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Comparison of the shape of the Central Sulcus in Hominids

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Poster n°WTh748

INTRODUCTION

- Gyrification of the neocortex
- Folding rich and complex in large brains, high inter-individual variability in humans [1,2].
- However major features are stable within species and even between species like the central sulcus (CS), dividing the motor cortex from the somatosensory cortex in primates [3].

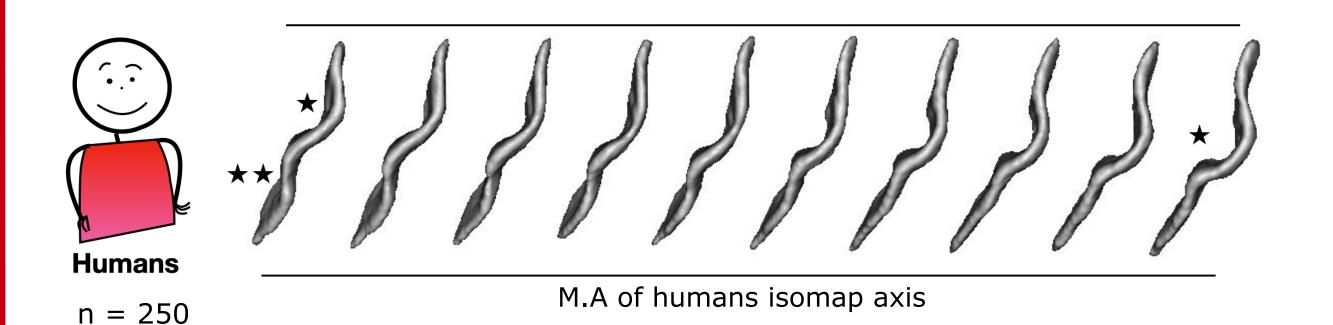
We examined here the morphological variability of the central sulcus in hominids, with a focus on the motor hand region, significant issue of human evolution.

RESULTS

1. INTRA-SPECIES VARIABILITY:

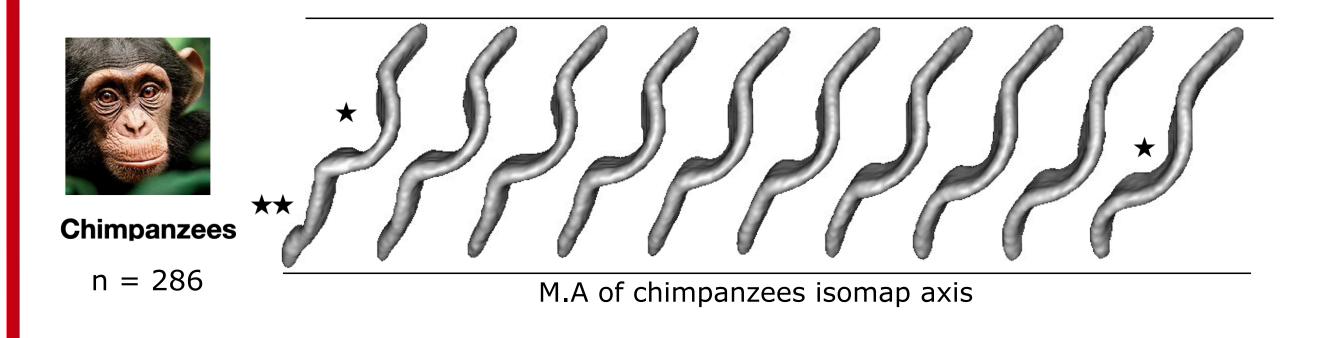
Comparison of moving averages (M.A) along the isomap axes for each species.

Humans: - similar to previous results on large human databases [5,6] - shape variability trait ranging from a single motor hand knob (*) configuration to a double knob (**) configuration: the hand knob is shifted dorsally while a second knob appears ventrally.

