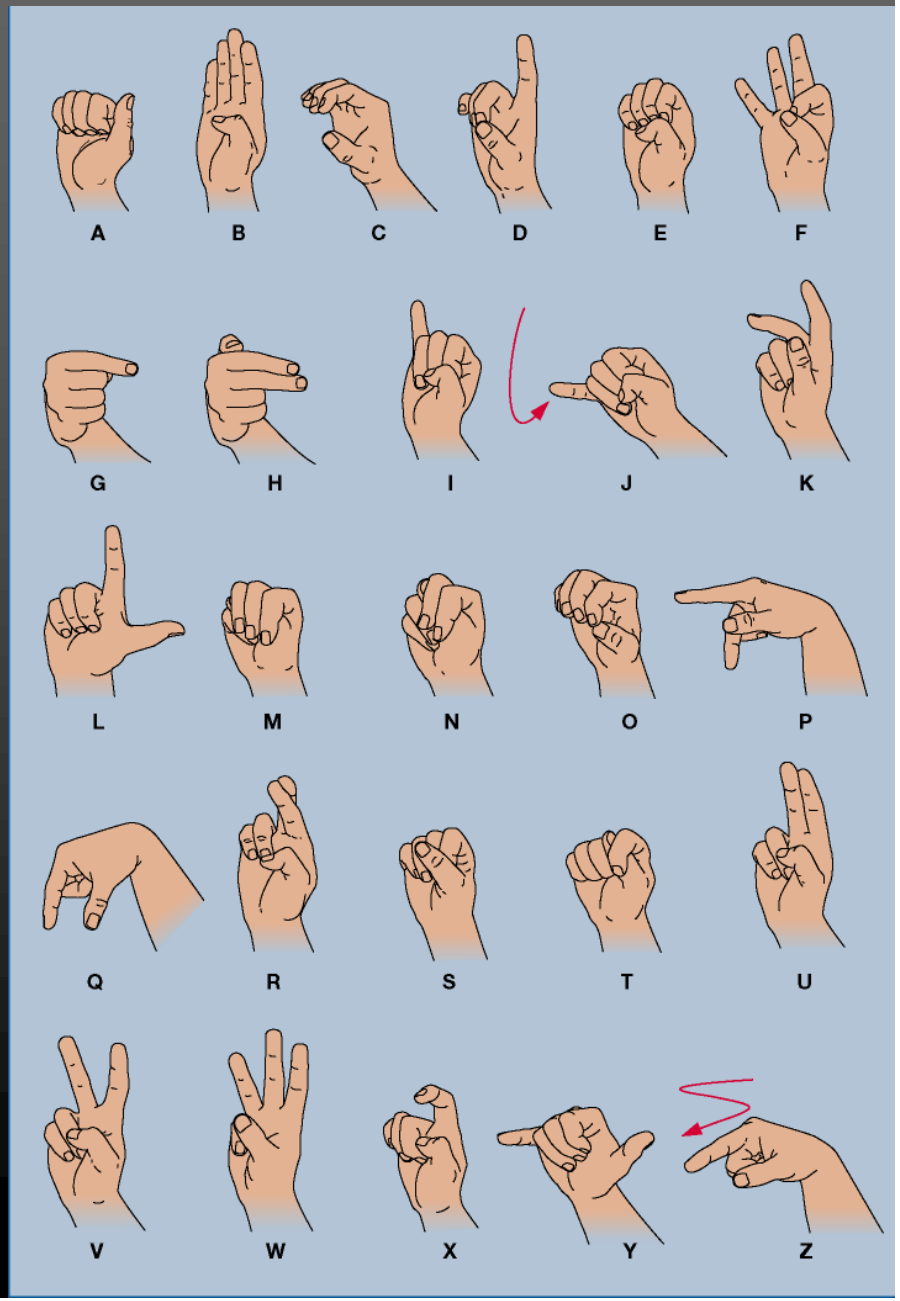
3) Keep one arm above your head



# LANGUAGE

## Chimpanzees and language

By using sign-language, Allan and Beatrix Gardner (1969) taught 132 signs to Washoe



# LANGUAGE

## Chimpanzees and language

This was a hard task..

As chimps tend to learn by imitation ("*to ape*"), they decided NOT to talk in the presence of Washoe; they could just use sign language.

In this way, Washoe could believe that this was the only way to communicate, without trying to use vocal sounds (as verbal language)

# LANGUAGE

## Chimpanzees and language

Washoe was able to:

1) Learn 132 signs

2) Use it in a 'creative' way

(criterion 10: creativity)

# LANGUAGE

## Chimpanzees and language

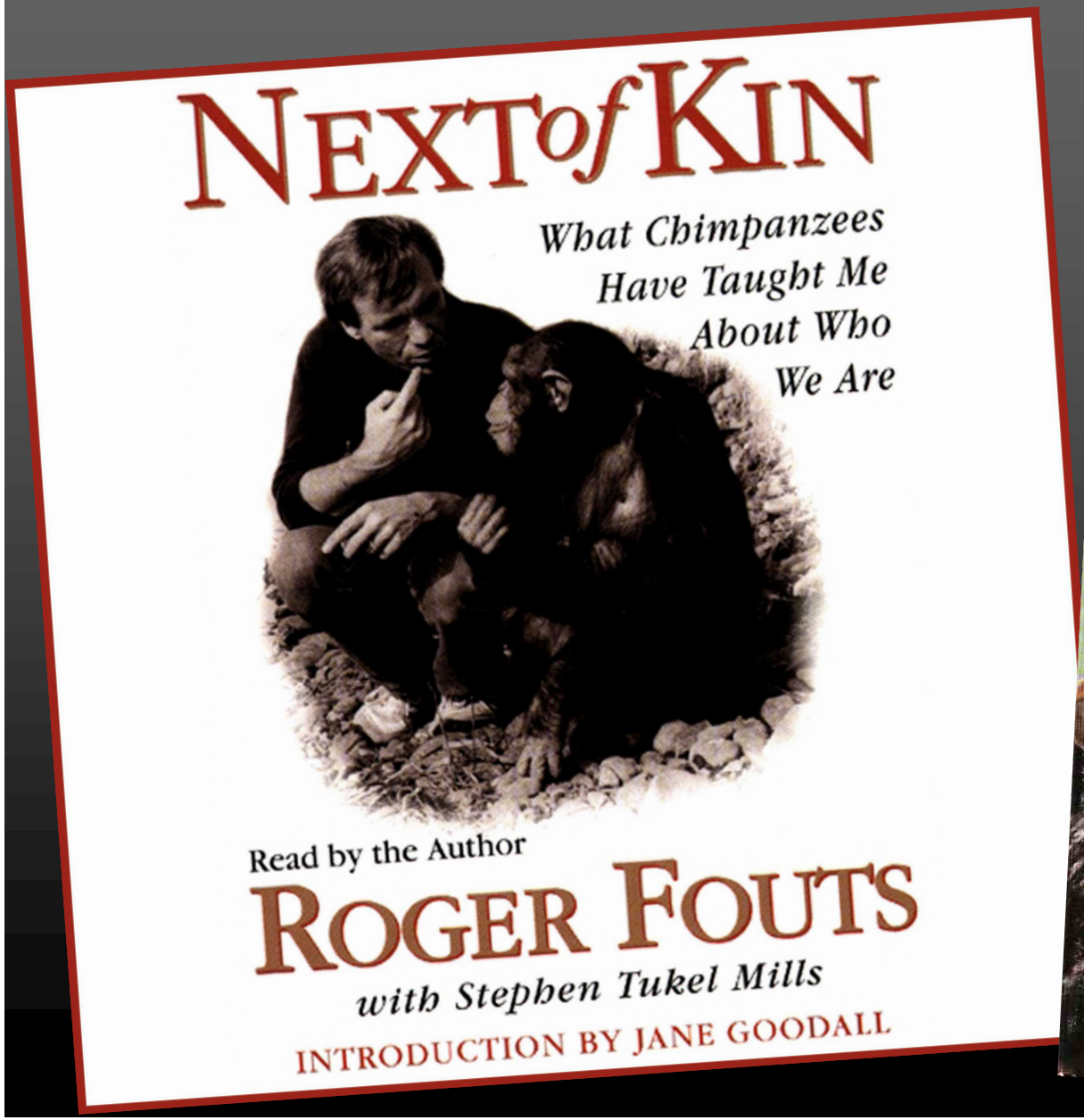
Watermelon

Fruit

Water

# LANGUAGE

## Chimpanzees and language




# LANGUAGE

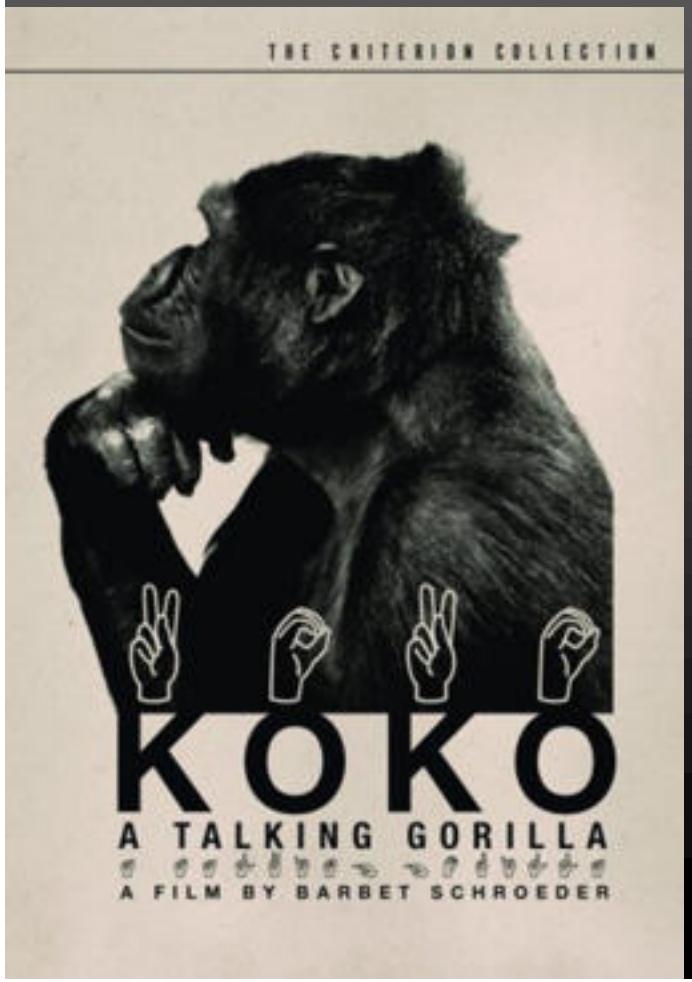
## Chimpanzees and language

(Washoe 0:00-2:32; Dar 4:45-5:50)

# LANGUAGE

## Gorillas and language

Patterson (1978) trained a female gorilla named 'Koko' to use signs




Koko

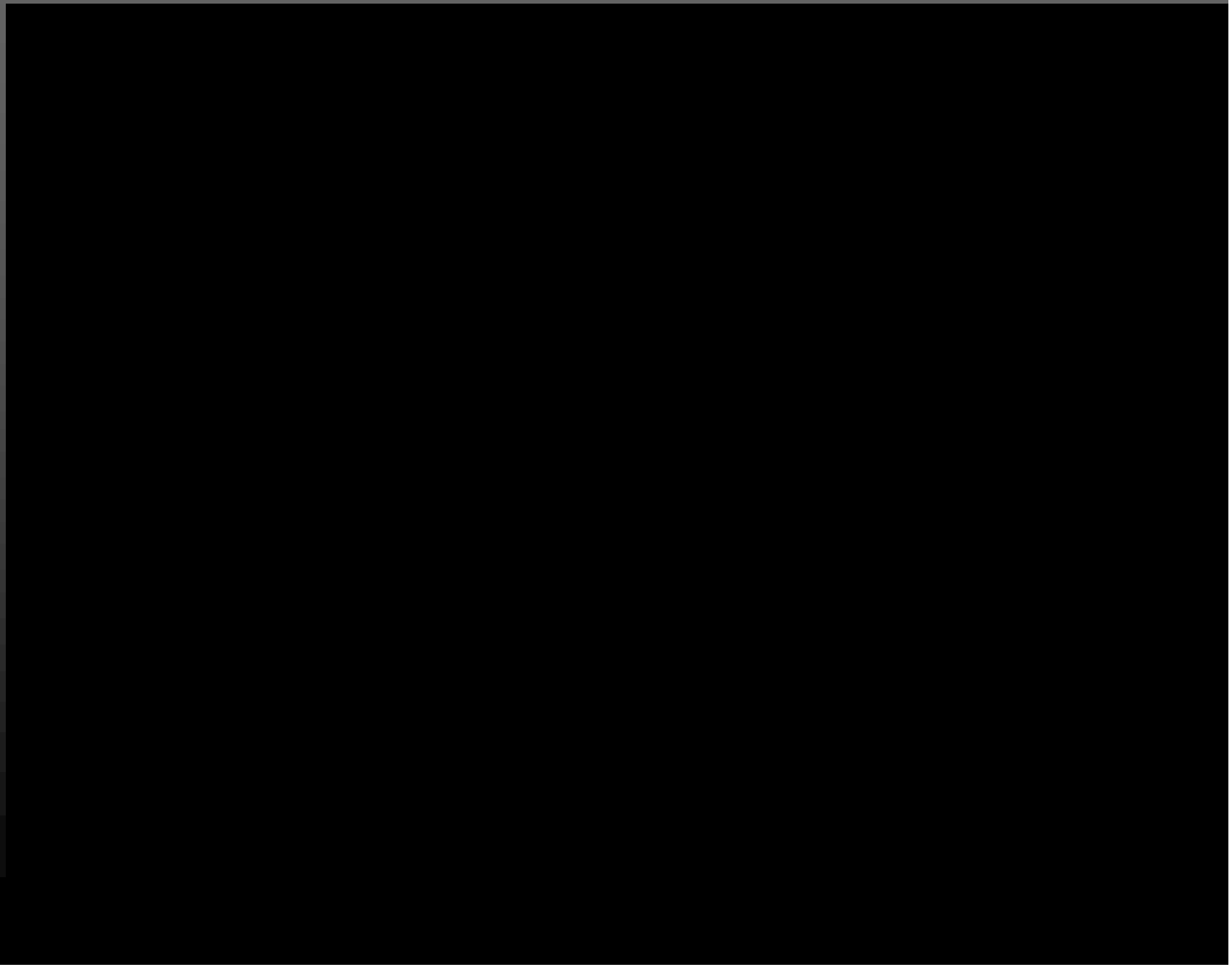
# LANGUAGE

## Gorillas and language

# LANGUAGE

## Gorillas and language

34:48 – 37.10
Paintings



# LANGUAGE

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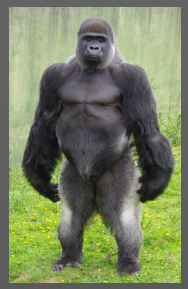


## Not dangerous ?

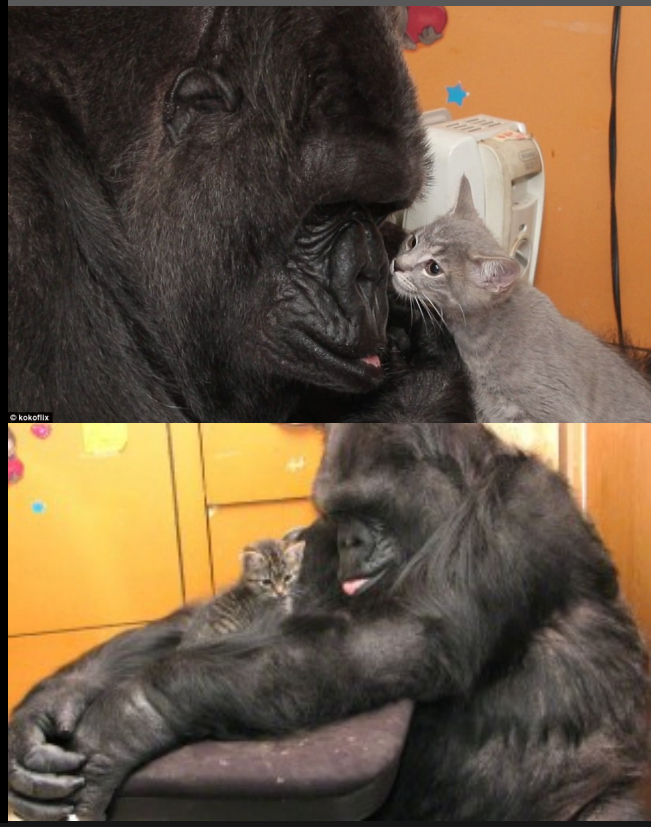

1) Raised as a child

2) Mainly herbivorous (less dangerous of chimps)

# LANGUAGE

## Gorillas and language

*19:40-*



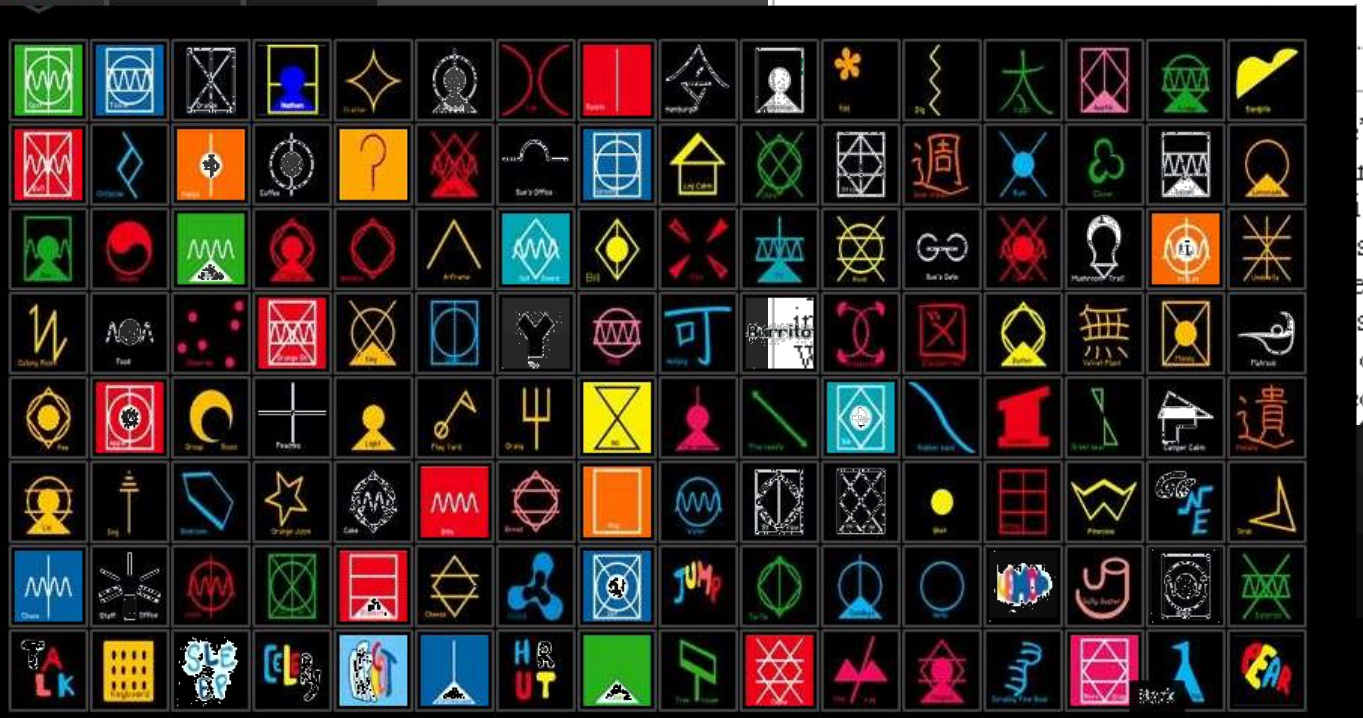

*Koko loved his kitty "all ball"*

# LANGUAGE

## Evolution of language

# LANGUAGE RESEARCH CENTER

Lexigram 1 | Lexigram 2 | Lexigram 3



nature

International weekly journal of science

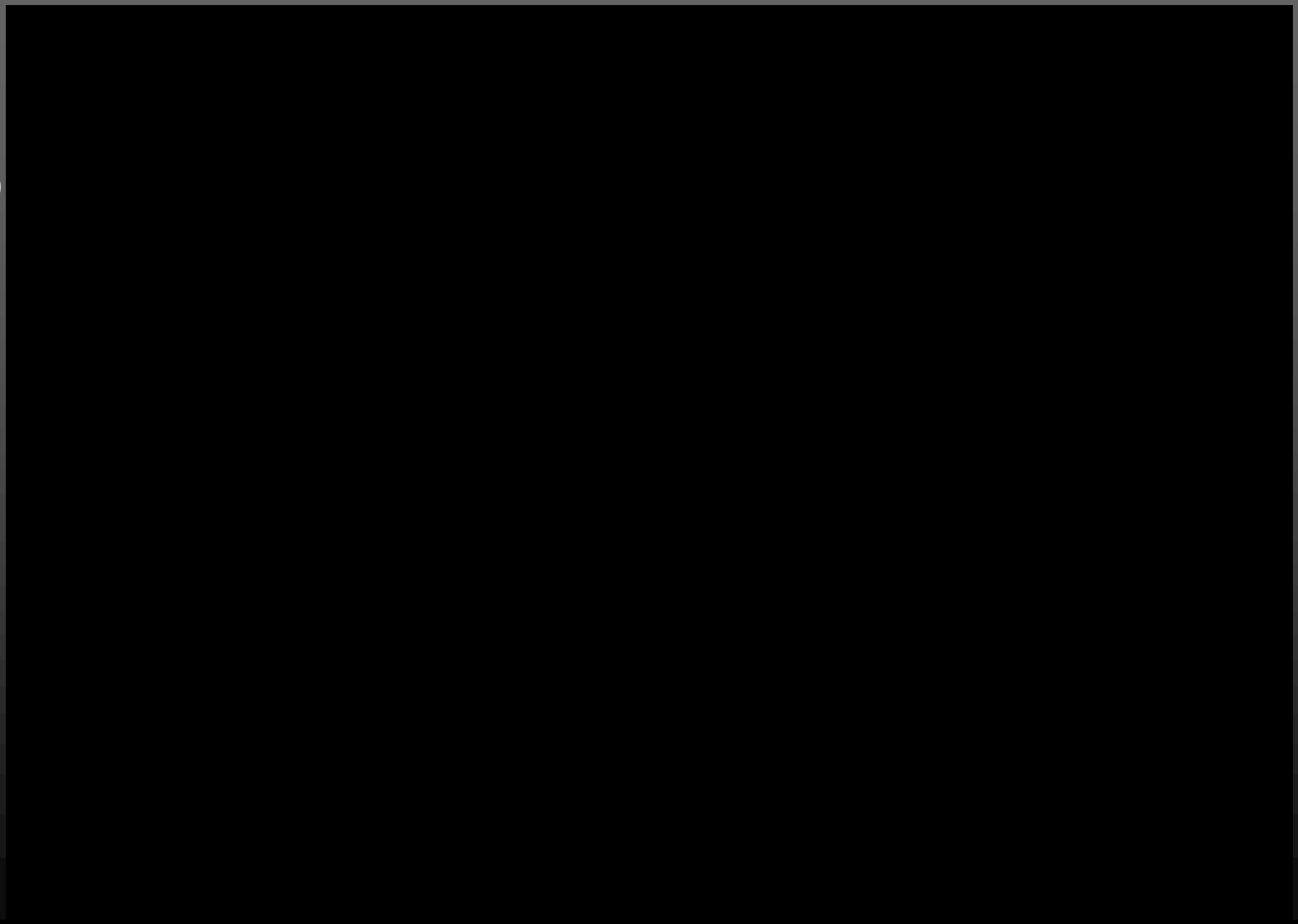
## Thinking of apes

**Intelligence of Apes and Other Rational Beings**

by Duane M. Rumbaugh & David A. Washburn

**Learning curve: the chimpanzee Lana has taught scientists a great deal about intelligence in apes.**

# LANGUAGE RESEARCH CENTER



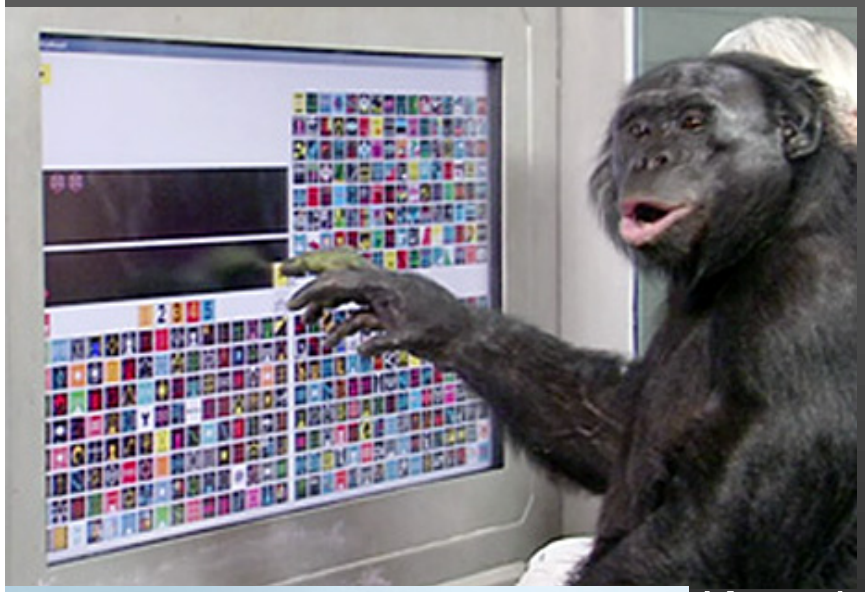
0 – 4:10

# LANGUAGE RESEARCH CENTER

LANA today (45 years old)

