A 3D MORPHOMETRIC APPROACH BETWEEN THE SKULL AND THE ENDOCAST INTEGRATION IN *PAN TROGLODYTES*, *GORILLA GORILLA* AND *HOMO SAPIENS*

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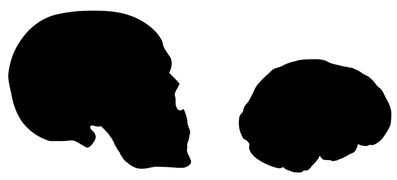
1. INTRODUCTION

One of the key factors to understanding the evolution of *Homo* is the identification and quantification of patterns of integration in the skull and endocast. These patterns can help us to understand how the brain affects or is affected by the morphology of the cranial structures [1,2].

2. GOAL

The main goal is to detect shared or species-specific integration patterns that can later be applied to extinct Hominin species.

3. MATERIAL



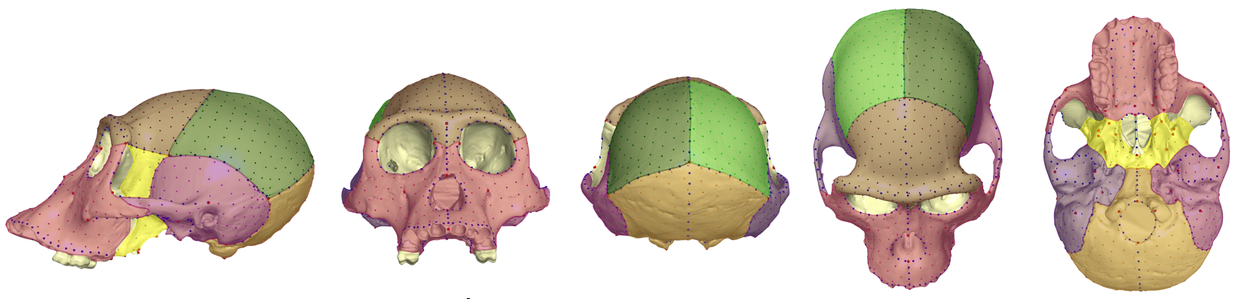
20 adult modern human skulls and endocasts
- 10 males
- 10 females

40 adult great apes skulls and endocasts
- 10 + 10 *Gorilla* and *Pan* males
- 10 + 10 *Gorilla* an *Pan* females

4. METHODS

We conducted a Procrustes-based 3D Geometric Morphometrics study on the skull and endocast surfaces of a sex-balanced *Gorilla, Pan* and *Homo sapiens* sample.

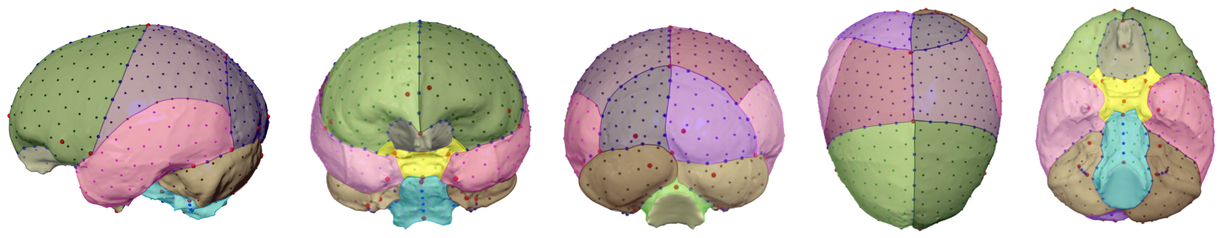
- **We defined 14 skull and endocast regions.**
- **We used the two-block partial least squares (rPLS) method pooled by species and allometry** to obtain the covariation values between each pair of regions [3].
- **We analysed the slope of the PLS1 scores through a Bootstrap estimation of 95% confidence interval of the slope in each species** [4], and explored shared or species-specific patterns.



- Skull Reference template
- 1389 landmarks

Regions

- Viscero-cranium
- Frontal bone
- Parietal bones
- Temporal bones
- Sphenoid bone
- Occipital bone