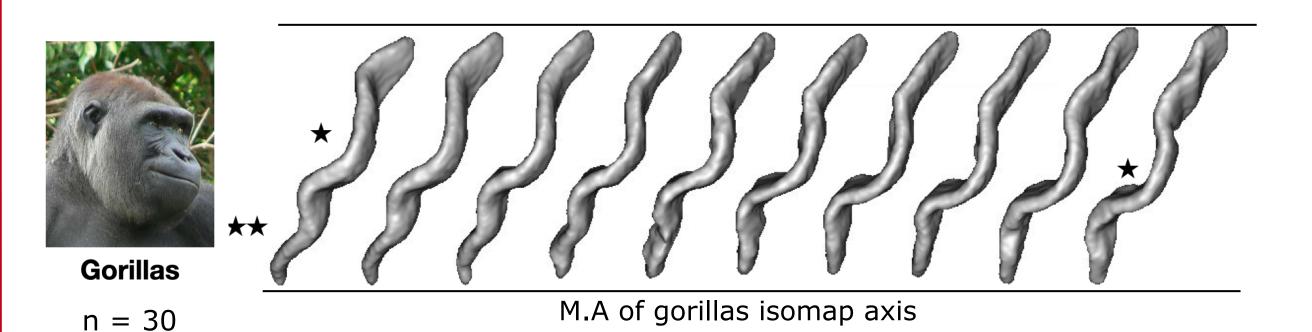


Chimpanzees: - single to a double knob configuration

- hand knob larger, deeper and more ventral than that of humans

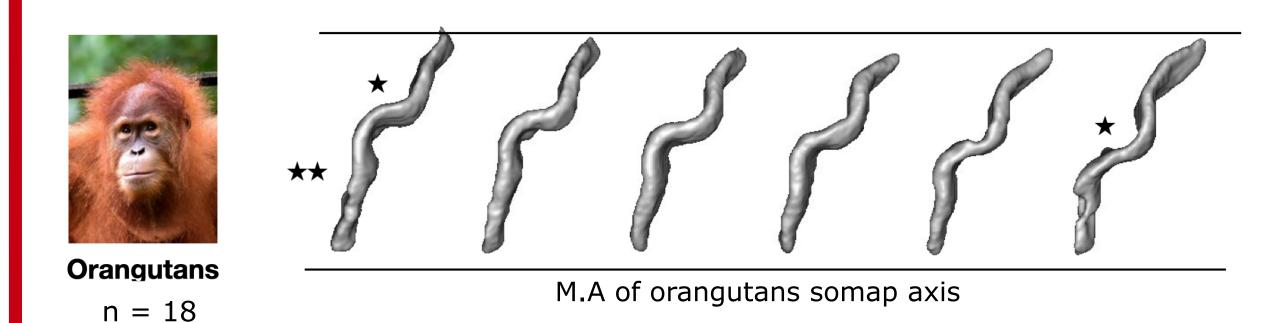


Gorillas: shape of CS and variability trait described on their isomap axis very similar to that of chimpanzees.



Orangutans: - very specific shape of CS

- seem to share the single vs double knob variability trait
- dorsal shift of the hand knob seems to allow for the development of a somatosensory knob rather than a real second motor knob.



CONCLUSION 1:

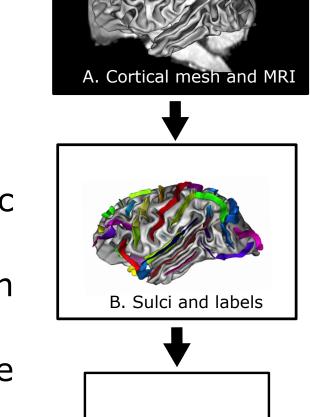
Inter-individual variability within all hominids: characterized primarily by a shape variation ranging from a single to a double knob configuration.

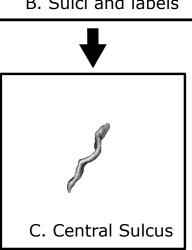
METHODS

1. Morphologist 2012 pipeline [4]

labelisation of the chimpanzee brain based on the human nomenclature

- 2. Brains affinely normalized to Talairach space.
- 3. Right sulci flipped to allow left/right comparison.
- 4. A cross-species scaling performed by applying a species-specific homothetic transformation to all sulci of the subset.
- 5. Pairwise shape similarity matrices computed after rigid alignment (from Sun et al., 2012).
- 6. Isomap to project high dimensional space spanned by the sulci to one single dimension.
- 7. All sulci rigidly aligned to the sulcus with the minimum average distance to the set.
- 8. Moving local average shapes computed at regular coordinates