# LANGUAGE RESEARCH CENTER

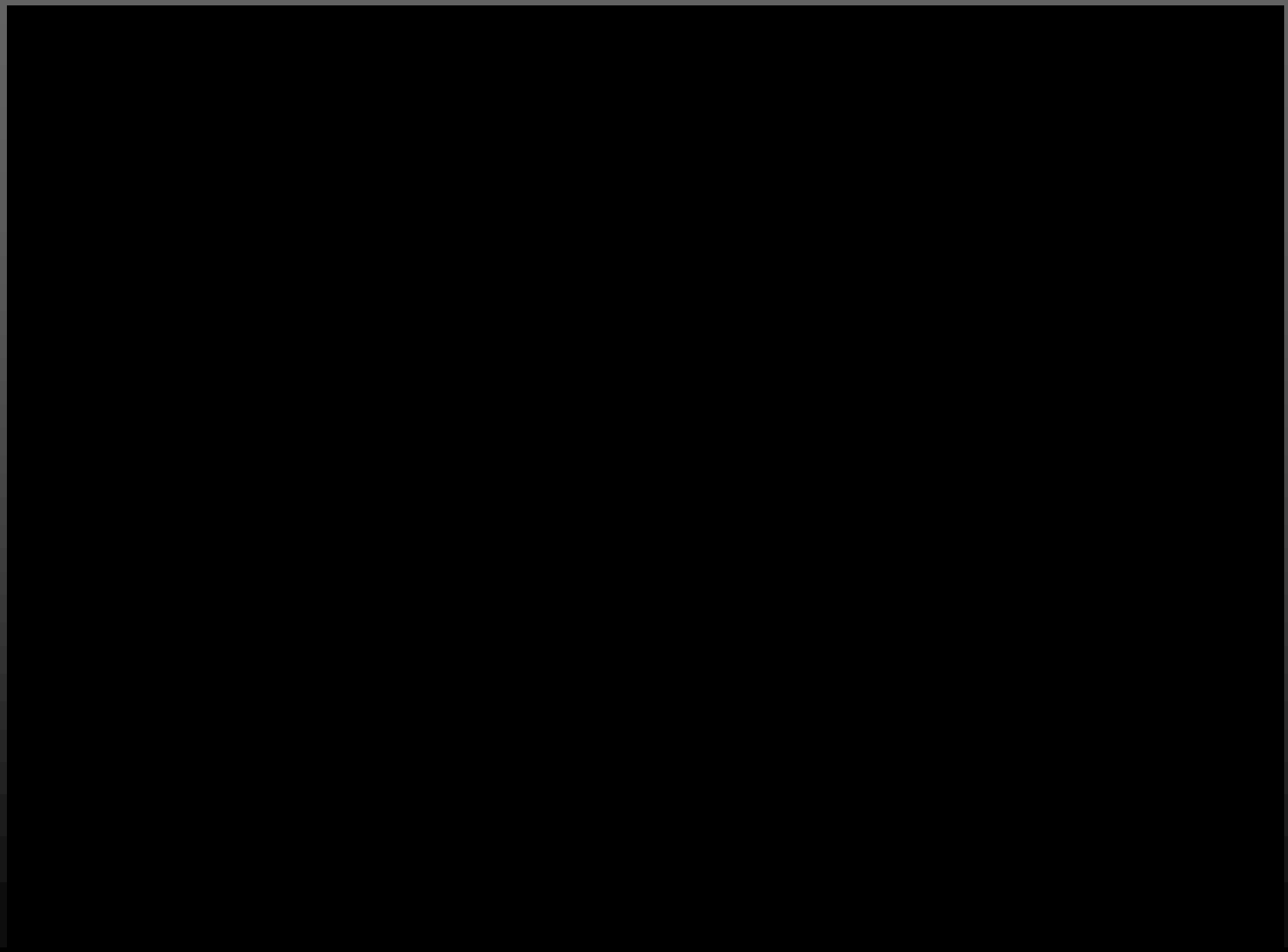
Today we know that chimps can associate visual symbols with hundreds of words (acoustic info)



Kamzi

We have also an electronic device that produces the English pronunciation of the word selected by the chimp

# LANGUAGE RESEARCH CENTER



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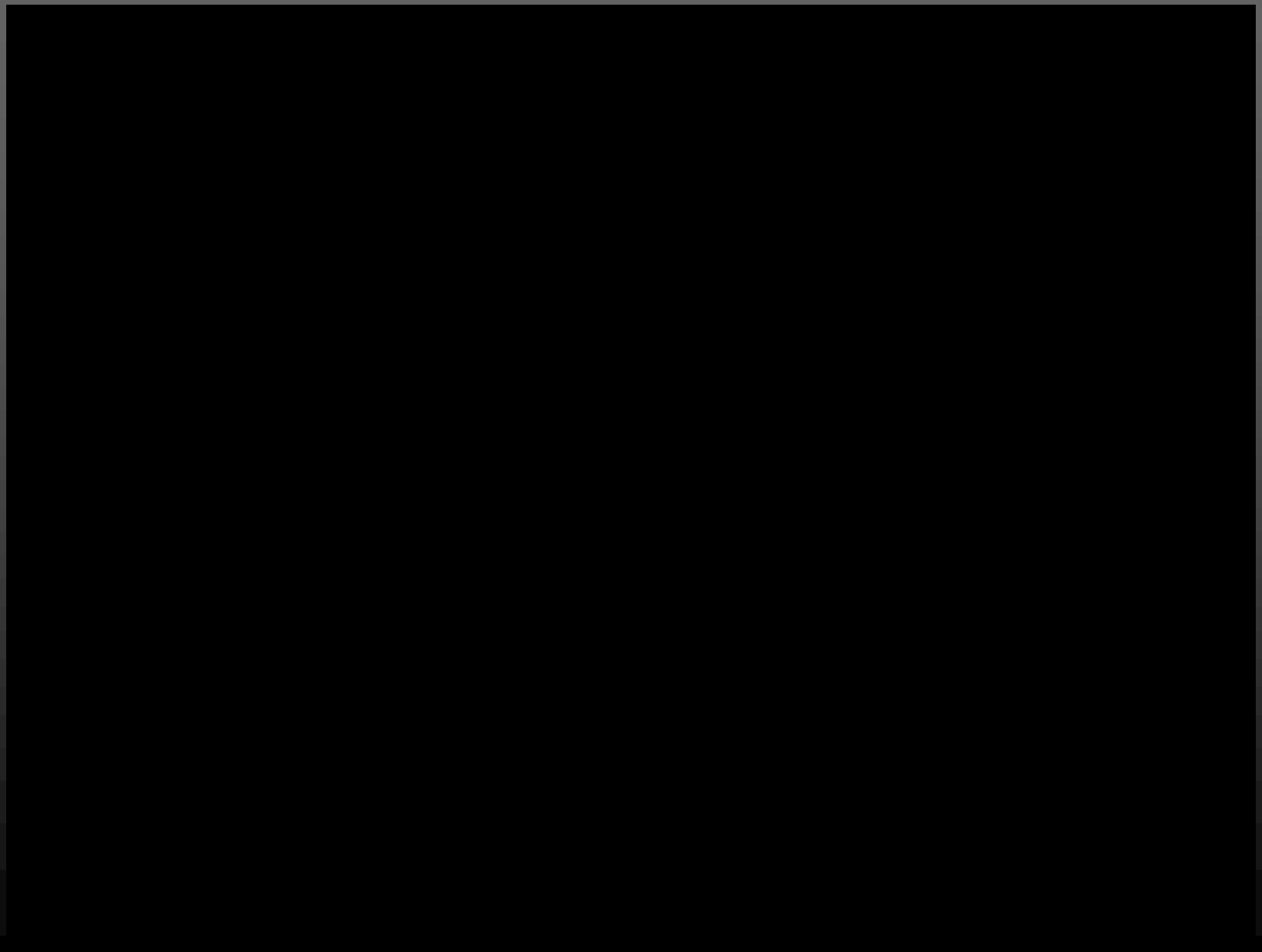
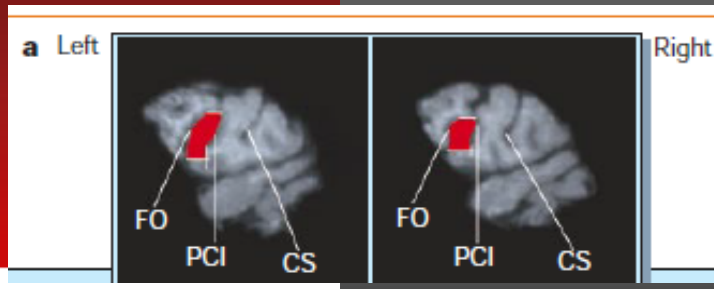


brief communications

# Asymmetric Broca's area in great apes

A region of the ape brain is uncannily similar to one linked with speech in humans.

nature International weekly journal of science








## Brief Communications

*Nature* **414**, 505 (29 November 2001) | doi:10.1038/35107134

## Asymmetric Broca's area in great apes

Claudio Cantalupo[1,2] & William D. Hopkins[1,2,3]

**Brodmann's area 44 delineates part of Broca's area within the inferior frontal gyrus of the human brain and is a critical region for speech production[1,2], being larger in the left hemisphere than in the right[1,2,3,4] — an asymmetry that has been correlated with language dominance[2,3]. Here we show that there is a similar asymmetry in this area, also with left-hemisphere dominance, in three great ape species (*Pan troglodytes*, *Pan paniscus* and *Gorilla gorilla*). Our findings suggest that the neuroanatomical substrates for left-hemisphere dominance in speech production were evident at least five million years ago and are not unique to hominid evolution.**

▲ Top

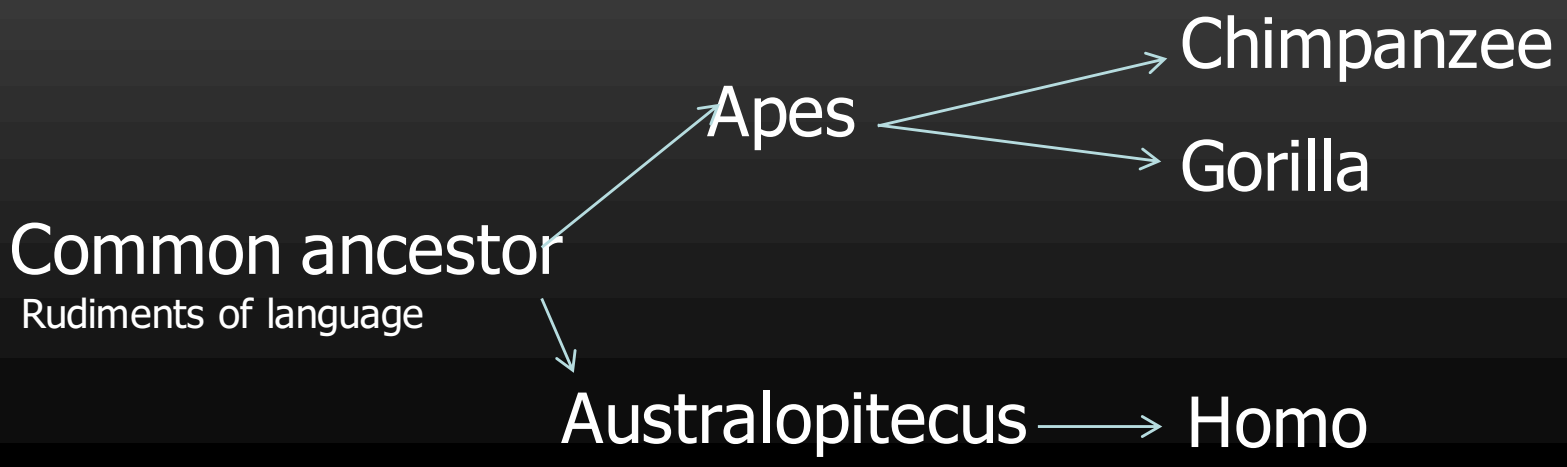
# LANGUAGE

## Evolution of language

### HENCE

1) Comparative psychology showed that apes cannot "talk" but have some sort of verbal comprehension. In addition they can process symbolic language (sign language + lexigrams)

2) They also exhibit neuro-anatomical differences (Broca's area) that suggests that language might have started to emerge in the common ancestor between hominiids and apes.



# LANGUAGE

Ready for the Planet of Apes ?

NOT REALLY..

Limited vocabulary

Not very spontaneous

Not very creative

Never parents/offspring transmission..

# LANGUAGE

## Evolution of language

### Rudiments of language in non-primate species:

1/2) BIRDS

# LANGUAGE

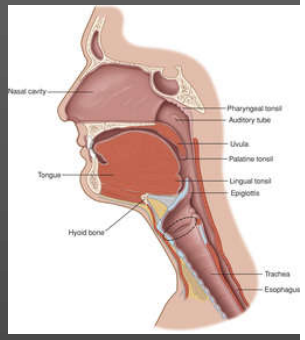
## The evolution of language

There are at least 2 main problems when we talk about the possibility to have language

### CENTRAL ISSUE

Do you have cognitve (abstract) skills to support language ?!?!

### PER L ISSUE






atomical range of

Do yo
structu
vocaliza

# LANGUAGE

## Evolution of language

Rudiments of language in non-primate species:

1/2) BIRDS

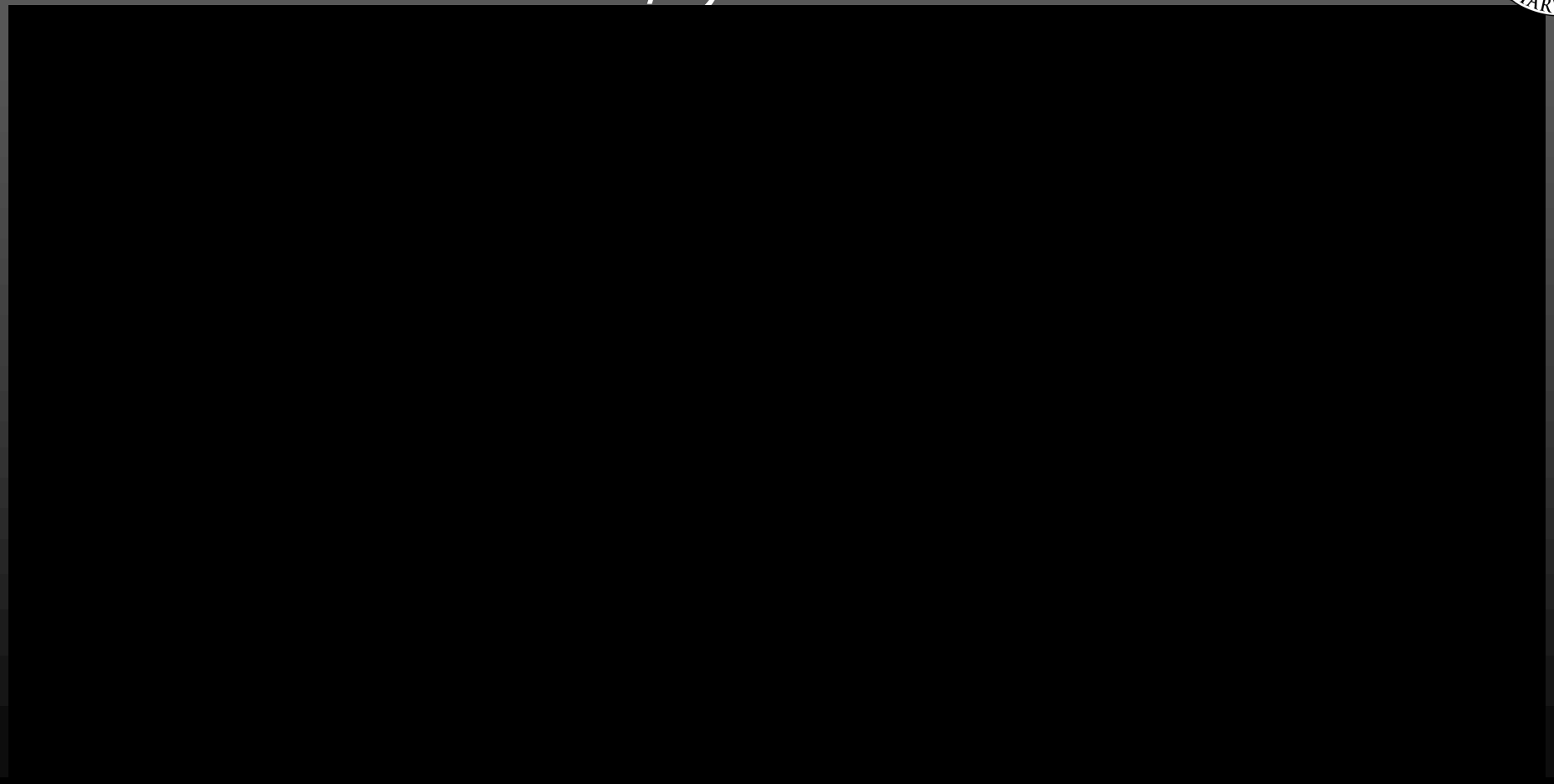
Alex, the famous parrot of Irene Pepperberg

# LANGUAGE

## Evolution of language

Rudiments of language in non-primate species:

1/2) BIRDS

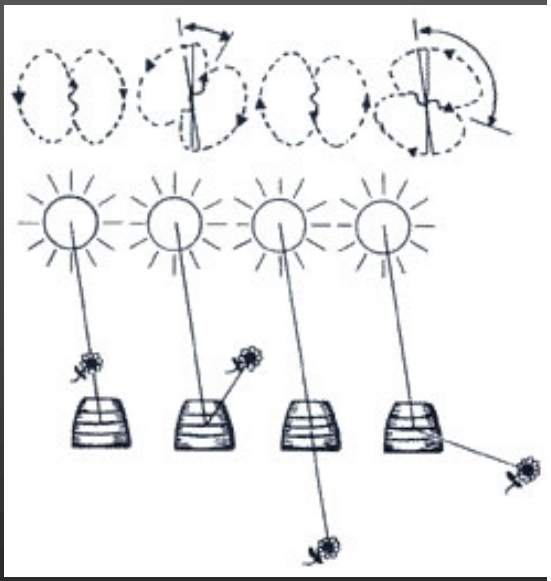


# LANGUAGE

## Evolution of language

## Rudiments of language in non-primate species:

2/2) BEES



Waggle (bee) dance

(but please note this is largely genetic and cannot be used to communicate anything else than distance and direction)

# LANGUAGE

## Evolution of language

Rudiments of language in non-primate species:

## Are Nonhuman Animals Capable of Real Language?

*Thanks to words, we have been able to rise above the brutes; and thanks to language we have often sunk to the level of demons.*

Aldous Huxley

If we accept the notion that human language occurs as a result of some innate, genetically determined language-learning mechanism, it is also logical to think that such a system might have evolved according to Darwinian concepts, and that creatures other than humans might possess some language capabilities.

Many animals communicate with one another, often in complex ways. Communication, however, is not the same as language (Dronkers, Pinker, & Damasio, 2000). Some animals have a fairly inflexible group of calls used for functions such as signaling danger and identifying territories. Others use signals that communicate magnitude, as in the case of bee dances that indicate the location of food. Finally, animals communicate through sequences of behavior, as in the case of birdsong. These animal behaviors, although clearly used for communication, do not match the flexibility and creativity of human language as described by Aitchison (1983; see Table 13.1).

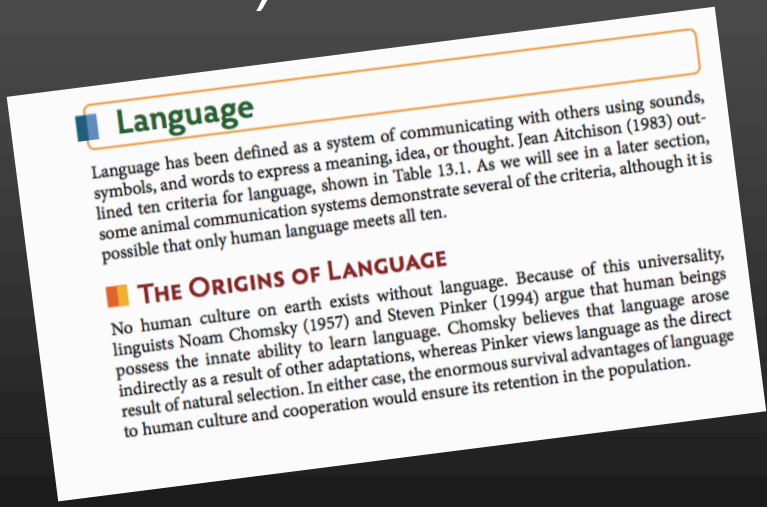
If we are to find an animal precursor to human language capability, the most logical place to start is with our nearest relatives, the great apes. In three species of great ape, Brodmann's area 44 (part of Broca's area) showed asymmetry between the left and right hemispheres similar to that typically seen in humans (Cantalupo & Hopkins, 2001). Although this doesn't prove that apes have the necessary brain structures for language production, it does suggest that human brain development for language is not completely unique. Other researchers point to the existence of mirror neurons in nonhuman primates as a possible precursor for human language (see Chapter 8). Mirror neurons are activated both when an animal performs an action and when it observes another animal perform an action (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Mirror neurons might have provided a mechanism allowing early humans to first gain an understanding of gestures, followed by language. The presence of mirror neurons in Broca's area in both apes and humans suggests a basis for the evolution of language (Corballis, 2004).

# LANGUAGE



Any human society has a language.