- Endocast Reference Template
- 662 landmarks

Regions

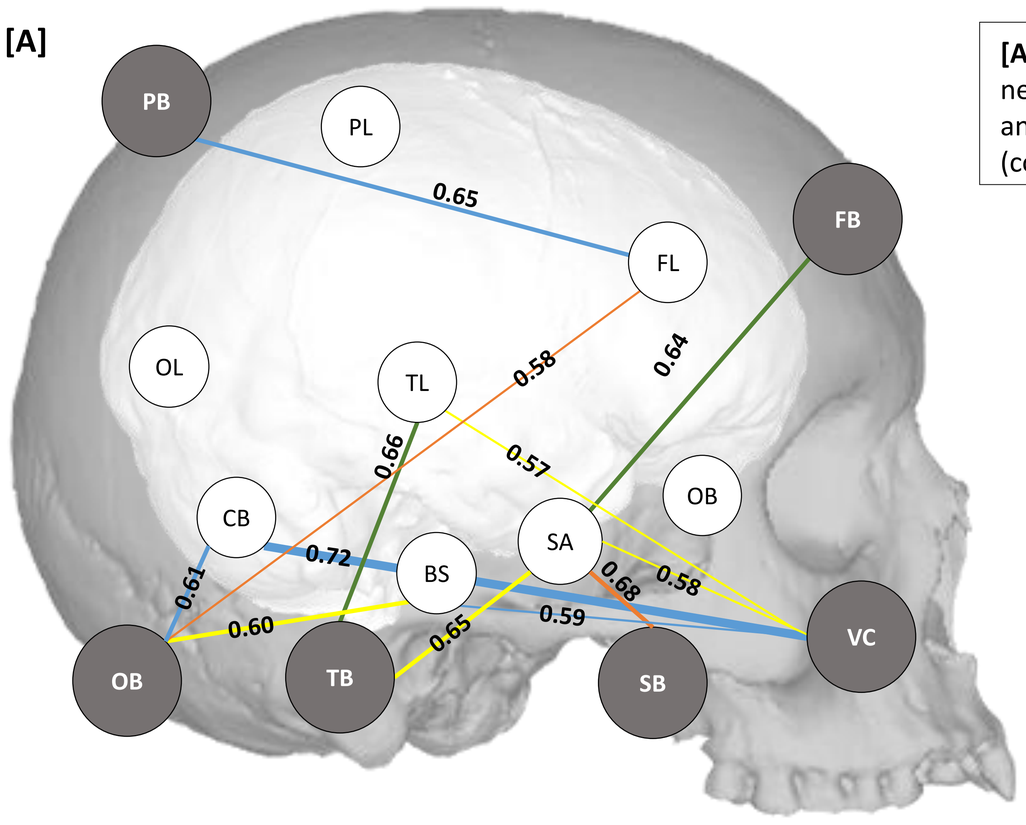
- Frontal lobes
- Brainstem
- Cerebellum
- Olfactory bulb
- Parietal lobes
- Sphenoid area
- Temporal lobes
- Occipital lobes

5. RESULTS

Results obtained suggest:

1. Low significant covariation values between the upper endocranial and cranial regions (mainly parietals, occipitals and frontals).
2. High significant covariation values between the basal skull and endocast, and the viscero-cranium.
3. Viscero-cranial covariation is highly related with the basal endocast regions (mainly theorical cerebellum, temporal and brainstem areas) showing, in most cases, different patterns of covariation between great apes and *Homo sapiens*.

[A]



[A] Significant covariations network (with rPLS values) and its patterns by species (coloured lines).

SKULL
VC = Viscero-cranium
FB = Frontal bone
PB = Parietal bones
TB = Temporal bones
OB = Occipital bone
SB = Sphenoid bone

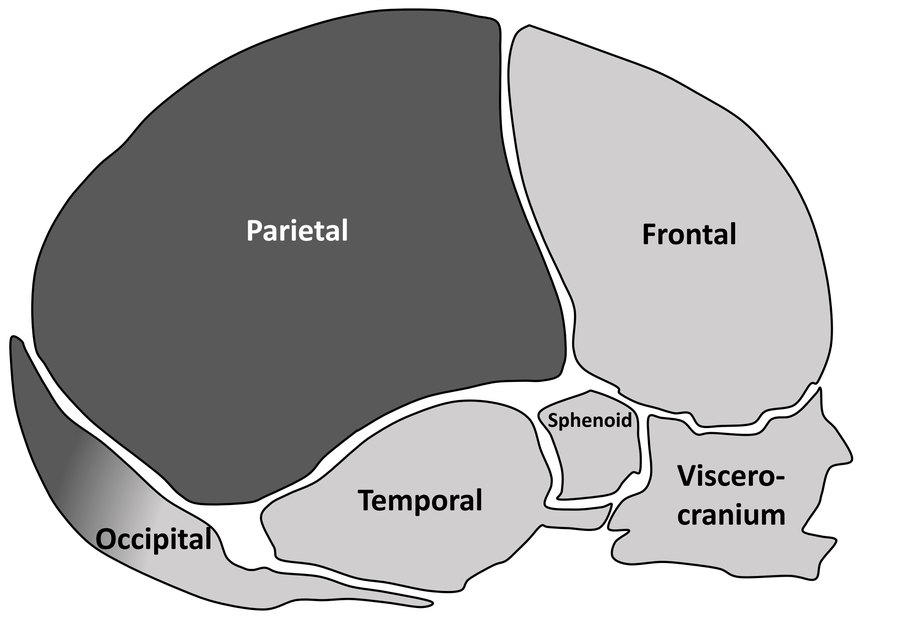
ENDOCAST
FL = Frontal lobes
PL = Parietal lobes
TL = Temporal lobes
OL = Occipital lobes
CB = Cerebellum lobes
BS = Brainstem
SA = Sphenoid area
OB = Olfactory bulb

- Shared covariation patterns between all genera
- Shared covariation patterns between *Pan* and *Gorilla*
- Shared covariation patterns between *Homo* and *Pan*
- Shared covariation patterns between only *Homo*, *Pan* or *Gorilla* with the other 2 genera

6. DISCUSSION AND CONCLUSIONS

1. The results suggest a high significant covariation between basal and viscero-cranial areas, showing shared and species-specific patterns by regions [A].

2. This could be reflecting different genus patterns in early embryonic brain development stages, maybe related to neural crest cells that, probably, would be constraining the skull morphology [5].



Mixed mesodermal and neural crest derived bones

Neural crest derived bones

3. The evaluation of these shared and species-specific covariation patterns between the skull and the endocast, can help us to understand, in more depth, the mechanisms of skull and brain shape development and the evolution of fossil human species.

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