

HOMININS and BIPEDALISM

PART 2.....

SKULL CHANGES ASSOCIATED WITH BRAIN DEVELOPMENT - ENDOCRANIAL FEATURES

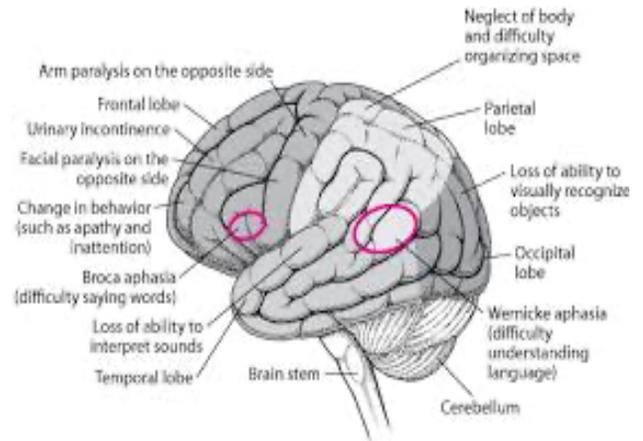
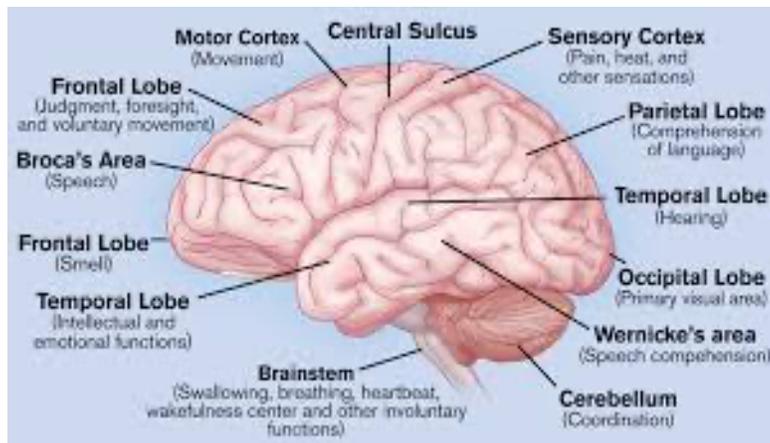
- Endocranial means 'inside the cranium'
- The shape and convolutions of the brain itself are reflected in the ridges on the inside surface of the cranium.
- Latex or plaster can be poured into the cranium to form an endocast.
- Endocasts are studied for characteristics such as shape and volume of the brain, and any significant structures that may give clues as to the abilities of the animal.

BRAIN

- Ape brain – 450cm³
- Human brain – 1375cm³
- Greatest expansion is in the forebrain called the cerebrum.
- The **outer cortex of the cerebrum** is folded-increasing the surface to volume ratio.
- In humans the cerebral cortex is even more folded than in chimps.
- This area is involved in reasoning, mathematical abilities, artistic ability, language, abstract thought and imagination, as well as creating sensory perceptions – sight, smell, taste, touch and hearing.

Cerebellum

- Cerebellum is greatly enlarged in humans.
- Cerebellum is the part of the brain concerned with balance and muscular co-ordination
- Related to the ability to carry out finely co-ordinated finger movements.



SPEECH

- Humans are regarded as the only animals that can communicate complex ideas by means of language.
 - Speech was probably one of the most significant advances in human evolution.
 - The ability to make sounds is partly due to the structure of the pharynx and partly in brain organisation.
 - Communication by speech is thus a complex activity and demands a highly organised brain.
1. **BROCA'S AREA** – this is responsible for the organisation of sounds into meaningful sequences.
 2. **WERNICKE'S AREA** – this region is concerned with the interpretation of sounds that are heard.

ADAPTIVE VALUE

- Speech greatly improves the ability to coordinate activities eg hunting large prey, defence against predators.
- Group activities more successful.
- More success in hunting - more food – healthier members of the group – the greater their survival - and ability to produce and raise offspring.
- Significant improvement in diet together with cultural evolution of tool manufacture and controlled use of fire, provided the brain with increased amounts of protein, greatly facilitating the brain's development (positive feedback cycle).