Anyway, we often have different (more/less) words that reflects our way to see the world



## Language

Language has been defined as a system of communicating with others using sounds, symbols, and words to express a meaning, idea, or thought. Jean Aitchison (1983) outlined ten criteria for language, shown in Table 13.1. As we will see in a later section, some animal communication systems demonstrate several of the criteria, although it is possible that only human language meets all ten.

### The Origins of Language

No human culture on earth exists without language. Because of this universality, linguists Noam Chomsky (1957) and Steven Pinker (1994) argue that human beings possess the innate ability to learn language. Chomsky believes that language arose indirectly as a result of other adaptations, whereas Pinker views language as the direct result of natural selection. In either case, the enormous survival advantages of language to human culture and cooperation would ensure its retention in the population.

CULTURAL PSYCHOLOGY

# LANGUAGE

My former supervisor (Essex, 2003): prof. Debi Roberson in Guinea

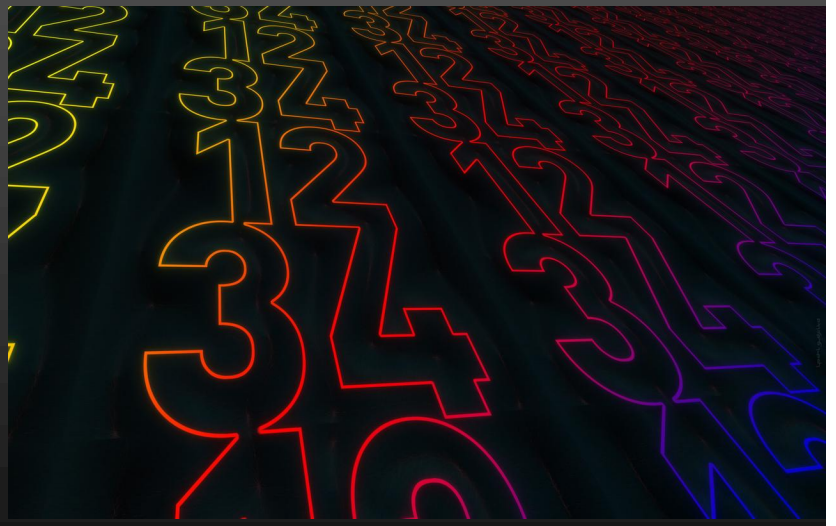
# LANGUAGE

## SOME EXAMPLES OF CULTURAL PSYCHOLOGY

### Munduruku (Brazil)

*5 words for numbers*

1
2
3
4
5
Many
Many
Many
Many



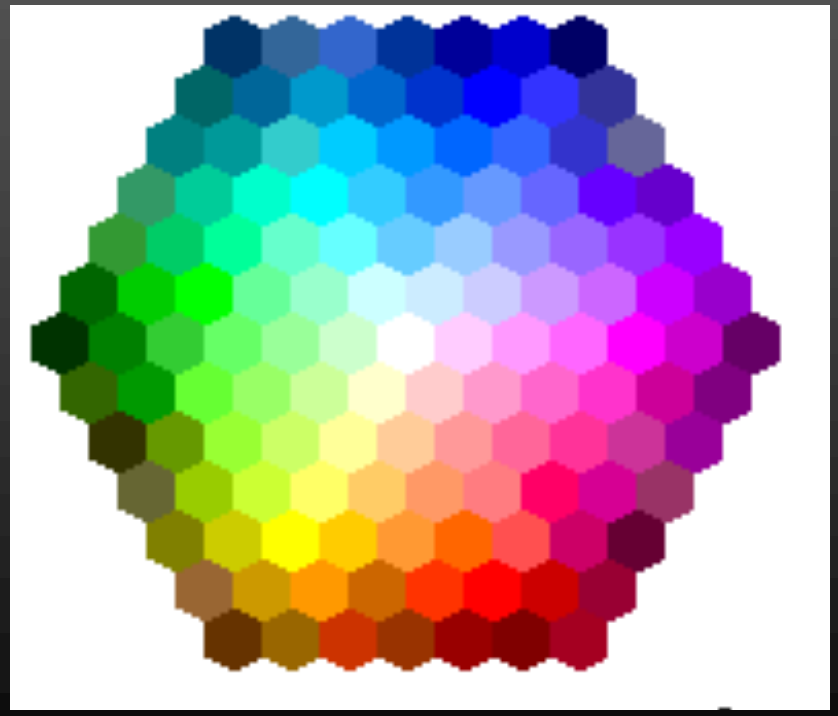
# LANGUAGE

## SOME EXAMPLES OF CULTURAL PSYCHOLOGY

**Dani (Guinea)**

2 words for colors


Light
Light
Light
Light
Dark
Dark
Dark
Dark



# LANGUAGE

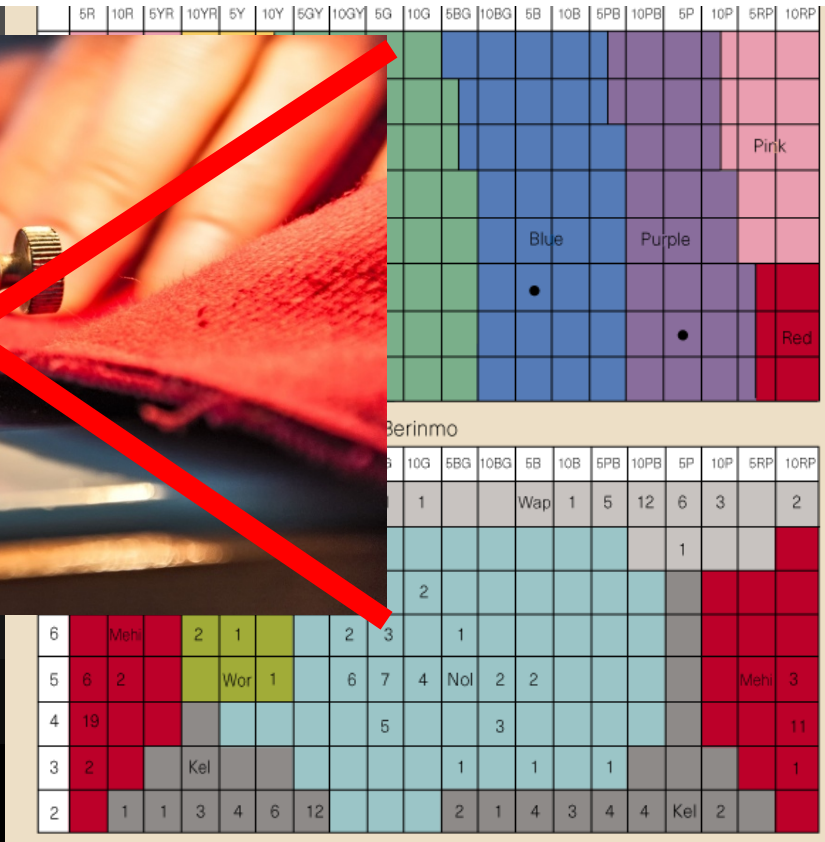
## SOME EXAMPLES OF CULTURAL PSYCHOLOGY

### Berinmo (Guinea)

*5 words for colors*


scientific correspondence

Colour categories in a stone-age tribe



# LANGUAGE

## SOME EXAMPLES OF CULTURAL PSYCHOLOGY

**Eschimos**
Several terms for snow

**Scotland**
Different terms for rain

# LANGUAGE

## The origin of human language

Which kind of rudimental sounds do we produce when we want to get the attention of conspecifics or heterospecifics?

# LANGUAGE

## CLICK LANGUAGES

Click Languages may be among the earliest human languages.
It includes sounds made by clicking the tongue.

# LANGUAGE

CLICK LANGUAGES (0:00-2:00)

# LANGUAGE

CLICK LANGUAGES (0:00-2:00)

# LANGUAGE

## CLICK LANGUAGES

African groups using click languages show that the groups are highly distinct from one another.

These groups have not shared ancestors for between 15,000 and 35,000 years, suggesting that the origin of click languages occurred in a time before human beings settled down to begin agriculture.

# LANGUAGE

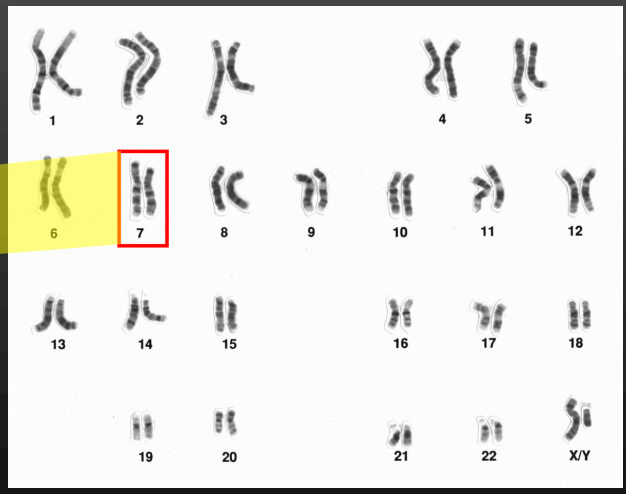
HENCE

Although a wide range of cross-cultural differences, language exists in all human cultures..

IS THERE A GENETIC ORIGIN?

One gene associated with speech and language is the "forkhead box *P2* gene (***FOXP2***)

A mutation in the gene leads to severe difficulties in the production of language



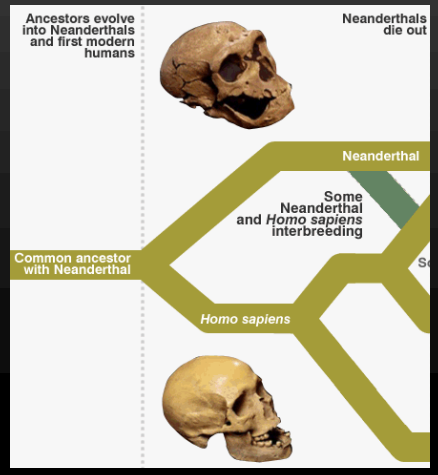
# LANGUAGE

## HENCE

Although a wide range of cross-cultural differences, language exists in all human cultures..

## IS THERE A GENETIC ORIGIN?

*FOXP2* is expressed differently in areas of the human brain than in the chimpanzee brain.




A crucial mutation required for modern language use occurred across hominiids' evolution (Nehanderthal had this genes, so it's more ancient than 300,000 - 400,000 years ago)

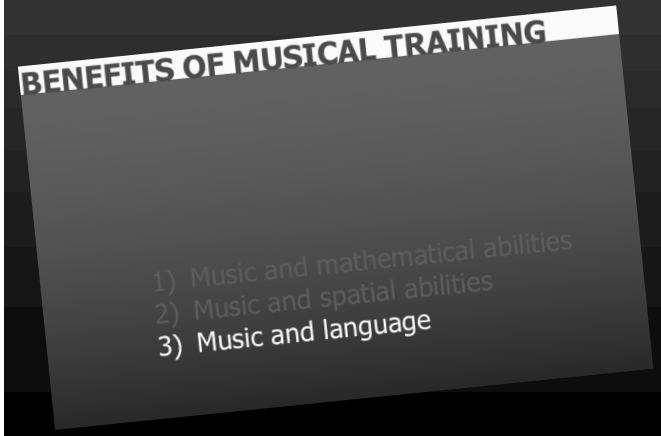
Probably this mutation happened in *Homo abilities* (approx. 2 million years ago).

# LANGUAGE

## MULTILINGUALISM

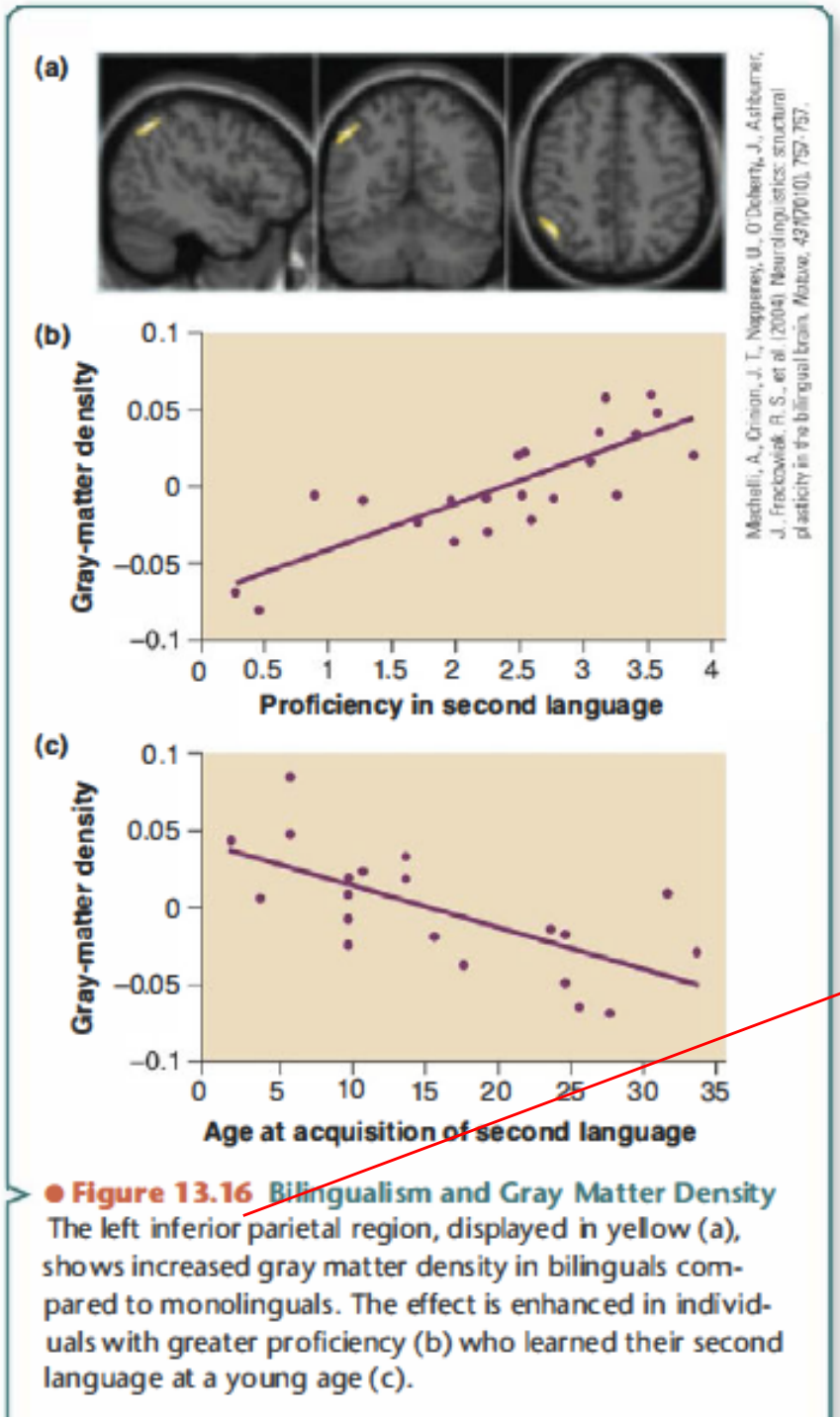
Multilingualism refers to proficiency in more than one language.

Multiple languages use some of the same areas in the brain *(indeed sometimes we start talking in 1 language and then insert words from another language)*
However the degree of overlap is not 100 %




The fact that the same areas are involved is not entirely new in the literature…

# LANGUAGE




● **Figure 13.16 Bilingualism and Gray Matter Density** The left inferior parietal region, displayed in yellow (a), shows increased gray matter density in bilinguals compared to monolinguals. The effect is enhanced in individuals with greater proficiency (b) who learned their second language at a young age (c).

## MULTILINGUALISM

Multilingualism refers to proficiency in more than one language.

For attentional processes related to language !

# LANGUAGE

## MULTILINGUALISM

Multilingualism refers to proficiency in more than one language.

Multiple languages use some of the same areas of the brain but that the degree of overlap is not 100 percent

*(indeed sometimes we start talking in 1 language and then insert words from another language)*

So why are we able to keep them separated very often?

'Language switch' hypothesis.

Picture-naming tasks

Single language task:
CANE

Mixed language task:
CANE / DOG

Switching language would involve "dorsolateral prefrontal cortex" (e.g. more esecutive functions), so it would be more costly to switch language than not.

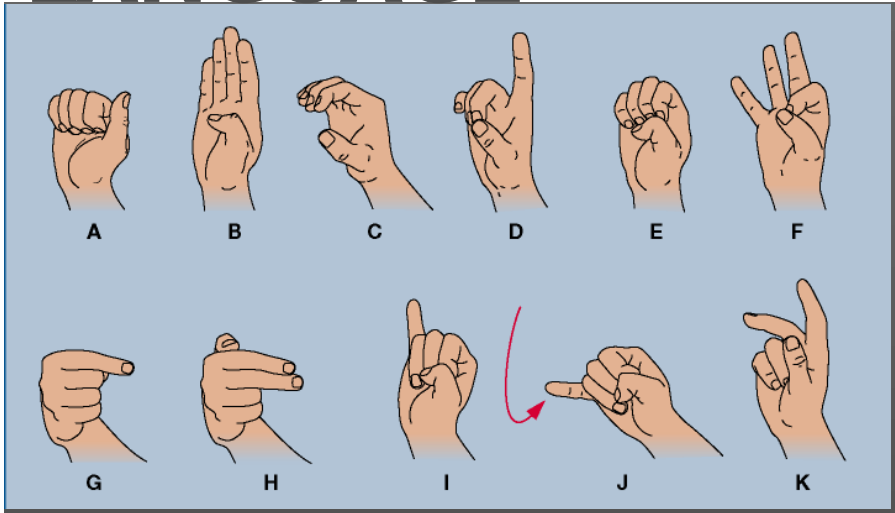
# LANGUAGE

## MULTILINGUALISM

Multilingualism refers to proficiency in more than one language.

Languages learned early in life are retained better after brain damage than languages learned later in life (or with less fluency)

# LANGUAGE




## SIGN LANGUAGE

Language not of sounds but of sight and movement.

## 2 Hypotheses on its brain localization

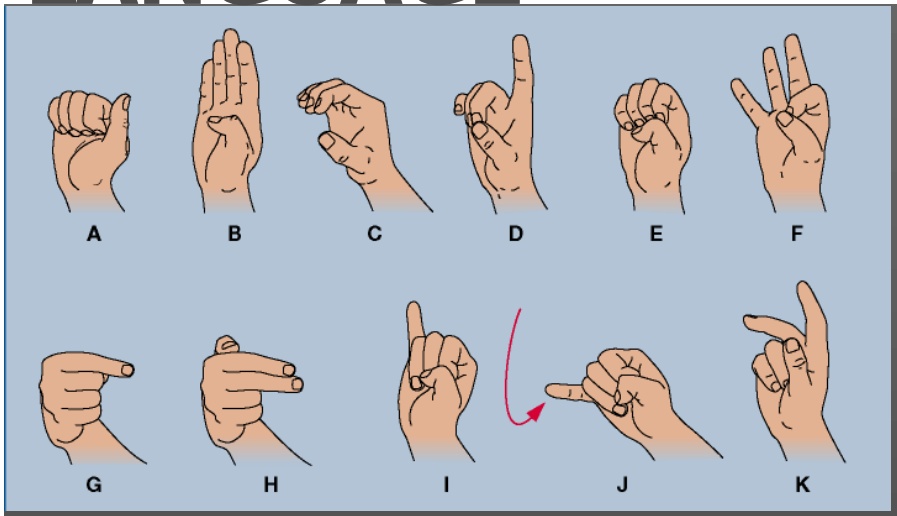
- As precise movements in the space (spatial ability) are involved, it mainly involves RIGHT hemisphere.

- As alternative symbolic language, it may involve LEFT hemisphere…

# SIGN LANGUAGE


Which hemisphere is mainly involved in sign language? Right/left/both equally

# LANGUAGE




## SIGN LANGUAGE

Language not of sounds but of sight and movement.

## 2 Hypotheses on its brain localization

- Precise movements in the space (spatial ability) it may involve RIGHT hemisphere.

- As alternative symbolic language it may involve LEFT hemisphere…


fMRI

LEFT HEMISPHERE
(Overalpping areas with verbal language)!

# COMMUNICATION DISORDERS and BRAIN MECHANISMS for LANGUAGE

# APHASIAS

Total or partial loss of the ability to either produce or comprehend spoken language

# LANGUAGE

## BROCA'S APHASIA

In 1861, Paul Broca began to study a 51-year-old man named Leborgne

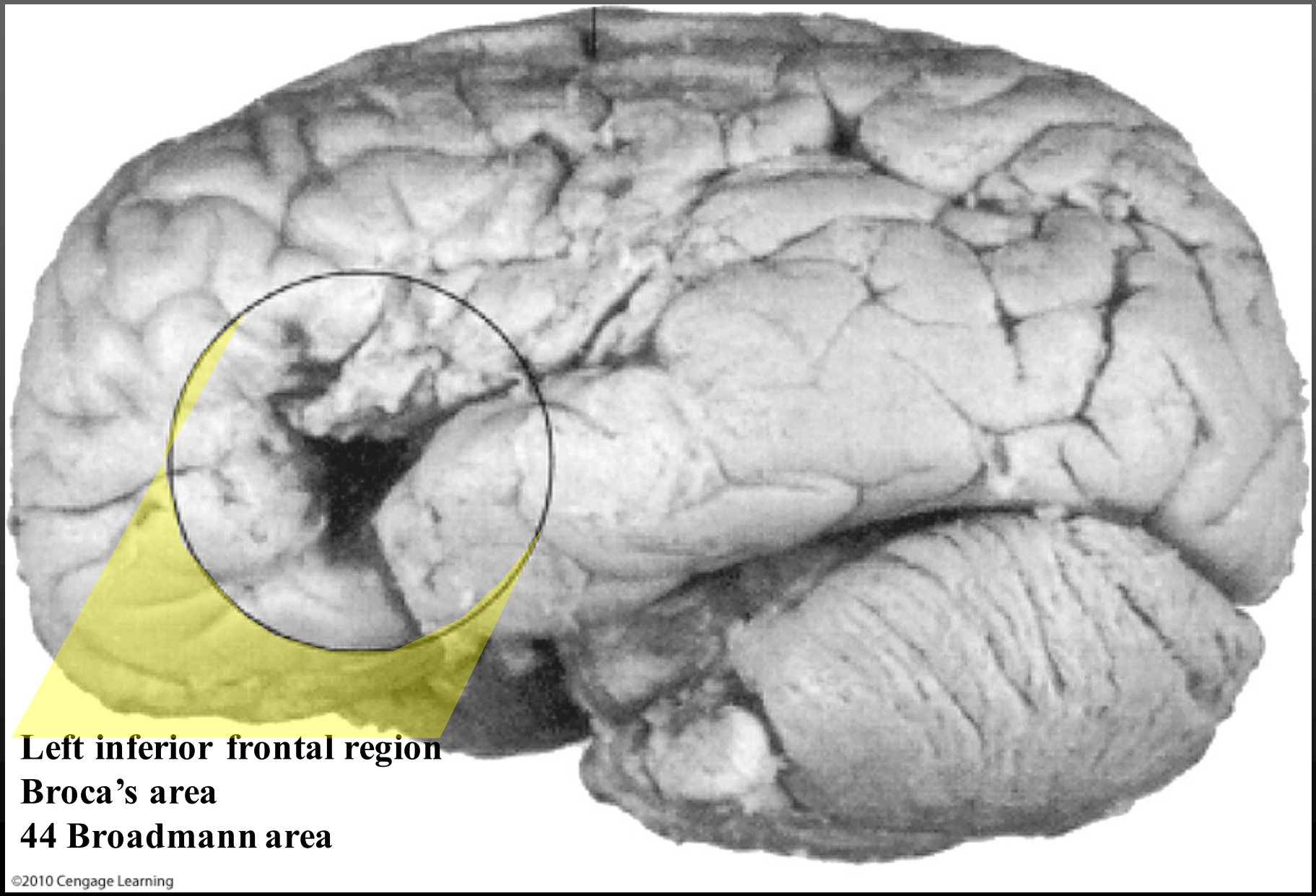
He called him "Tan" patient because "tan" was one of a very few syllables he could produce.