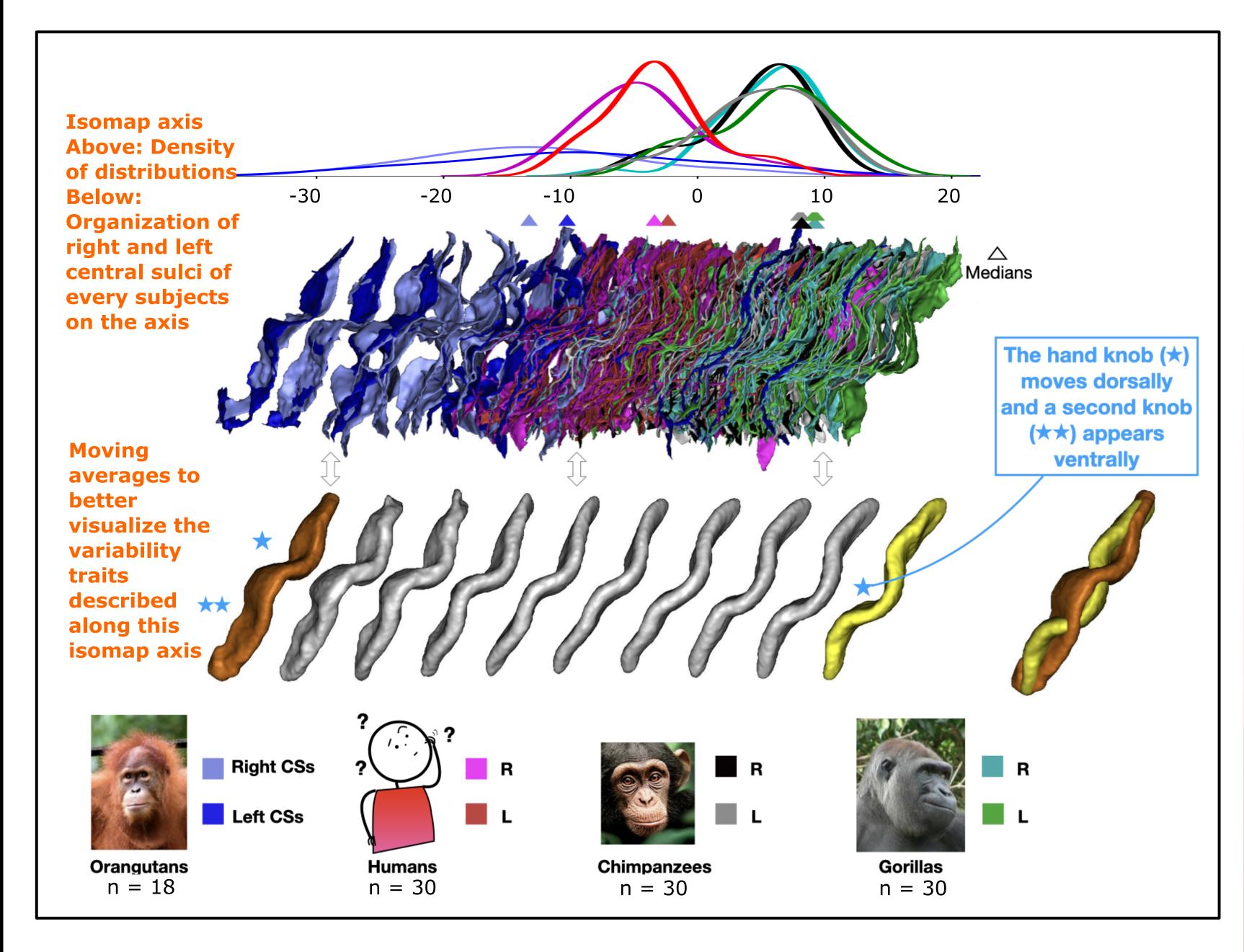


2. INTER-SPECIES VARIABILITY:

how different species are organised on the same isomap axis?

1° FOUR SPECIES

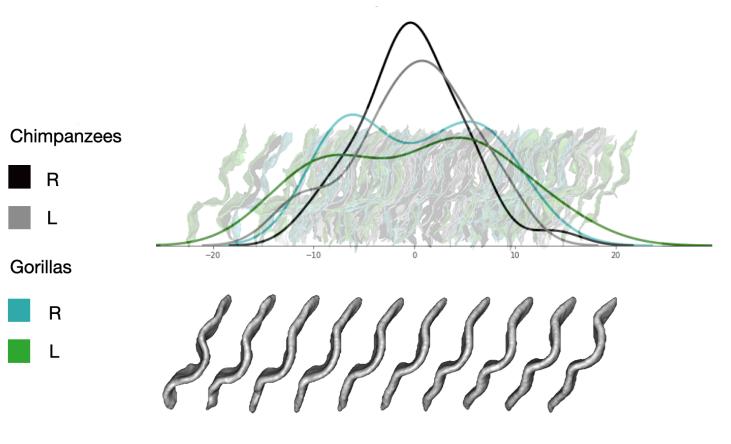
- Chimpanzee and gorilla populations share the same variation in CS shape
- Humans and orangutans appear to have their own variability trait
- Trait along the axis: single knob to a double knob, addition of a rotation of the sulcus on the orangutan side.
- Shift between the two parts of the SC, dorsal and ventral to the knob, at the level of humans and which develops towards the orangutans: development of a more ventral somatosensory knob rather than a real second motor knob?



2° CHIMPANZEES AND GORILLAS

Chimpanzees and gorillas were compared on an axis of their own.

- -> Although the two species are close when compared to humans and orangutans, one would think that a shape specificity would distinguish them
- -> but the two species are not separated on their isomap axis (U1=1733; p=0.72).



CONCLUSION 2:

The four species together: "single-to-double-knob" no longer enough to describe all the variability. differences in overall sulci shape between species prevail; but not for chimpanzees and gorillas together.

R

L

DISCUSSION

Humans and orangutans: buried gyrus in the central region of the CS, suggesting greater sensory-motor connectivity and integration between their motor and somato-sensory cortices [3].

- This could explain the similarity in shape of their hand-knob
- It could also explain the appearance of a knob in their somato-sensory cortex on the axis common to all 4 species.
- Their better sensory-motor integration could reflect an increase in hand and digits use for bipedal humans and an increase in hand and foot grasping for tree-dwelling orangutans

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