HOMININS and BIPEDALISM

GENETIC EVIDENCE FOR BRAIN DEVELOPMENT

CASE STUDY

- A British family (16 members) over 3 generations had severe speech problems.
- Speech was unintelligible, difficulty understanding other's speech, had difficulties applying rules of grammar.
- Had problems making complex movements of mouth and tongue.
- They were found to have a mutated form of the FOXP2 gene.

FOXP2 gene

- FOXP2 gene (language gene) found on chromosome 7.
- Gene is concerned with the development of language and speech
- The human and Neanderthal variant of FOXP2 differs by just 2 amino acids from its counterpart in chimpanzees.
- This could account for the difference in speech in humans and absence in chimpanzees.
- **FOXP2 is thus a mutation that fuelled the evolution of the brain.**

SRGAP2 gene

- This gene helps drive the development of the neocortex.
- The neocortex in humans controls brain functions such as language and conscious thought.
- People with mutations in this gene are prone to epileptic fits.
- This gene went through a number of duplications (3.4MYA, 2.45 MYA)
- Duplication can result in increased neuron connectivity and overall increase in the brain's processing power.
- It is likely that duplication 2.5MYA were instrumental in allowing our ancestors' brains to go through a marked increase in size, organisation, complexity, etc.
- This gene duplication would have changed brain development dramatically and immediately.

OTHER EVIDENCE

SOME METHODS OF DATING FOSSILS.

1. RADIOCARBON DATING.

- Relies on the observation that cosmic radiation from stars bombards our atmosphere at a mostly constant rate and that a radioactive isotope decays at a known and constant rate.
- As cosmic radiation from hits nitrogen atoms it turns them into carbon-14 atoms, which join with oxygen atoms to make carbon dioxide .
- The ratio of carbon containing 12 C and 14C is mostly constant and both forms of carbon become incorporated in plants by photosynthesis.
- When animals, including humans, eat plants or animals that have eaten plants, their tissues also contain the same ratio of carbon-12 to carbon-14.
- Once the organism dies, it is no longer taking in new carbon atoms.
- As the carbon-14 atoms decay the ratio changes and can be used as a 'clock' to date how long it has been since the organism died.
- Carbon-14 has a half-life of 5730±40 yrs. In this time half the C-14 will break down to nitrogen-14
- This means that radiocarbon techniques can usually date only samples less than **60,000 yrs.**
- Older samples have to low numbers of C-14 to be detected.

2. POTASSIUM-ARGON (K-Ar) DATING.

- Potassium-40 decay into argon-40 and calcium -40 at a known rate.
- The half-life of potassium-40 is approx. 1.25 billion yrs.
- This method is used to date rock surrounding fossils, which means there has to have been local volcanic activity for the rock to have sufficient potassium.
- Mostly used to date sites in the **1-1.5 million year old range.**
- Could be used to date rock **4.6 billion to 10, 000 yrs.**

3. FISSION TRACK DATING.

- Uranium-238 tracks in rocks caused by spontaneous fission. These are counted
- When uranium -238 decays to lead, the exploding uranium atoms emit particles of such high energy that they make tracks about 10 microns long in the surrounding rock.
- These tracks can be counted with microscopes
- Very useful as it gives an estimate independent of K-Ar dating.
- Limited to **use in volcanic areas**

4. THERMOLUMINESCENCE AND ELECTRON SPIN RESONANCE.

- **Used to date pottery and charred flint tools.**
- It depends on the fact that clays (and many other minerals) contain traces of radioactive elements which emit electrons as they decay.
- The electrons are trapped within the crystalline structure of the clay, but when it is heated the clay emits the energy of the stored electrons in the form of light.
- The longer the time since the pottery was last heated the more electrons are trapped, and the greater the luminescence when heated in the laboratory.
 - Electron spin resonance also relies on electrons trapped in crystals.

5. INDEX FOSSILS

6. WRITTEN RECORDS