Although this inability to produce language, he understood much of what was said to him (for instance, he retained his ability to answer numerical questions by raising an appropriate number of fingers on his left hand)

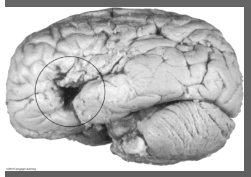
Broca performed an autopsy on his patient's brain..

# LANGUAGE

## BROCA'S APHASIA

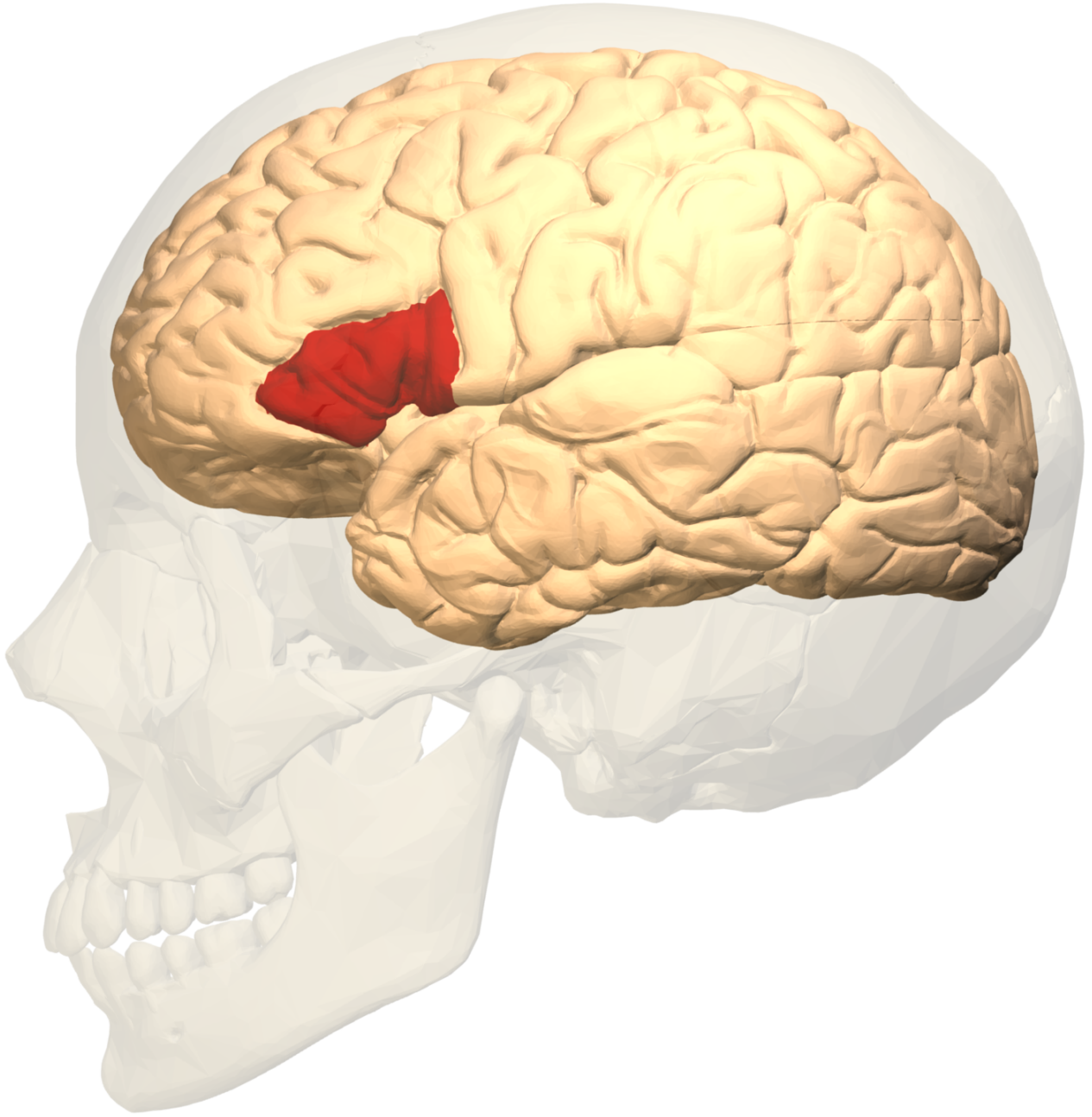


# LANGUAGE



## BROCA'S APHASIA

# LANGUAGE



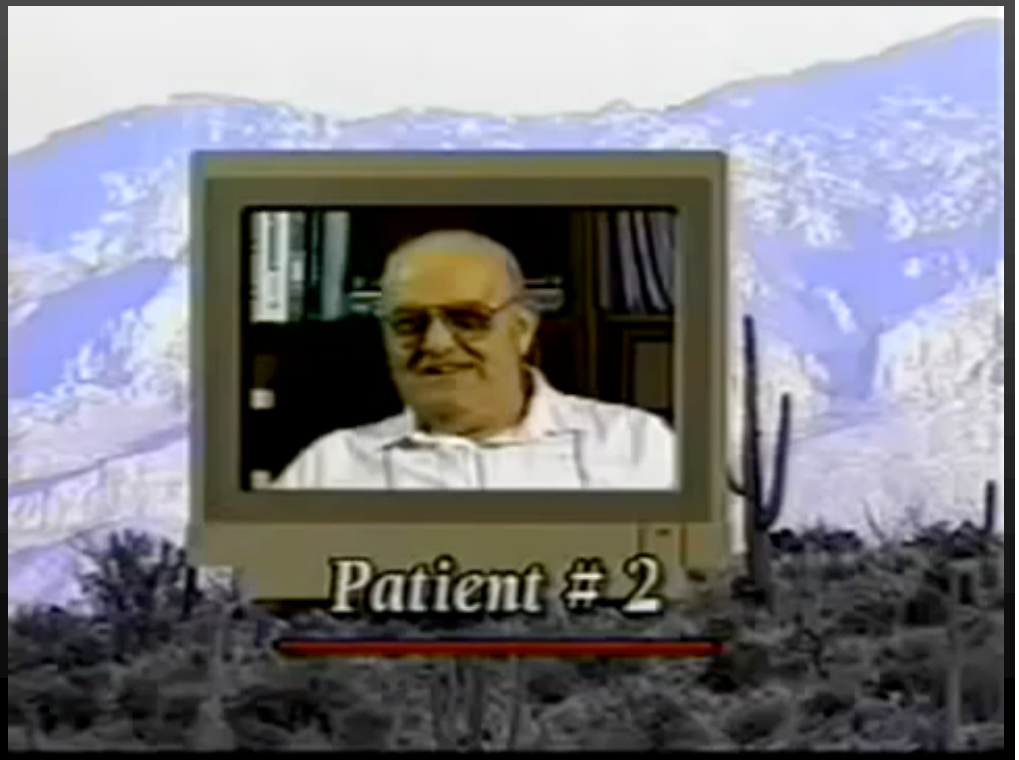
# LANGUAGE

## BROCA'S APHASIA

# LANGUAGE

## BROCA'S APHASIA


0:20 –



# LANGUAGE

## BROCA'S APHASIA

- Speech is very slow
- Requires signifcant effort

Telegraphic quality to the speech

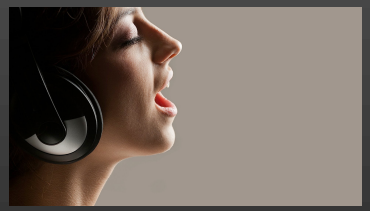
- Errors in production
- Errors in repetition
- Anomia

# LANGUAGE

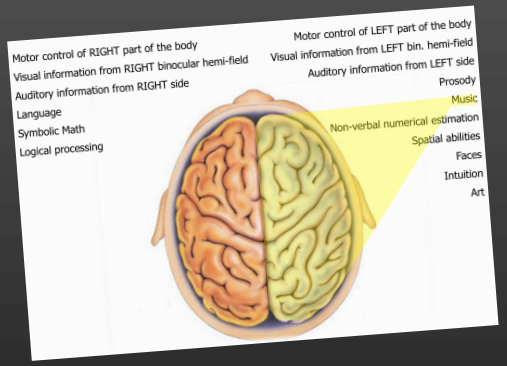
## BROCA'S APHASIA

### A SIMPLE MOTOR DEFICIT IN SPEECH PRODUCTION?

**NO**



Broca's patients can still sing songs they know well.




Their writing shows many of the same errors and omissions

(If the damage to Broca's area affected motor control of the vocal apparatus only, one would expect that patients' written communication would not show the same deficits as their speech)

# LANGUAGE

## BROCA'S APHASIA

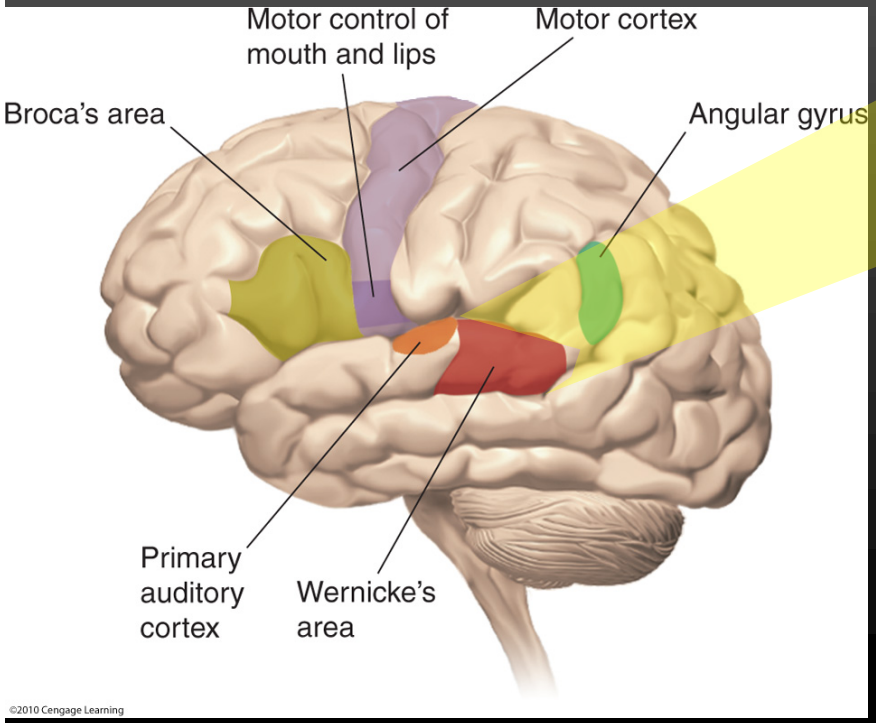
### Summary Table: The Major Aphasias

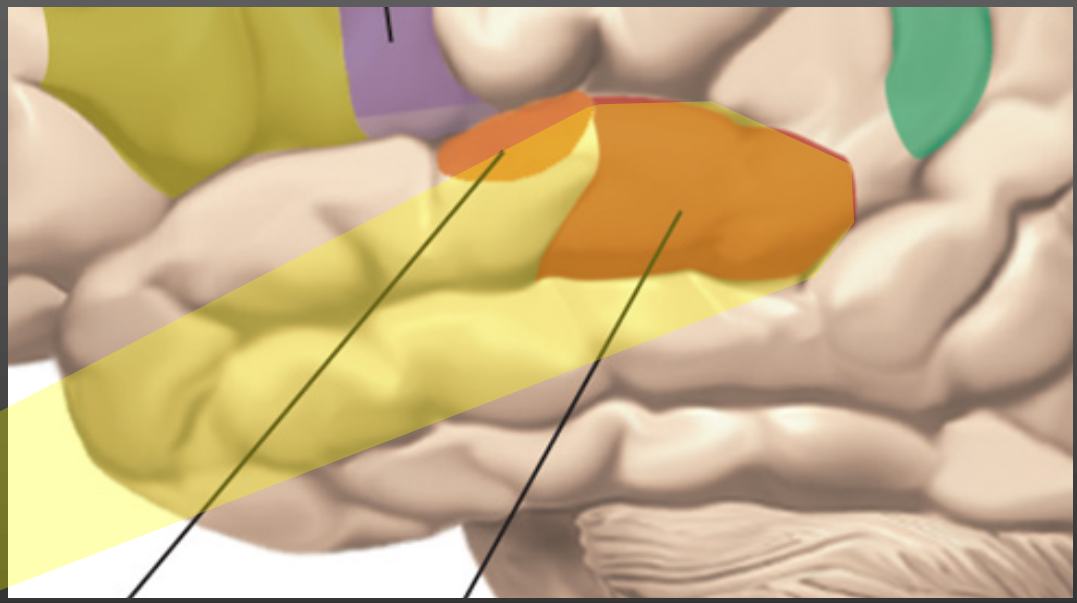
| Type of Aphasia | Location of Damage | Ability to Produce Speech | Ability to Comprehend Meaning of Spoken Words | Does Person Exhibit Paraphasia (Sound Substitutions)? | Ability to Repeat Spoken Words Accurately | Ability to Name Objects |
|---|---|---|---|---|---|---|
| Broca's aphasia | Broca's area | Not fluent | Good | Not common | Poor | Poor |

# LANGUAGE

## WERNICKE'S APHASIA

**Superior surface of the temporal lobe,** adjacent to structures involved with audition and with memory
(22 Broadmann area)



# LANGUAGE

## WERNICKE'S APHASIA

**Superior surface of the temporal lobe,** adjacent to structures involved with audition and with memory
(22 Broadmann area)


The major deficit in Wernicke's aphasia is **COMPREHENSION**, for both the written and spoken word.

These patients can neither repeat nor understand words or sentences that they hear.

Speech is rapid and fluent but virtually meaningless.

Patients with Wernicke's aphasia seem totally unaware that they are not making sense (whereas patients with Broca's aphasia are typically frustrated by their inability to communicate)

# LANGUAGE

## WERNICKE'S APHASIA

**Superior surface of the temporal lobe,** adjacent to structures involved with audition and with memory
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# LANGUAGE

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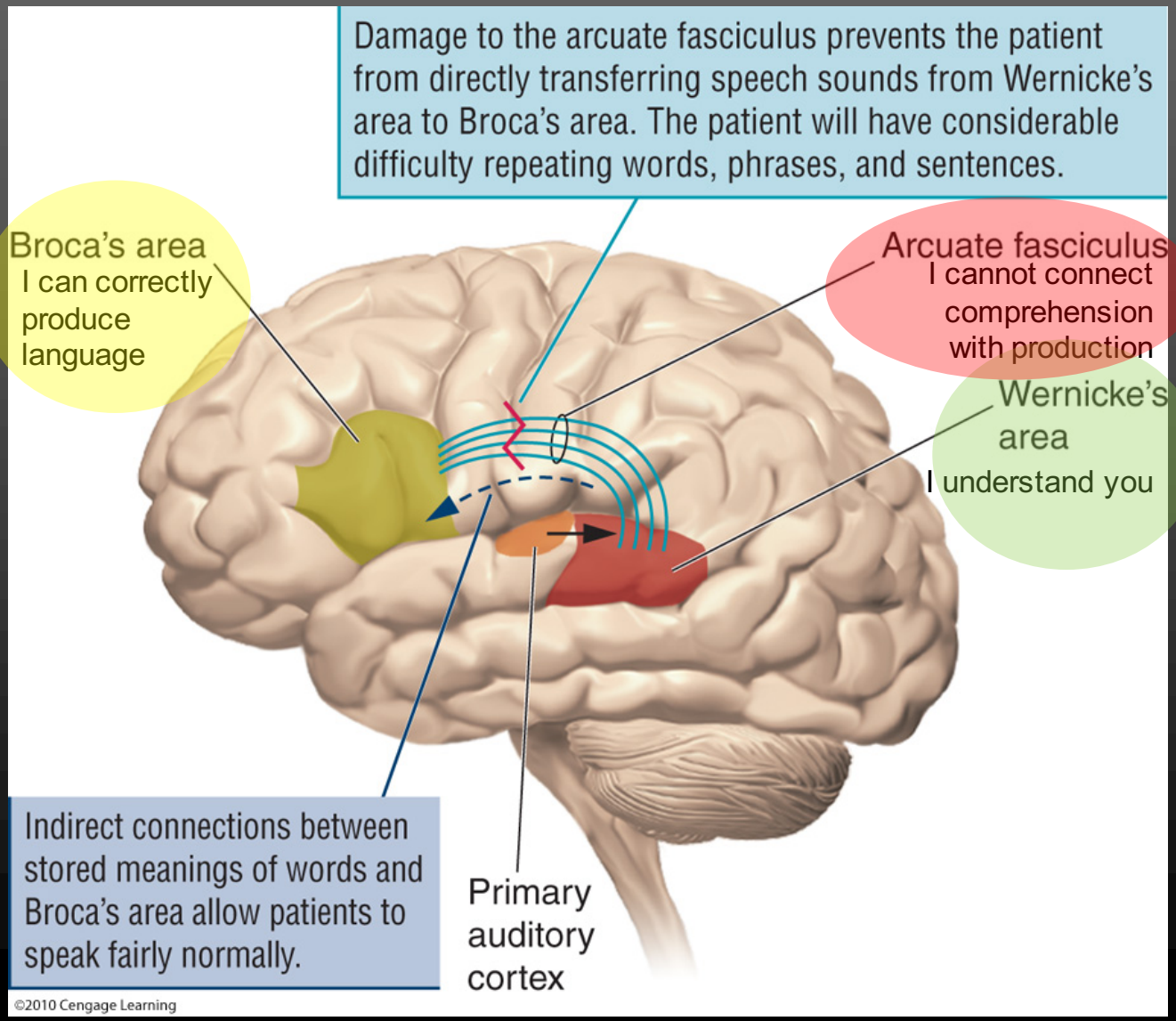
| Broca's aphasia | Broca's area | Not fluent | Good | Not common | Poor | Poor |
| Wernicke's aphasia | Wernicke's area | Fluent | Poor | Common | Poor | Poor |

# LANGUAGE

## CONDUCTION APHASIA

A band of fibers known as the **arcuate fasciculus** connects the two areas.



# LANGUAGE

## CONDUCTION APHASIA

A band of fibers known as the **arcuate fasciculus** connects the two areas.

Talk please:
*OK, I am born in Venice in 1978…*

Use fingers to tell me how many pens are on the table:

*4! (by fingers)* 

Speech remains fluent, and comprehension is fairly good

So repeat after me:
*"4 is larger than 3"*

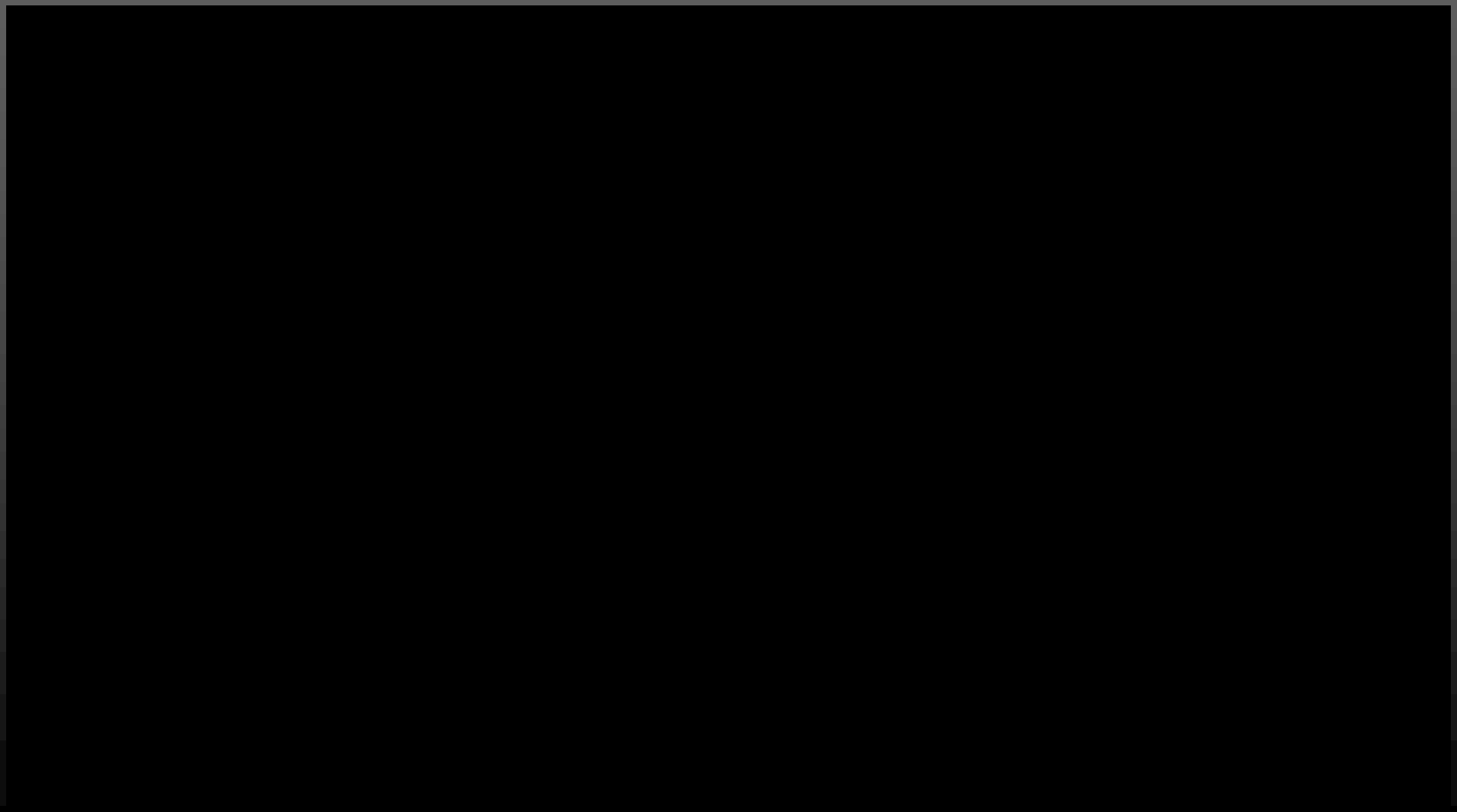
….. Repeat after me…
!?!

Repeating sentence is difficult !

# LANGUAGE

## CONDUCTION APHASIA

A band of fibers known as the **arcuate fasciculus** connects the two areas.



# LANGUAGE

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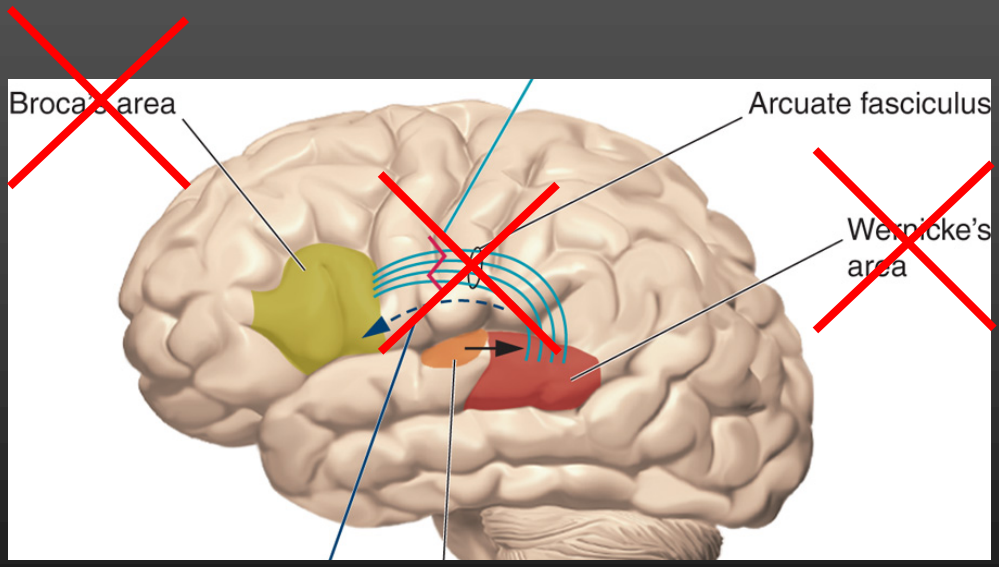
| Broca's aphasia | Broca's area | Not fluent | Good | Not common | Poor | Poor |
| Wernicke's aphasia | Wernicke's area | Fluent | Poor | Common | Poor | Poor |
| Conduction aphasia | Arcuate fasciculus | Fluent | Good | Common | Poor | Poor |

# LANGUAGE

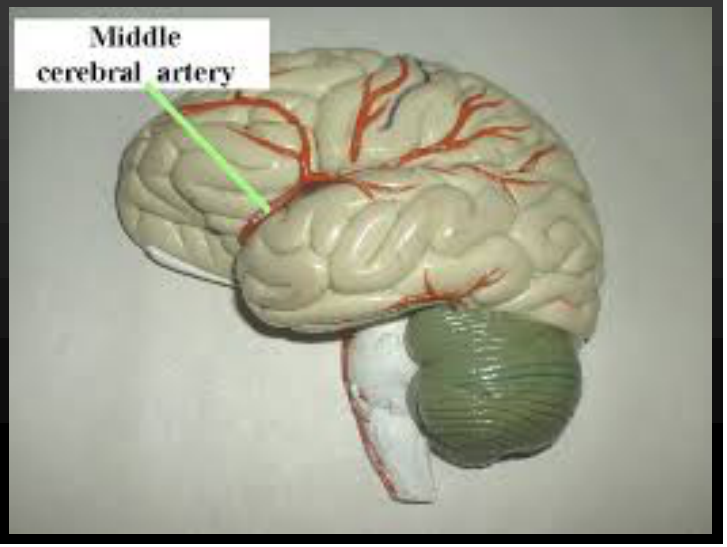
## GLOBAL APHASIA

Patients lose essentially all language functions

This condition combines all of the deficits of Broca's, Wernicke's, and conduction aphasia.




+ other cortical areas




Often due to damage to the **middle cerebral artery** which serves the language centers of the left hemisphere

# LANGUAGE

## GLOBAL APHASIA

# LANGUAGE

## GLOBAL APHASIA

### Summary Table: The Major Aphasias

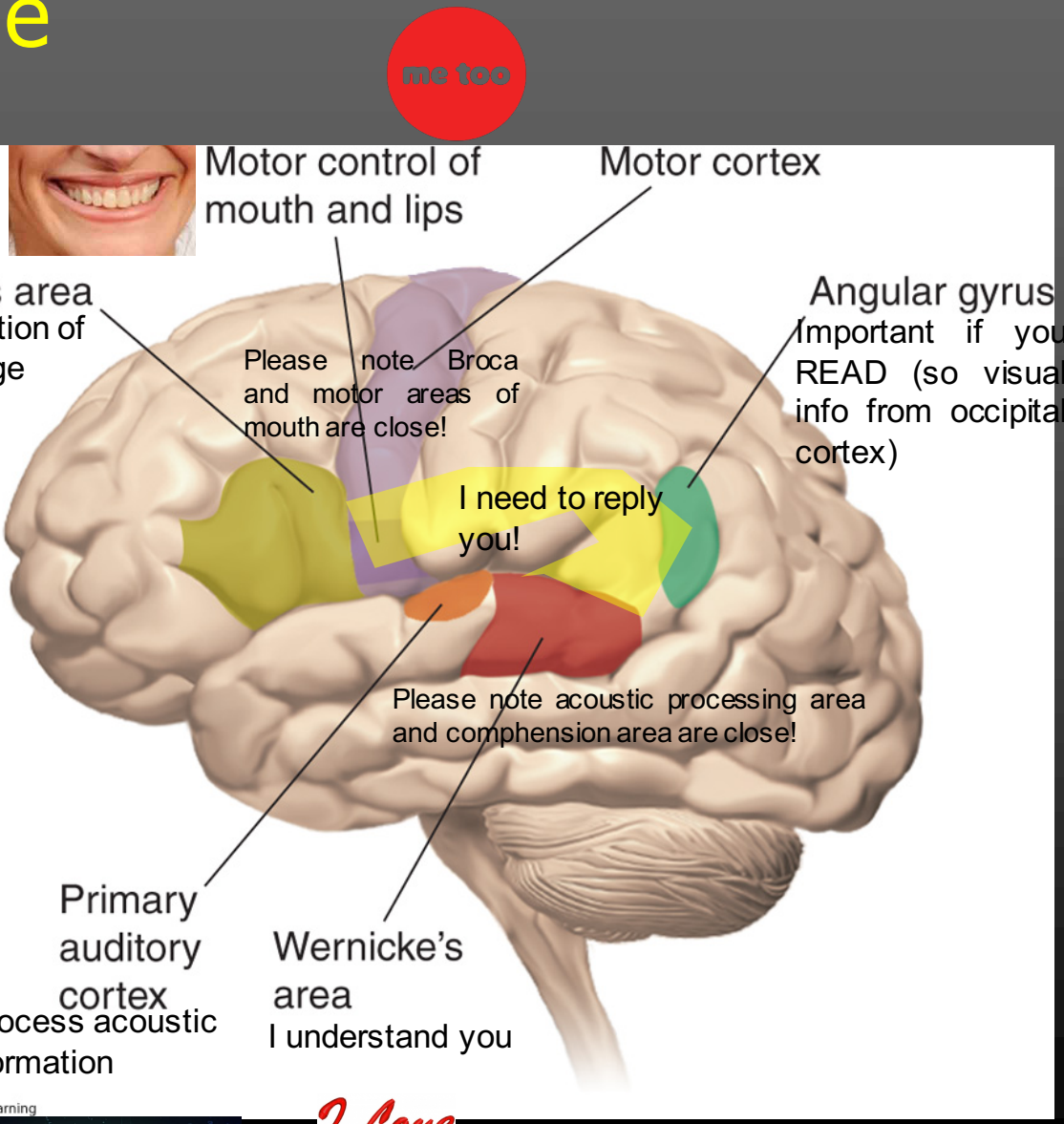
| Type of Aphasia | Location of Damage | Ability to Produce Speech | Ability to Comprehend Meaning of Spoken Words | Does Person Exhibit Paraphasia (Sound Substitutions)? | Ability to Repeat Spoken Words Accurately | Ability to Name Objects |
|---|---|---|---|---|---|---|
| Broca's aphasia | Broca's area | Not fluent | Good | Not common | Poor | Poor |
| Wernicke's aphasia | Wernicke's area | Fluent | Poor | Common | Poor | Poor |
| Conduction aphasia | Arcuate fasciculus | Fluent | Good | Common | Poor | Poor |
| Global aphasia | Broca's area, Wernicke's area, and the arcuate fasciculus | Not fluent | Poor | Variable | Poor | Poor |

When you right hemisphere is required to provide a verbal response

but pretend not to have listen

# LANGUAGE

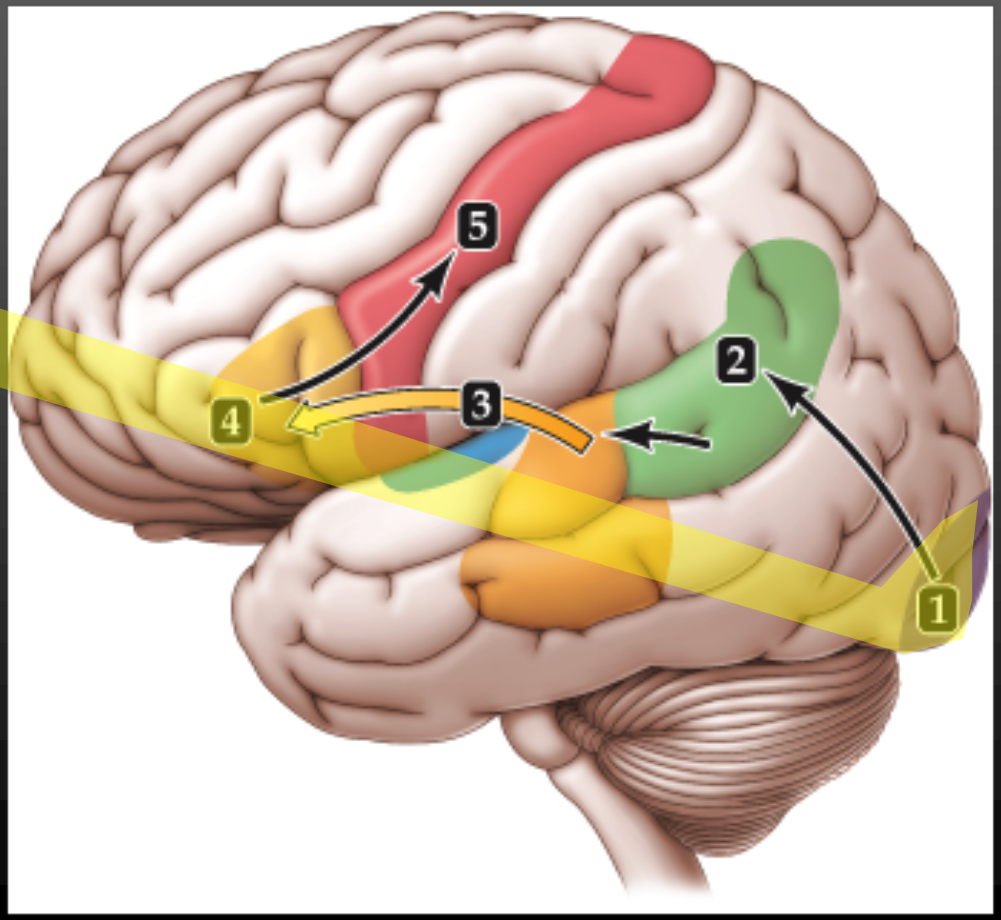
## A short summary of main brain areas related to language



# LANGUAGE

## WERNICKE-GESCHWIND MODEL

Please read this word…

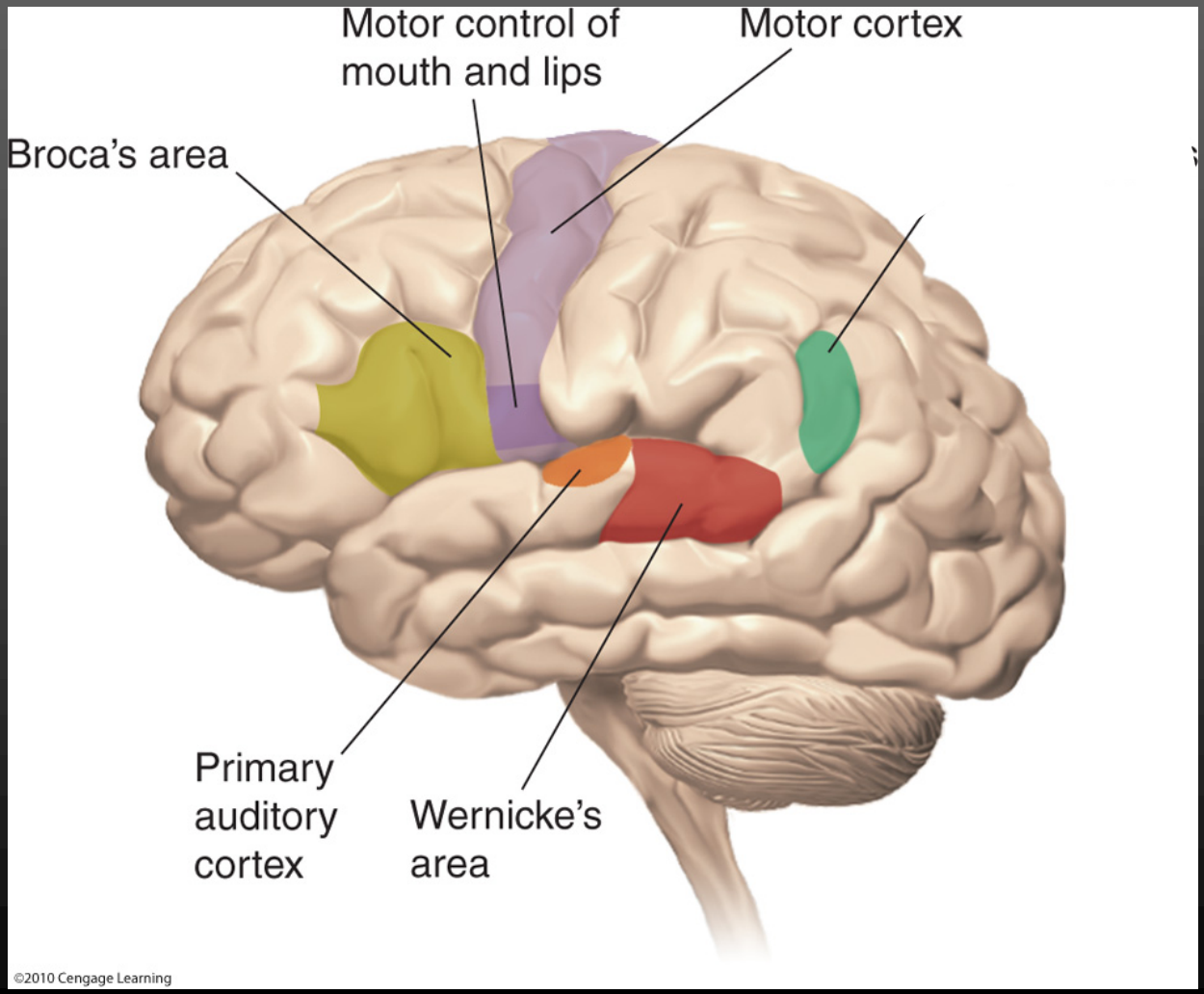



# LANGUAGE

## WERNICKE-GESCHWIND MODEL

Please repeat with me

CHAIR



READING

WRITING

# LANGUAGE

## DISORDERS OF READING AND WRITING

Reading and writing developed relatively recently in human history, probably at some point in the past 5,000 to 6,000 years.

For most people, reading and writing are localized in the same hemisphere as speech.

Unlike spoken language, people do not learn reading and writing simply through exposure.

**ALEXIA** (reading disorder)

What's your name?
Andrea

Where do you live?
Rome

OK Production and Comprehension of speech

Can you read this name?
?!?

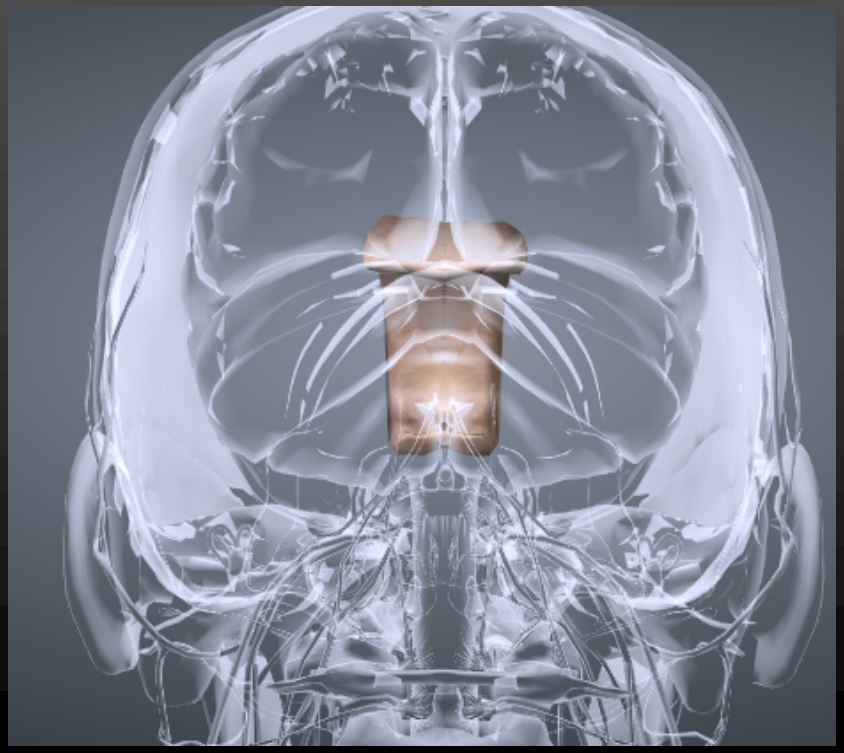
# LANGUAGE

## DISORDERS OF READING AND WRITING

**ALEXIA** (reading disorder)

**LEFT OCCIPITAL CORTEX**
They cannot perceive well "written words"

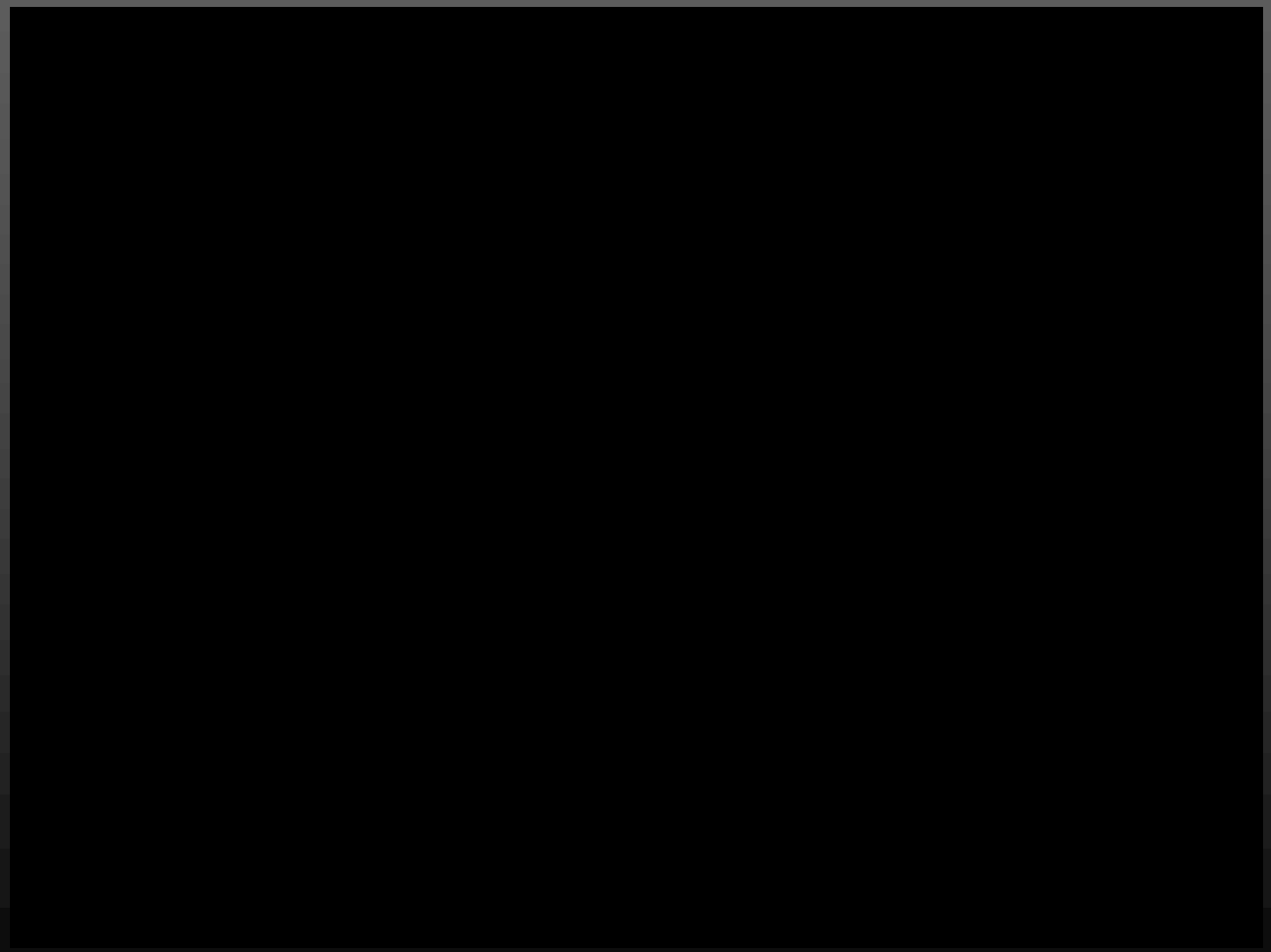
**CORPUS CALLOSUM**
Prevent to transfer info to the right hemisphere (that works properly)



# LANGUAGE

## DISORDERS OF READING AND WRITING

### ALEXIA



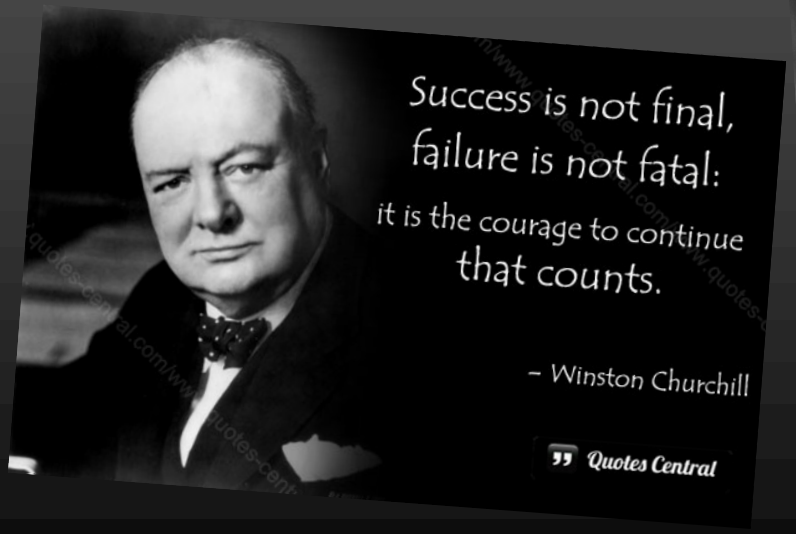
# LANGUAGE

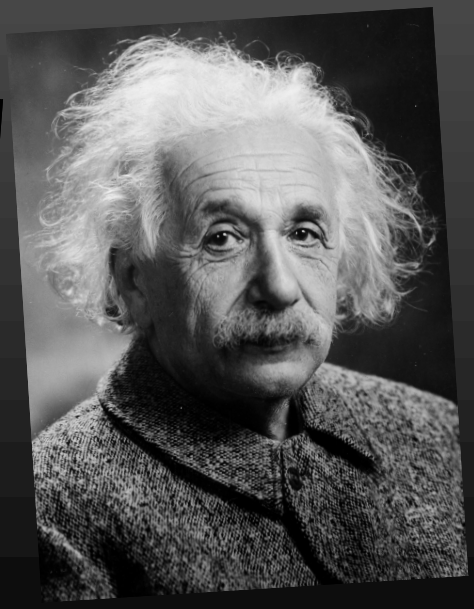
## DISORDERS OF READING AND WRITING

### DYSLEXIA

Unexpected difficulty in reading fluently in spite of normal intelligence and exposure to normal teaching methods.

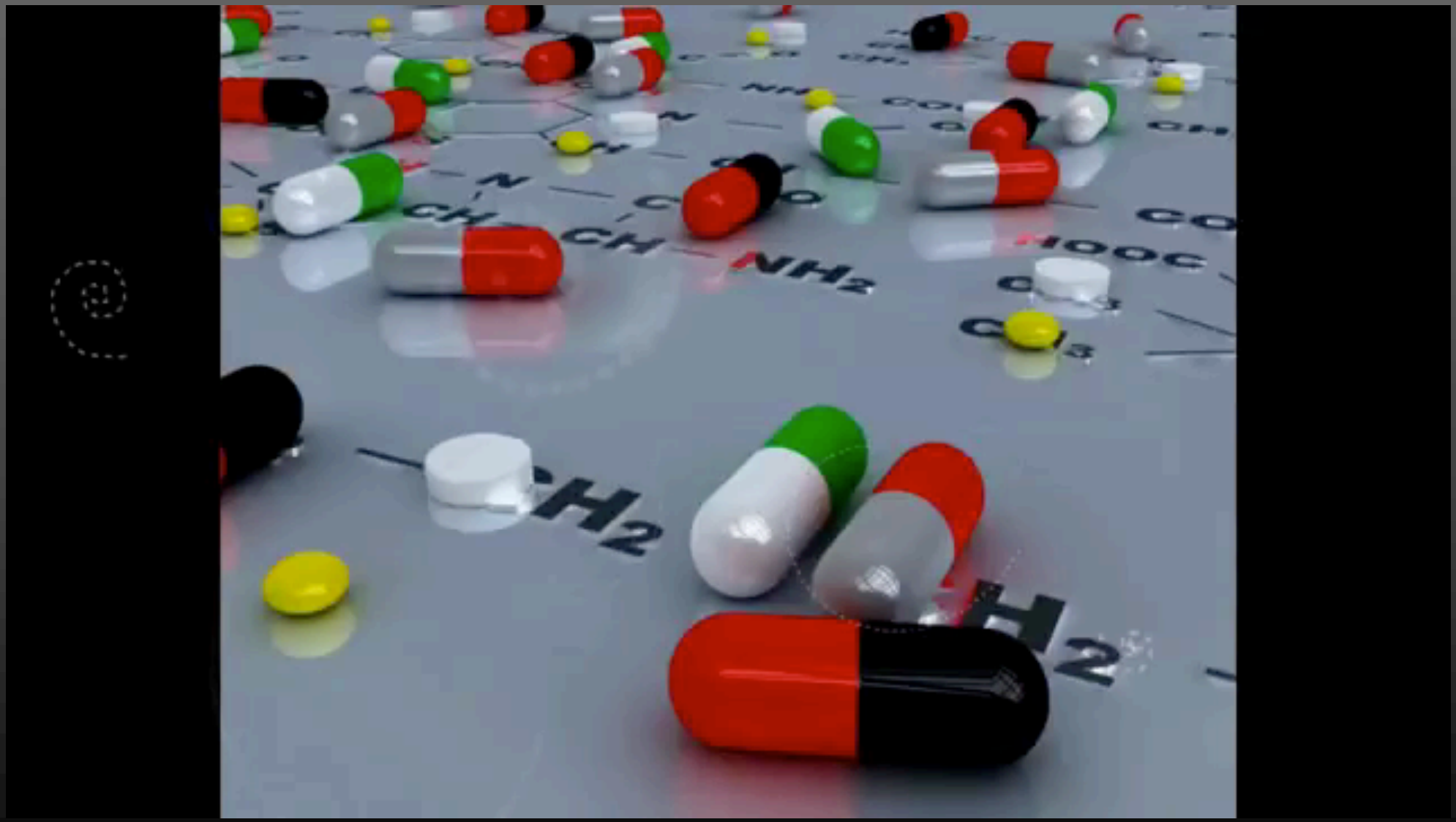
It is the most common form of learning disability
10 to 30 % of the population



# LANGUAGE

## DYSLEXIA

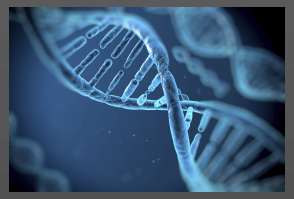


# LANGUAGE

## DISORDERS OF READING AND WRITING

## DYSLEXIA

Important genetic origin

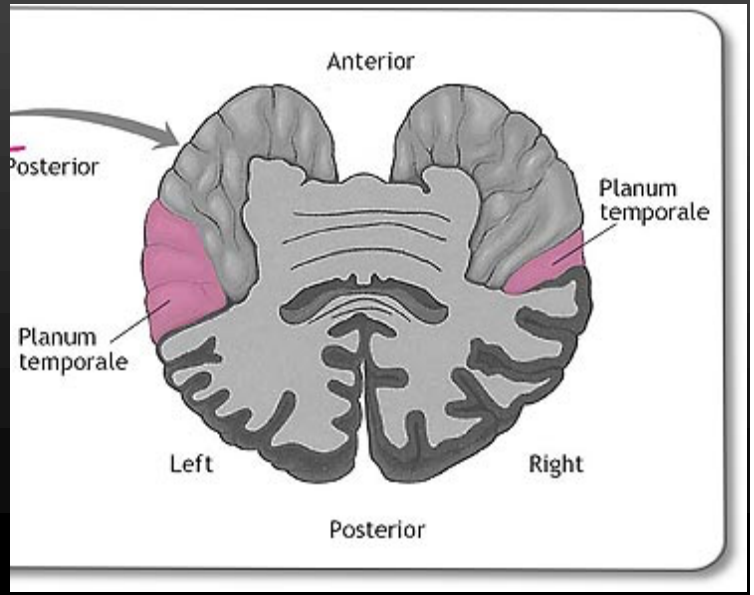


A parent with dyslexia has a 23 to 65 % chance of producing a child with dyslexia, and 40 % of the siblings of a child with dyslexia will also have the disorder

Anatomical features of dyslexia include differences in hemispheric symmetry.

The left planum temporale is usually larger in people whose language functions are located in the left hemisphere.

Participants with dyslexia have less difference between the right and left planum temporale

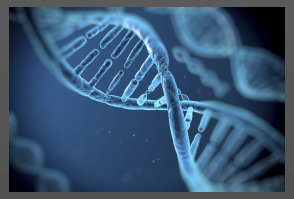


# LANGUAGE

## DISORDERS OF READING AND WRITING

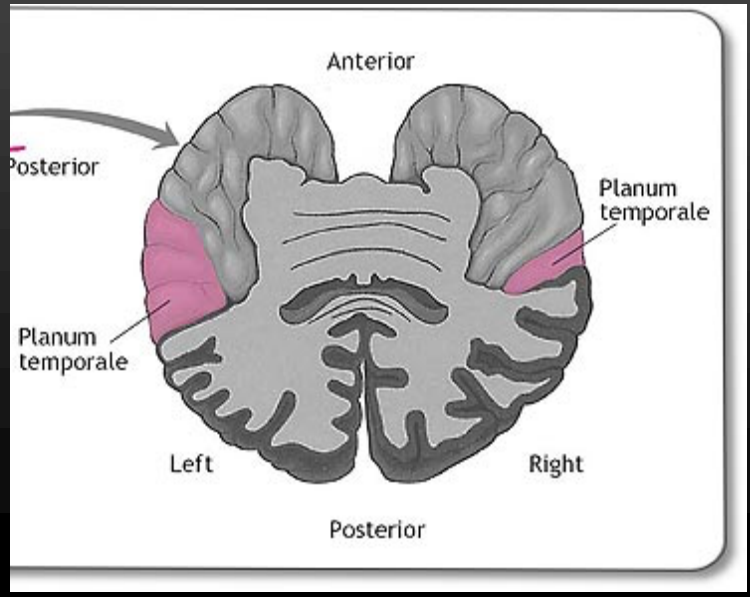
## DYSLEXIA

Important genetic origin



A parent with dyslexia has a 23 to 65 % chance of producing a child with dyslexia, and 40 % of the siblings of a child with dyslexia will also have the disorder

People with dyslexia are slightly more likely to be left-handed or ambidextrous than people without dyslexia

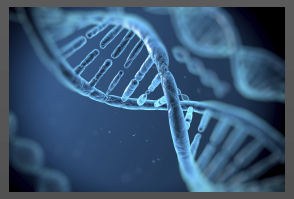


# LANGUAGE

## DISORDERS OF READING AND WRITING

### DYSLEXIA

Important genetic origin



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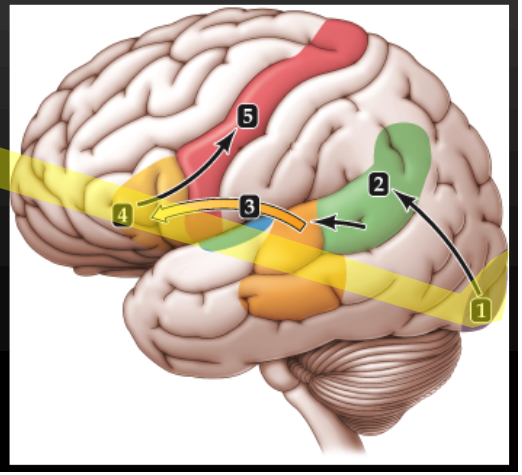
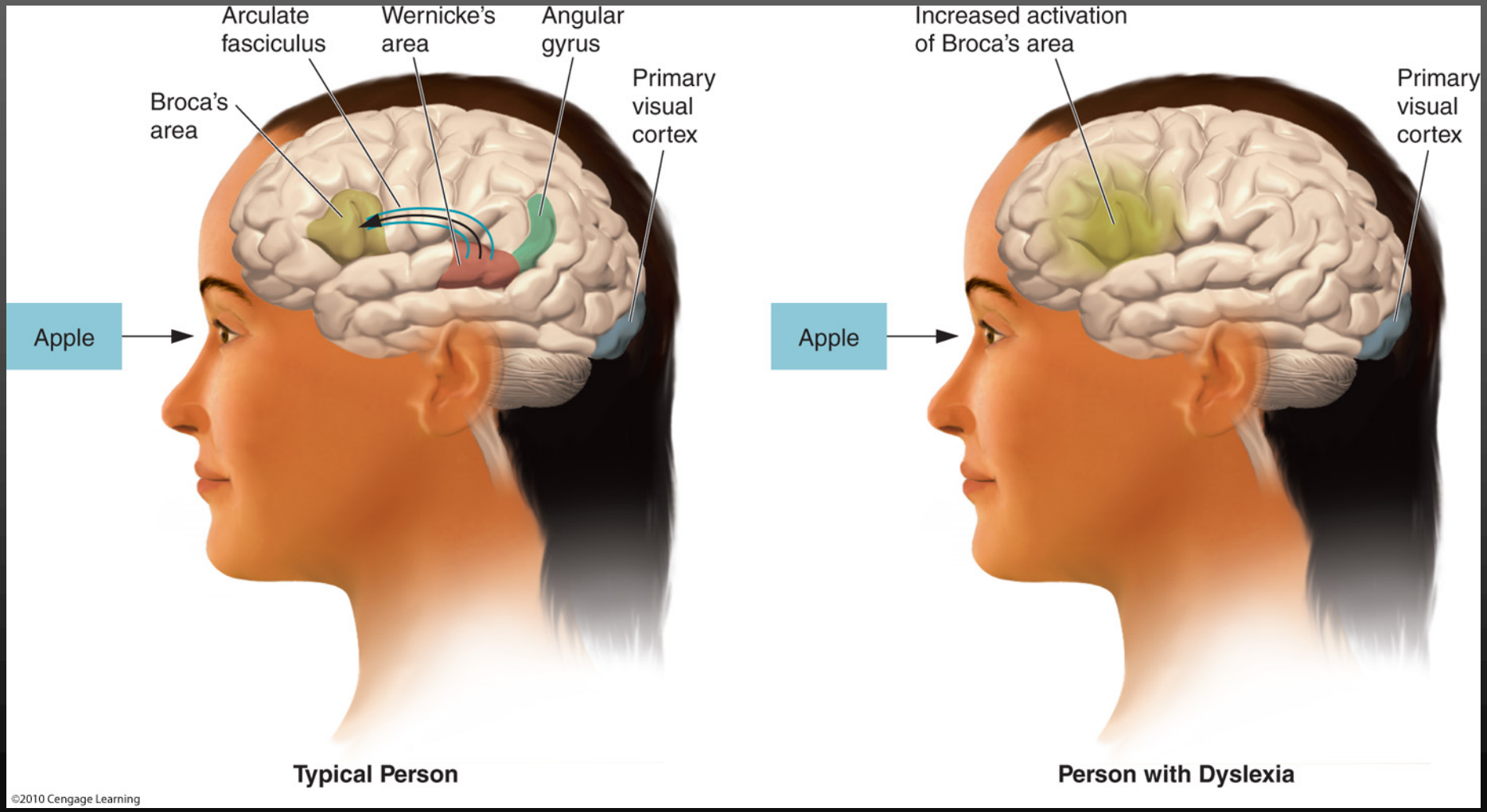



In readers with dyslexia, the posterior language areas are hardly used. Instead, there is a much greater activation in the anterior language areas.

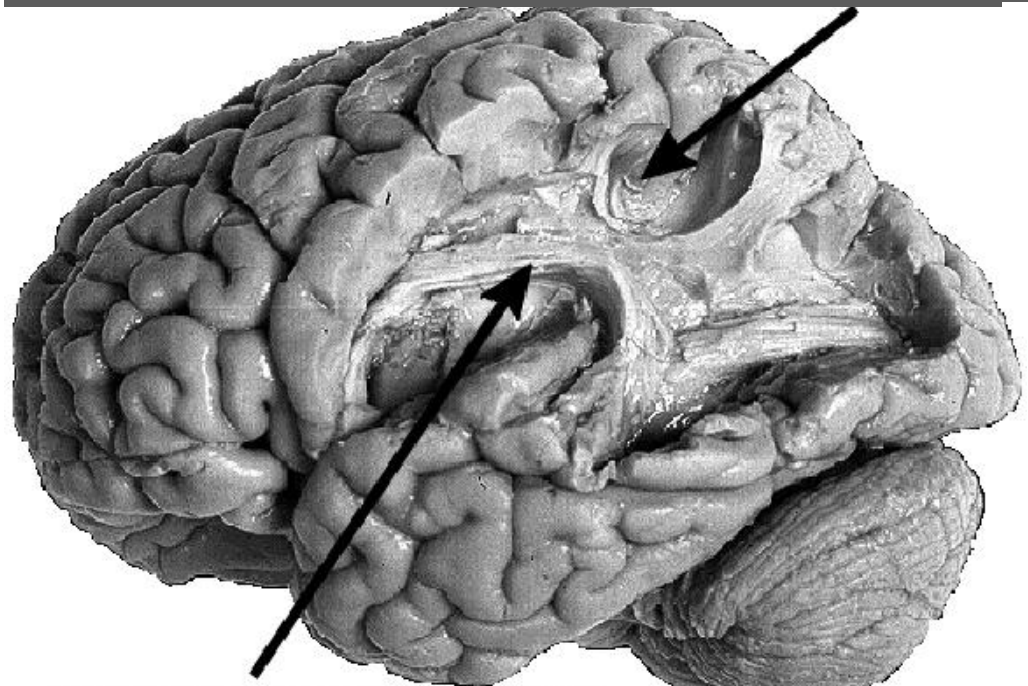
# LANGUAGE

## DISORDERS OF READING AND WRITING

### DYSLEXIA

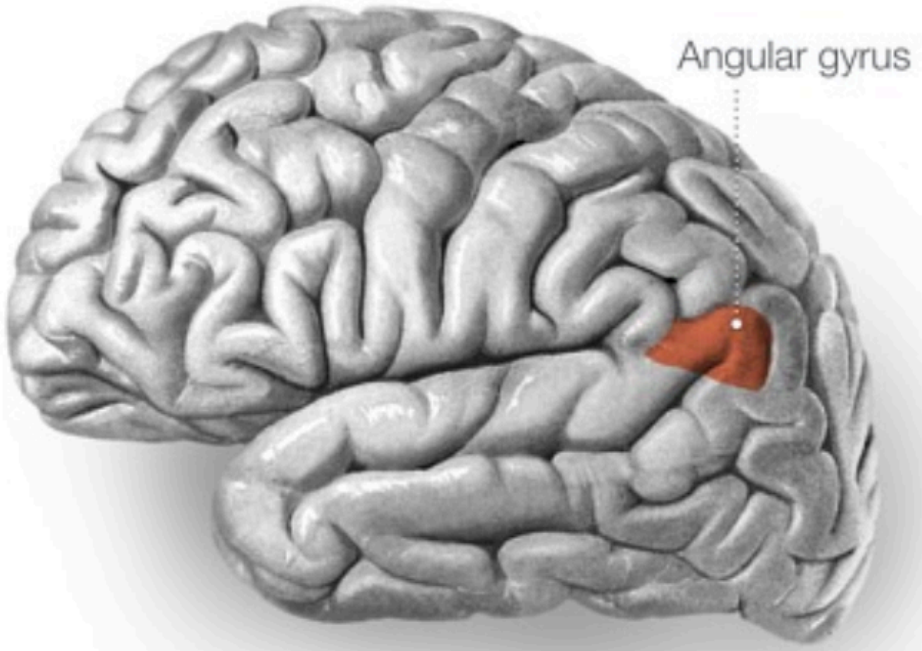


## Arcuate fasciculus

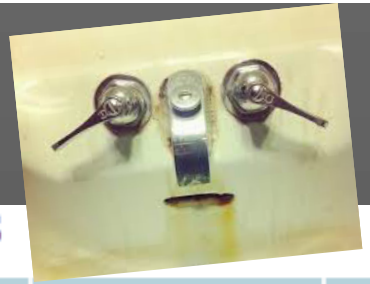


The arcuate fasciculus connects the frontal lobe with temporal and parietal lobes

## Angular gyrus



# LANGUAGE



## Summary Table: The Major Aphasias

| Type of Aphasia | Location of Damage | Ability to Produce Speech | Ability to Comprehend Meaning of Spoken Words | Does Person Exhibit Paraphasia (Sound Substitutions)? | Ability to Repeat Spoken Words Accurately | Ability to Name Objects |
|---|---|---|---|---|---|---|
| Broca's aphasia | Broca's area | Not fluent | Good | Not common | Poor | Poor |
| Wernicke's aphasia | Wernicke's area | Fluent | Poor | Common | Poor | Poor |
| Conduction aphasia | Arcuate fasciculus | Fluent | Good | Common | Poor | Poor |
| Global aphasia | Broca's area, Wernicke's area, and the arcuate fasciculus | Not fluent | Poor | Variable | Poor | Poor |
| Transcortical motor aphasia | Supplementary motor area, cortex adjacent to Broca's area | Not fluent | Good | Common | Good | Poor |
| Transcortical sensory aphasia | Cortex at the junction of temporal, parietal, and occipital lobes | Fluent | Poor | Common | Good | Poor |

# LANGUAGE

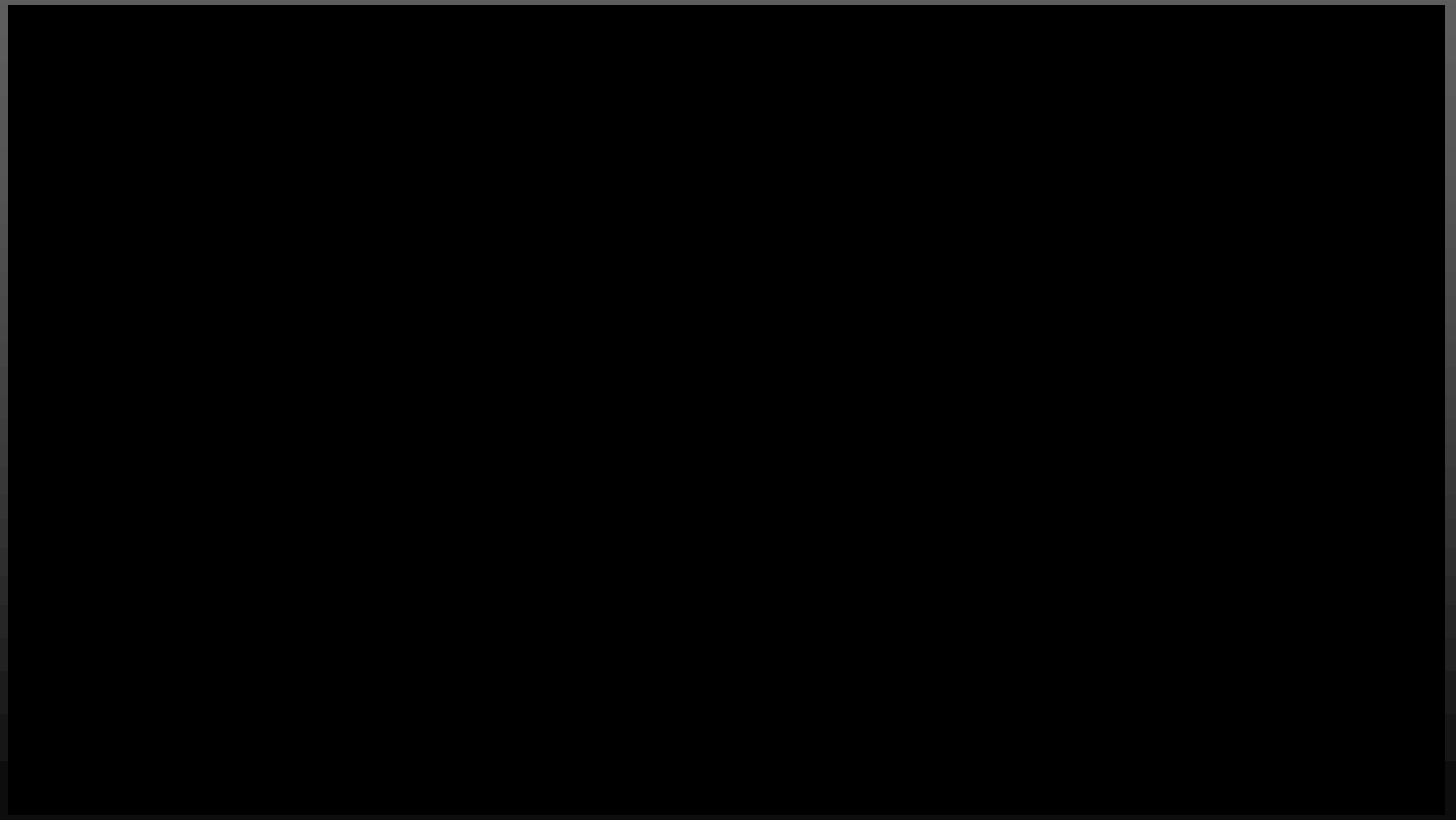
## DISORDERS OF READING AND WRITING

(1.48-)

# LANGUAGE

## DISORDERS OF READING AND WRITING

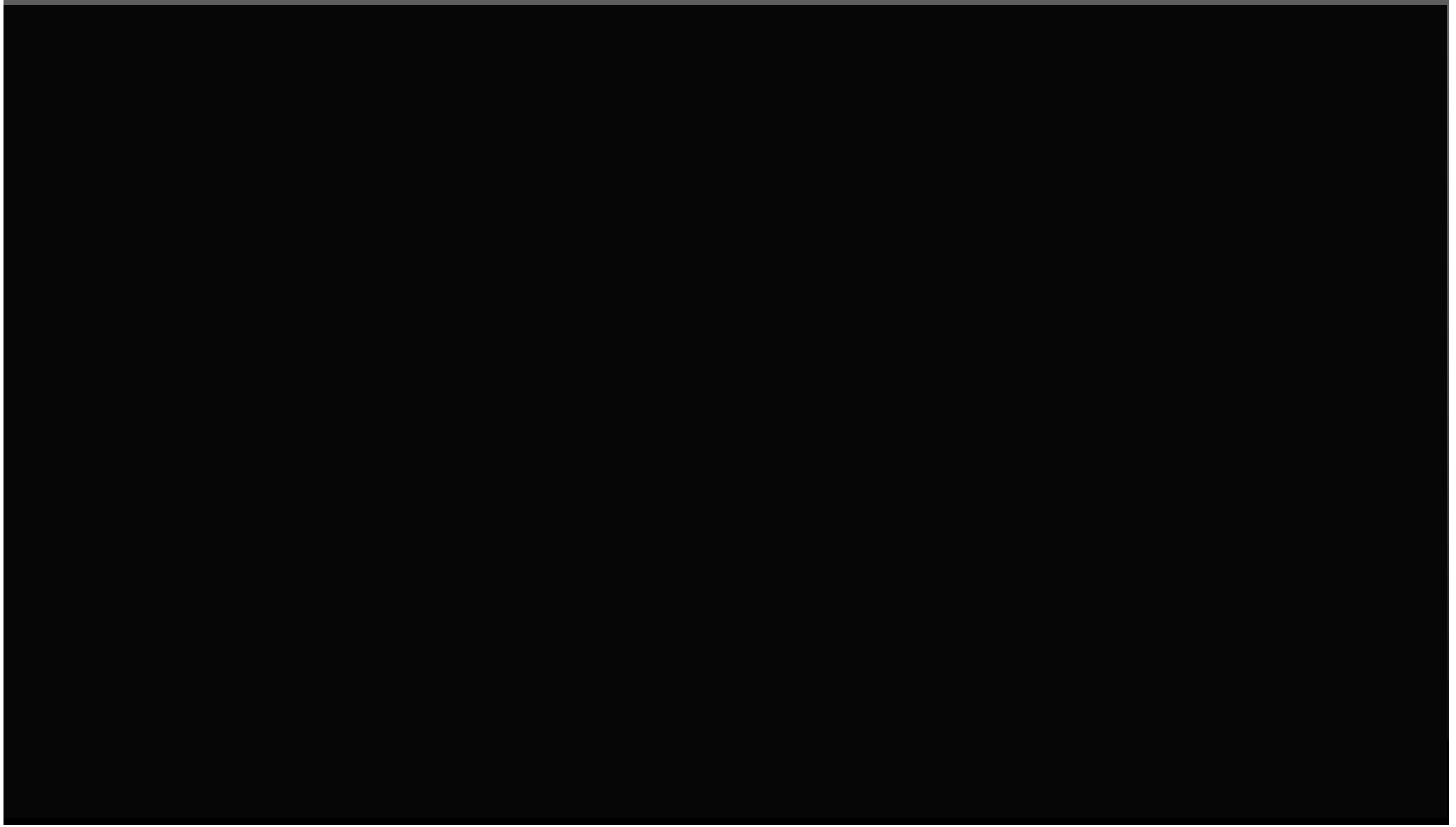
(2-32 – 3.15)



# LANGUAGE

## DISORDERS OF READING AND WRITING

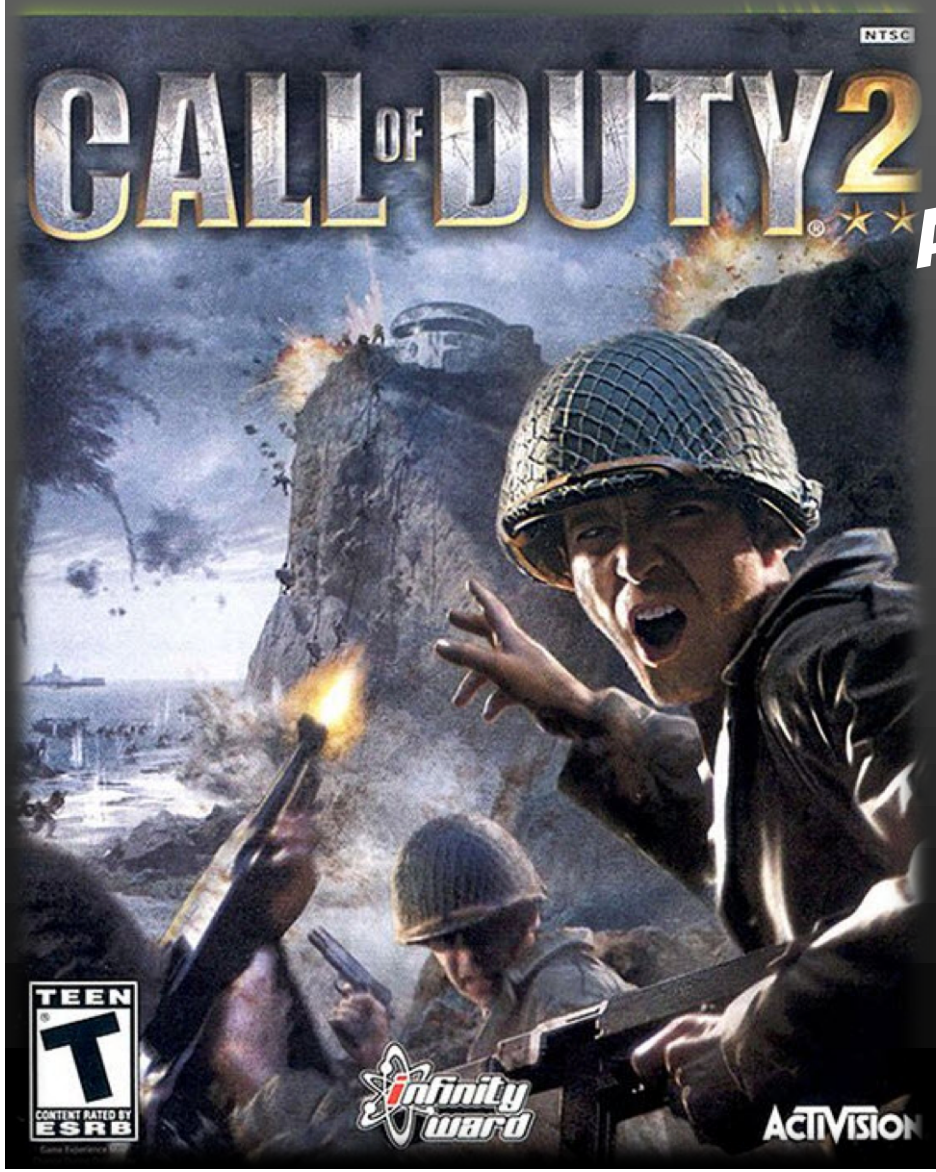
(0-3.30)



# LANGUAGE

## DISORDERS OF READING AND WRITING

**Action video games can help!!**




# LANGUAGE

## DISORDERS OF READING AND WRITING

### DYSLEXIA

# LANGUAGE

## DISORDERS OF READING AND WRITING

**AGRAPHIA** (Writing disorder)

What's your name?
Andrea

Where do you live?
Rome

OK Production and Comprehension of speech

Can you write your name?
?!?

# LANGUAGE

## DISORDERS OF READING AND WRITING

### AGRAPHIA (Writing disorder)

Damage to the motor areas responsible for making skilled movement

**Phonological agraphia**

The inability to write by sounding out words.
They can write familiar words (probably by using visual memory) but not new words or non-sense words.
BRAIN AREA: Left posterior superior temporal gyrus

**Orthographic agraphia**

A condition in which a person can spell phonetically but experiences difficulty spelling words that are spelled irregularly, such as “through”
BRAIN AREA: *unknown*

# STUTTERING

To abnormally repeat or prolong speech sounds when speaking

# LANGUAGE

## STUTTERING


1% adult population

Children begin to stutter between the ages of 2 and 7 years, with a peak onset at about 5 years of age.

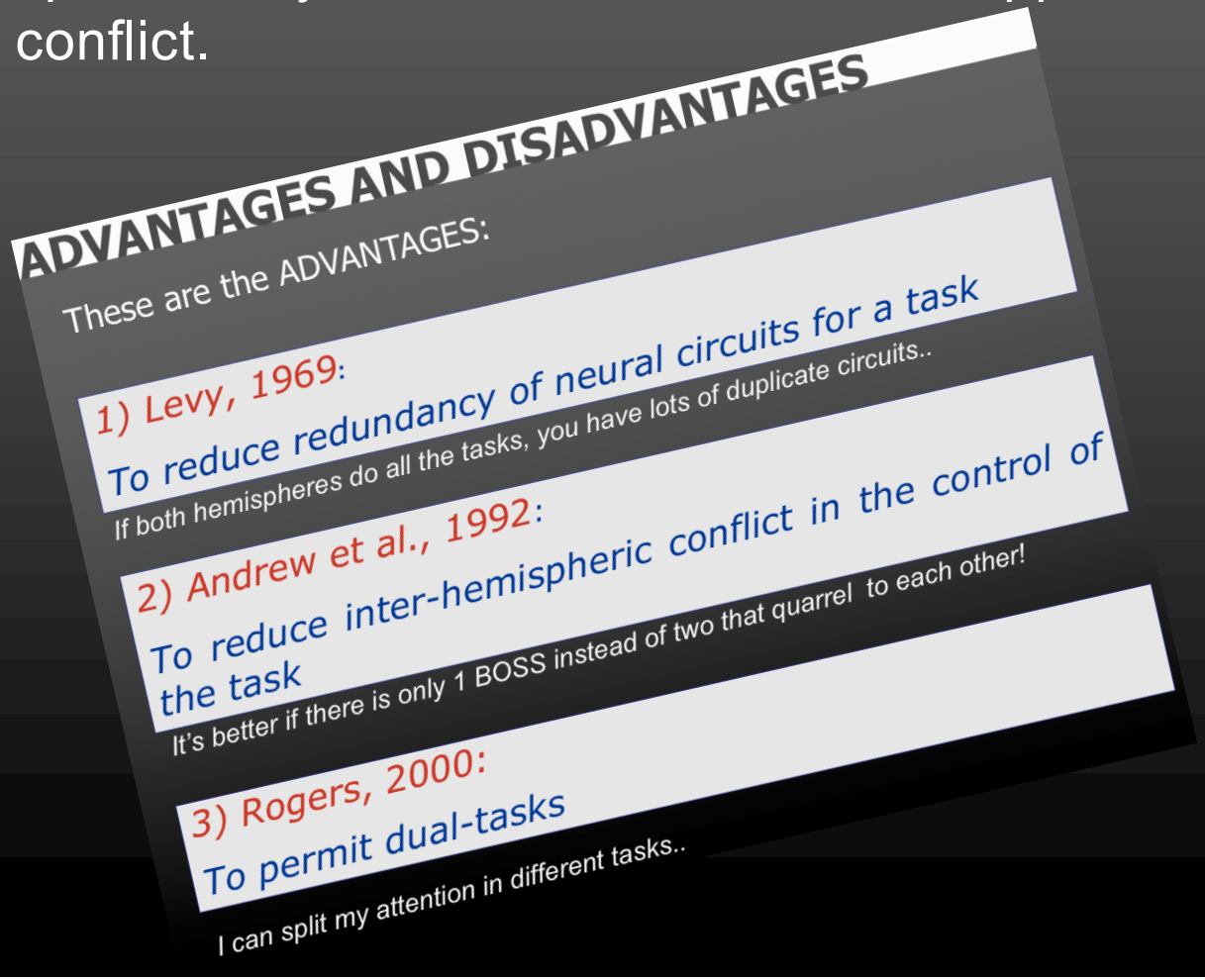
Males are more than 3 times as likely as females to stutter.

# LANGUAGE

## STUTTERING

**WHY?**

1) They process some part of language in the right hemisphere.
As a result, both hemispheres try to control the vocal apparatus simultaneously, leading to conflict.

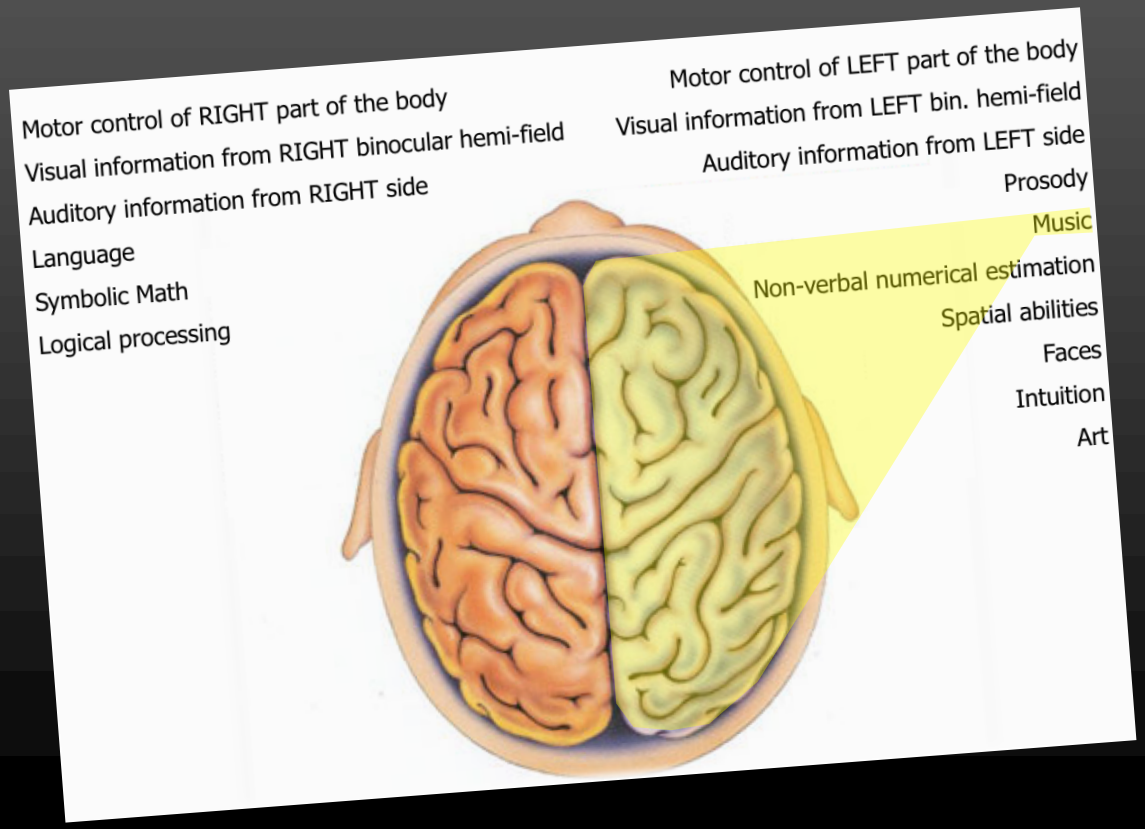


# LANGUAGE

## STUTTERING

**WHY?**

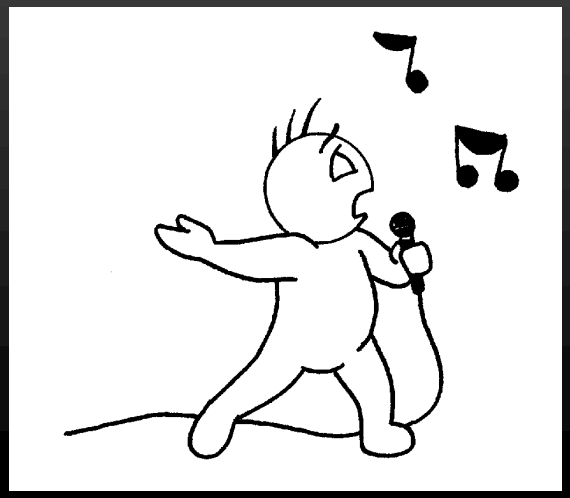
This conflict is resolved to some extent when the stuttering person sings because singing activates right-hemisphere areas that are not otherwise involved in speech.



# LANGUAGE

## STUTTERING and SINGING


0:45-



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(1) the purpose and character of the use, including whether such use is of a commercial nature or is for non-profit educational purposes;
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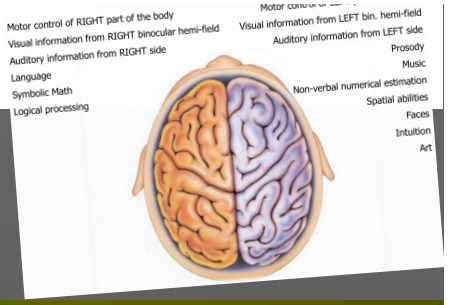
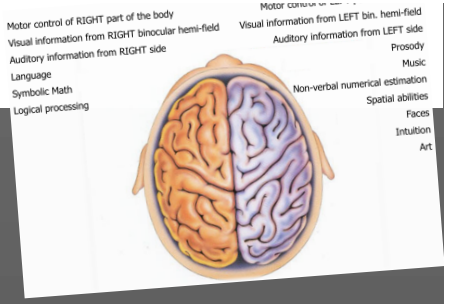
# LANGUAGE

## STUTTERING and SINGING



# LANGUAGE




## STUTTERING and SINGING

## A TMS study (Transcranial magnetic stimulation)

0.00-1.42

# LANGUAGE

## STUTTERING

**WHY?**

2) Abnormal activity in the basal ganglia and midbrain motor structures

Getting closer to the end of chapter 13

INTELLIGENCE

Your face before starting this issue


Your face AFTER my lesson

# INTELLIGENCE

## Definition

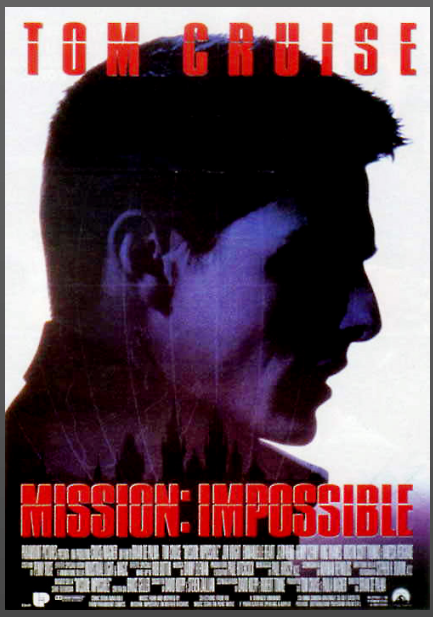
Our ability to engage in “goal-directed adaptive behavior.” (Stenberg & Salter 1982)

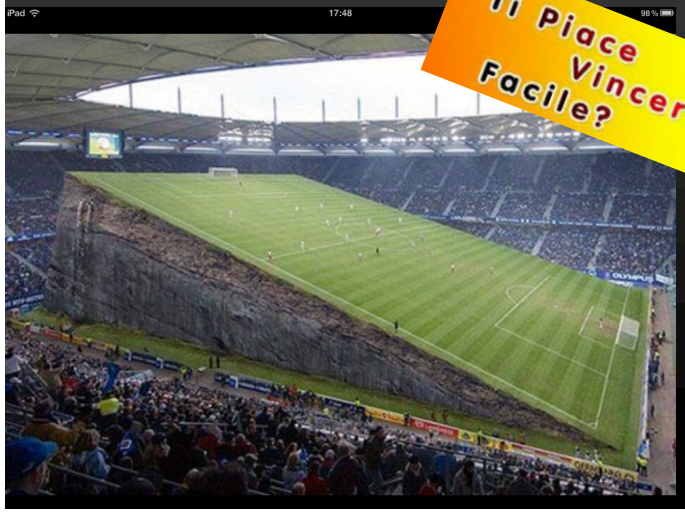
In other words, intelligence reflects our ability to learn and solve problems

# INTELLIGENCE

## Definition

It is simply impossible to have a scale of intelligence of all organisms
(*avoid anthropocentrism*!)




*You like to win easily? Use your own concept of intelligence for all species..*

# INTELLIGENCE

## Definition

Alfred Binet

In 1904, Alfred Binet was charged by the French government to find an objective tool to identify the potential of school children

# INTELLIGENCE

## Definition

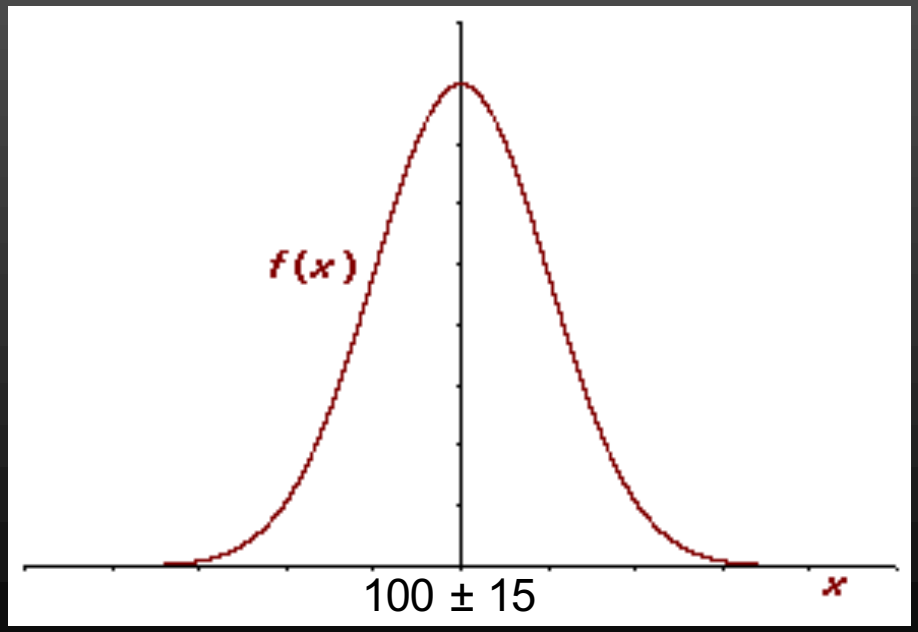
Researchers assumed that relatively bright children behaved cognitively like older children, whereas less intelligent children would behave like younger children.

They devised items that they believed would indicate a child's "mental age" or "intelligence quotient" (IQ).

# INTELLIGENCE

## Definition

The IQ tests used today, such as the Wechsler Adult Intelligence Scale-Revised (WAIS-R) or the Stanford-Binet, are structured in such a way that the results fall along a statistically normal curve



# INTELLIGENCE

## Definition

| IQ Score | Population with This Score (%) | Characteristics |
|---|---|---|
| 130 or above | 2 | Gifted (academics should be easily mastered) |
| 115–129 | 14 | Above average (above-average academic performance) |
| 85–114 | 68 | Average (average academic performance) |
| 70–84 | 14 | Below average (average to poor academic performance) |
| 50–69 | 1.7 | Mild mental retardation (can learn academic skills up to sixth grade) |
| 35–49 | 0.2 | Moderate mental retardation (can learn academic skills up to second grade) |
| 20–34 | 0.08 | Severe mental retardation (can learn to talk and to perform supervised work) |
| Below 20 | less than 0.02 | Profound mental retardation (requires constant supervision) |

# INTELLIGENCE

## How much of our intelligence is determined by our genes?

Comparisons between identical (monozygotic) and fraternal (dizygotic) twins

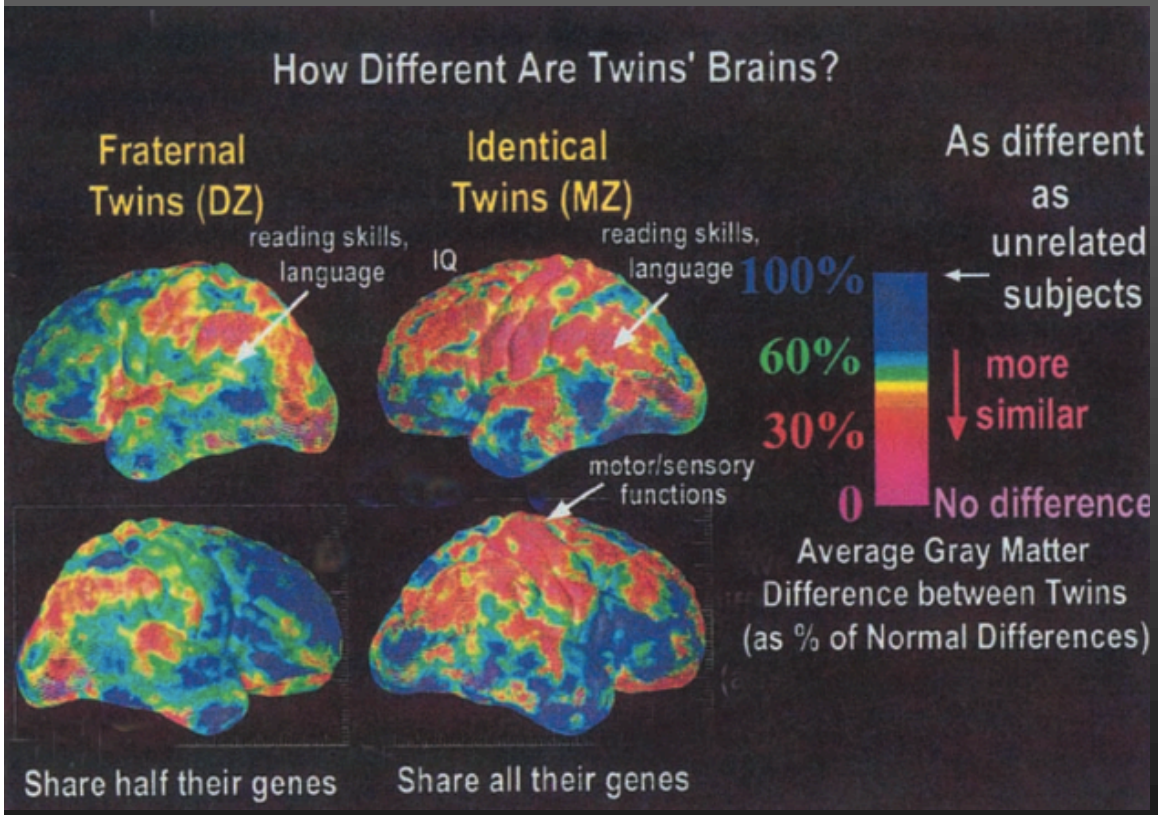
# INTELLIGENCE

## How much of our intelligence is determined by our genes?

Cortical thickness and volume of gray matter are highly correlated with a measure of cognitive ability

# INTELLIGENCE

## How much of our intelligence is determined by our genes?




Monozygotic twins display a .95 correlation in the volume of gray matter

(1.0 correlation would mean the twins had identical gray matter).

The volume of gray matter in monozygotic twins was especially similar in the frontal lobe and language areas.

# INTELLIGENCE

How much of our intelligence is determined by our genes?

HENCE

Gray matter volume is related to GENES, which in turn is associated with cognitive ability (INTELLIGENCE)

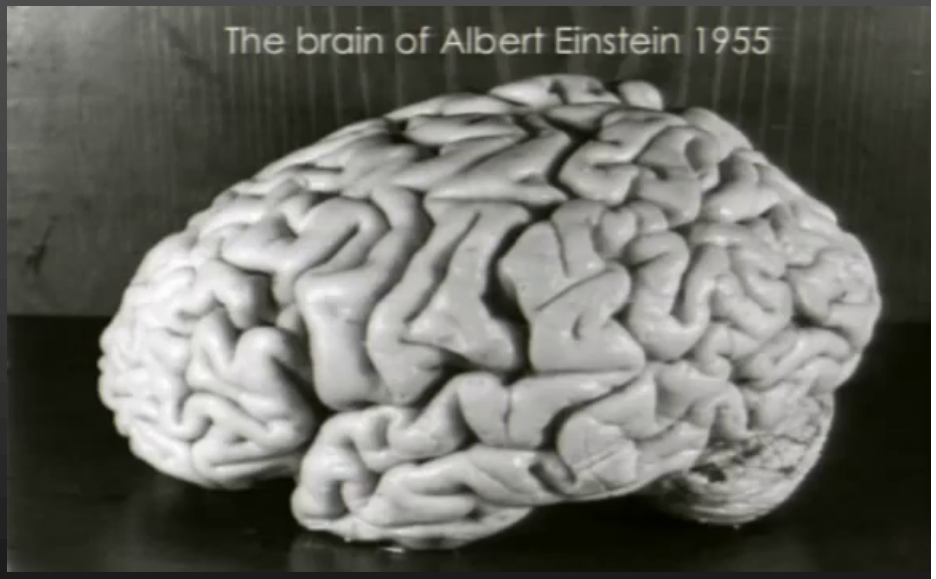
# INTELLIGENCE

## Brain areas related to QI ?

Dahlia Zaidel (2001) examined slides made from Albert Einstein's brain after he died (76 years old).

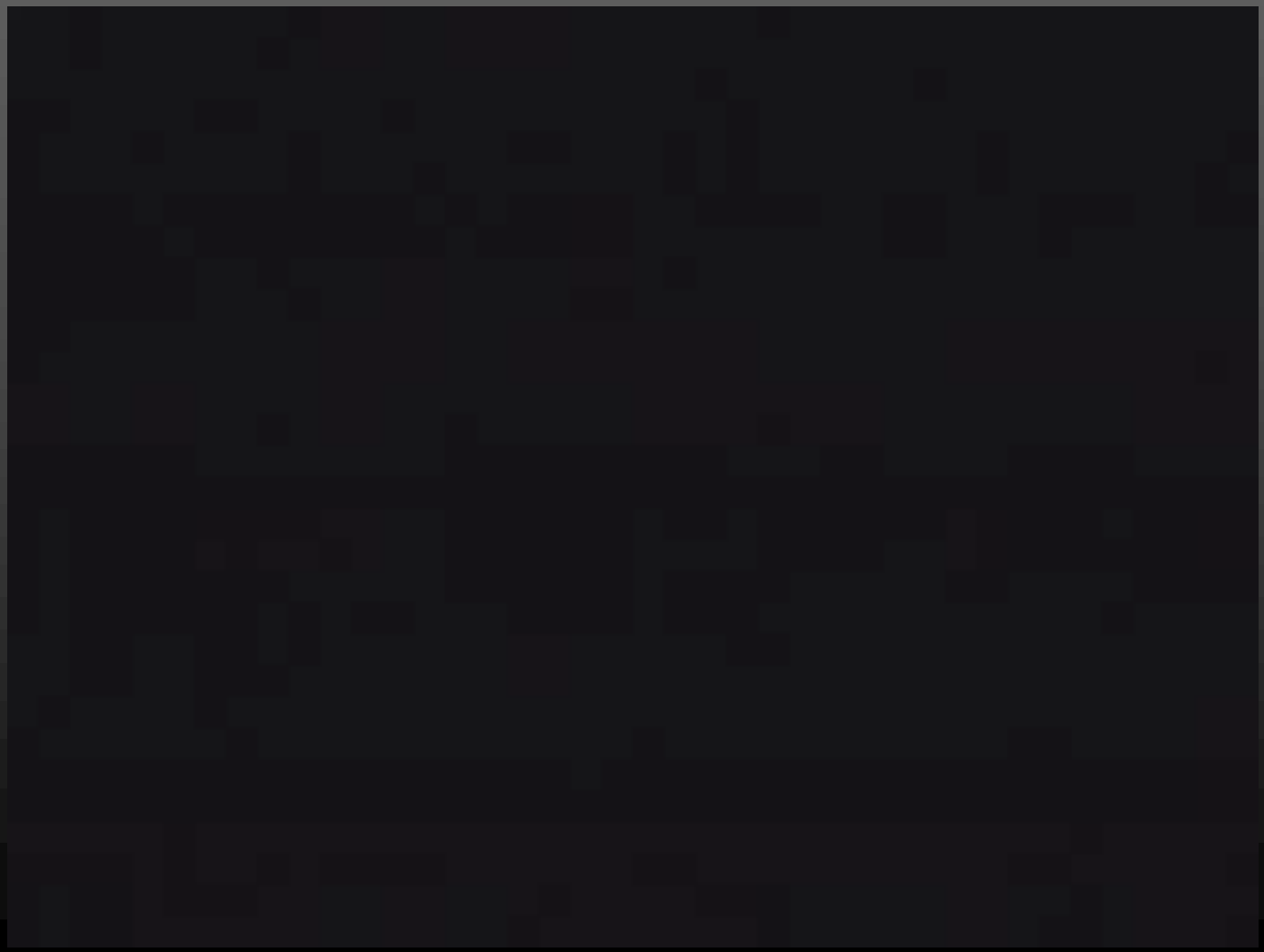
1. Left hippocampus > right one

2. Inferior parietal lobe, an area believed to be related to mathematical and abstract reasoning, was about 15 % larger than comparable areas of control participants.
Most of this difference was due to GLIAL CELLS.



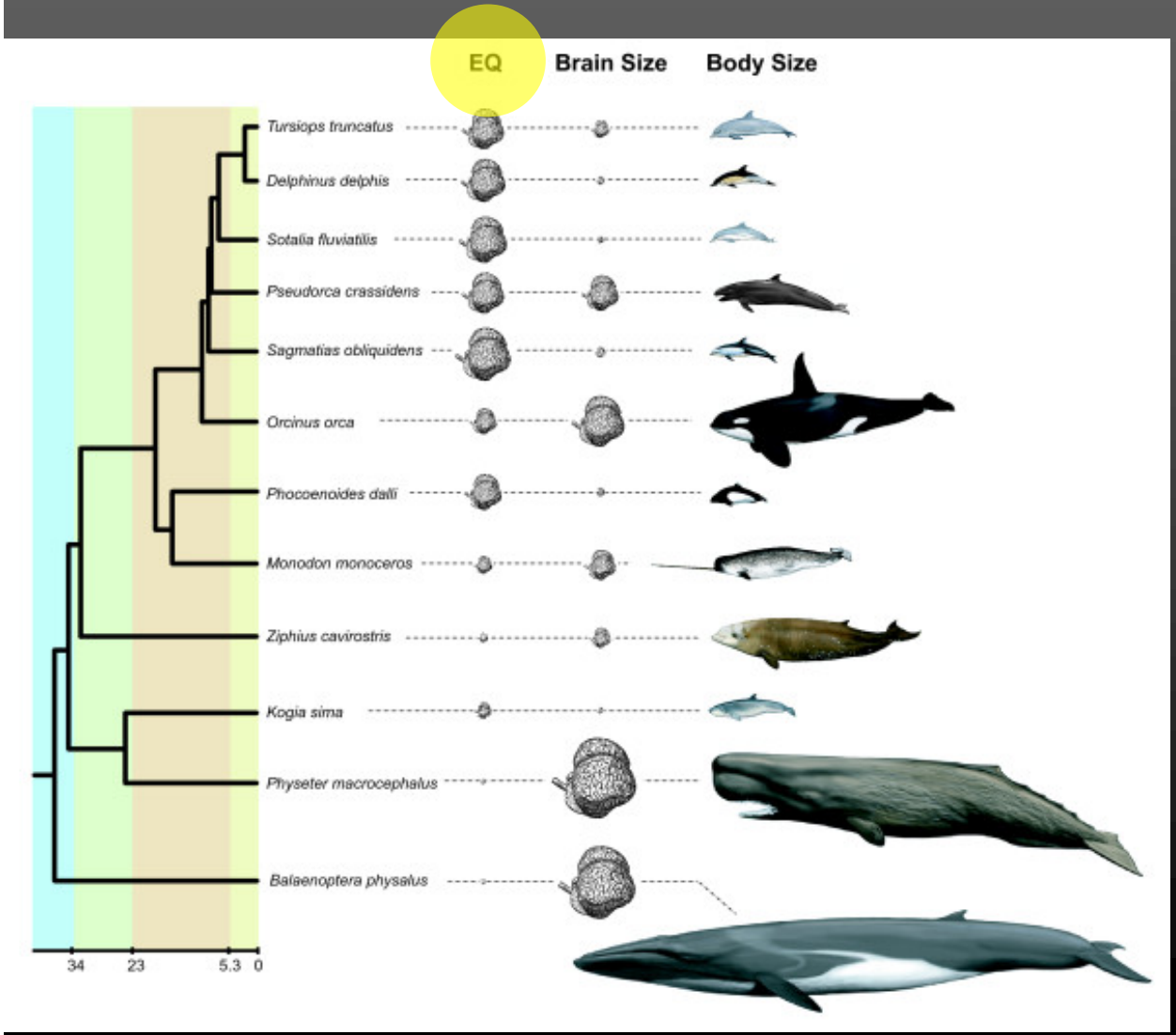
# INTELLIGENCE

Brain areas related to QI ?



# INTELLIGENCE

## Relative brain size is often positively correlated with cognitive abilities in animal models




Relative brain size (brain size compared to body size),!

# INTELLIGENCE

**(a) Brain Weight (g)**

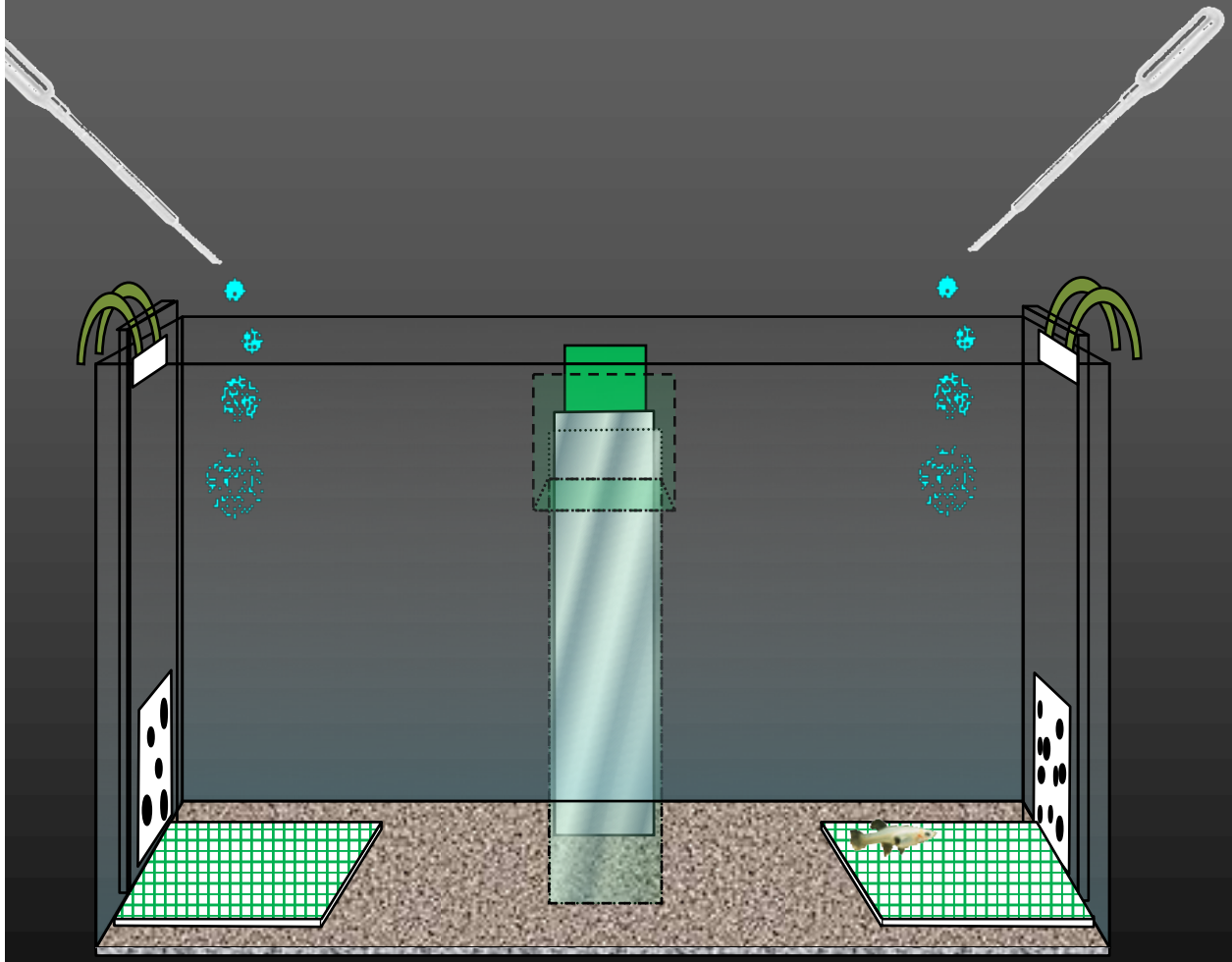
| Squirrel | Cat | Sheep | Chimpanzee | Human | Dolphin | Elephant |
|---|---|---|---|---|---|---|
| 6 | 30 | 100 | 400 | 1,400 | 1,600 | 5,000 |

**(b) Brain Weight as a Percentage of Body Weight**

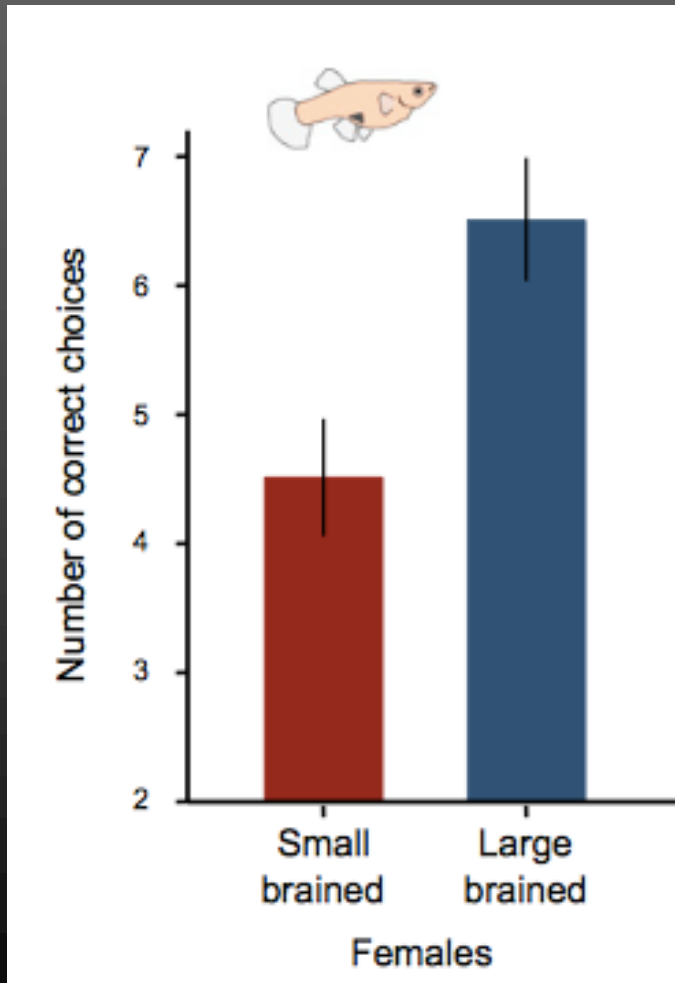
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Brain weight (g) / Body weight (g) | 7,500 / 5,000,000 | 100 / 40,000 | 6 / 900 | 30 / 3,300 | 1,600 / 173,000 | 400 / 42,000 | 1,400 / 60,000 |
| Percentage: | 0.15% | 0.25% | 0.67% | 0.91% | 0.92% | 0.95% | 2.33% |

# INTELLIGENCE

## Brain size is positively correlated with cognitive abilities in animal models



CURRENT BIOLOGY, 2013




Cognitive Ability Improves with Increased Brain Size

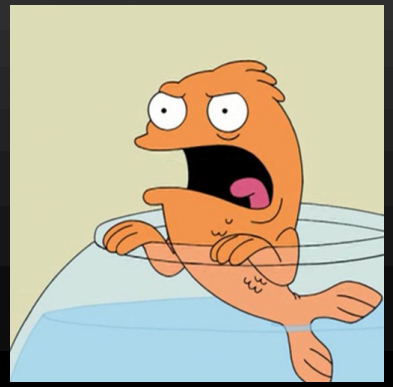
# INTELLIGENCE

Larger brain, higher numerical abilities…

Is that enough to conclude that intelligence is positively correlate to brain size?

1) PERSONALITY ?

Larger brain, bold personality… hence I am braver during the task!



# INTELLIGENCE

Larger brain, higher numerical abilities…

Is that enough to conclude that intelligence is positively correlate to brain size?

## 2) MOTOR SKILLS ?

Larger brain, more active fish… hence I am more willing to swim and do more trials

# INTELLIGENCE

## HENCE

We must pay attention before drawing conclusions… we need to assess whether this correlation is due to other concumitant factors.

# INTELLIGENCE

## A Single number of all my intelligence?!?

This seems to be quite a limited pictures, according to several psychologists …

Social intelligence = 0/100
Numerical estimation = 99/100

Min 4.05

*Can you count quickly the number of toothpicks?*

# Multiple Intelligences

Howard Gardner

(Harvard University)

# 1/7) Linguistic Intelligence

- Ability to write or read
- Ability to rhyme
- Ability to name
- Good speakers

# 2/7) Logical/Math Intelligence

- Ability to do math
- Ability to estimate quantities

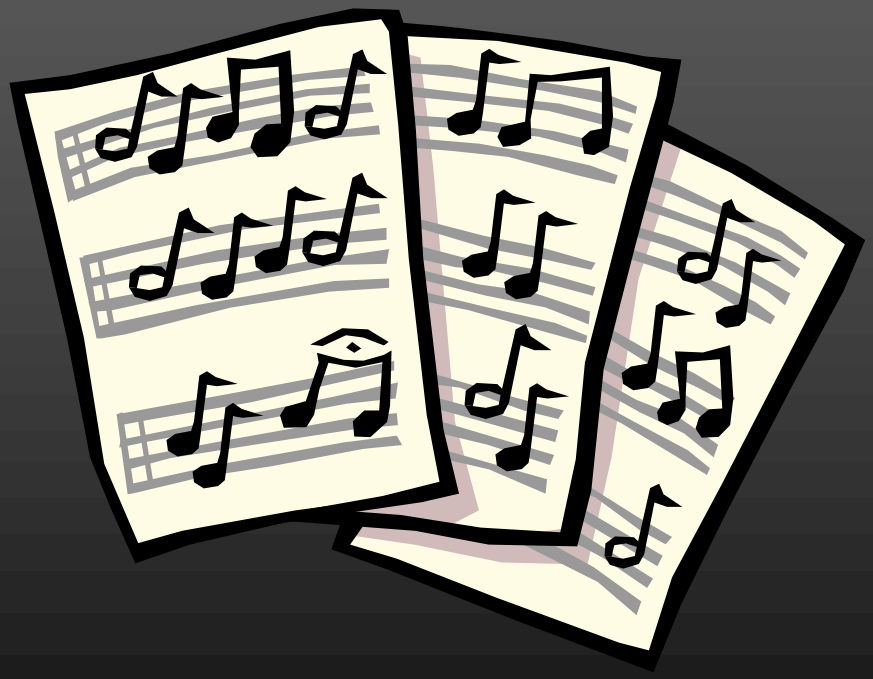
# 3/7) Spatial Intelligence

- Mental rotation
- Navigation
- Draw pictures correctly

# 4/7) Kinesthetic Intelligence

- Body moment
- Position of the body

# 5/7) Musical Intelligence



- Read music
- Rhythm, armony, melody perception
- Play an instrument

# 6/7) Interpersonal Intelligence

- Social skills

# 7/7) Intrapersonal Intelligence

- Good at analyzing our own strengths and weaknesses
- Excellent self-awareness

# INTELLIGENCE

## Multiple intelligences

Of course, we can have a pleasant life without one of them (e.g., musical intelligence)

WHICH IS THE MOST IMPORTANT INTELLIGENCE FOR *Homo sapiens sapiens*?

# INTELLIGENCE

## Multiple intelligences

**Interpersonal intelligence** is fundamental!

0.00-1.03