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Comparison of the shape of the Central Sulcus in Hominids

Ophelie Foubet¹, Zhong Yi Sun¹, William Hopkins², Jean-François Mangin¹

¹NeuroSpin, CEA Saclay, Gif-sur-Yvette, Ile de France, ²University of Texas MD Anderson Cancer Center, Bastrop, TX

Poster
n°WTh748

INTRODUCTION

- Gyrfication 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].

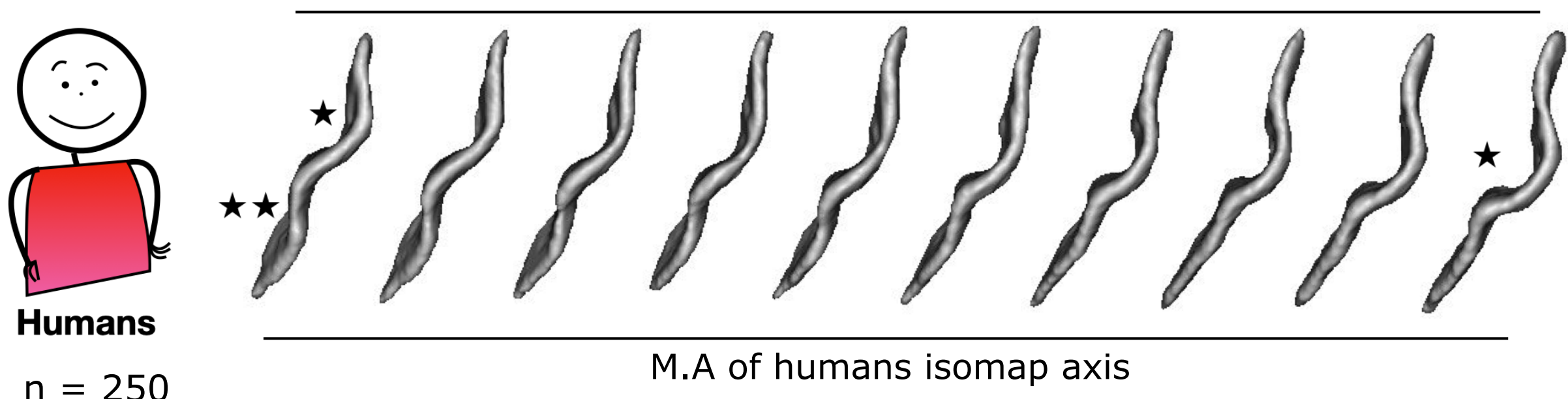
We examined here the morphological variability of the central sulcus in hominids, with a focus on the motor hand region, significant issue of human evolution.

RESULTS

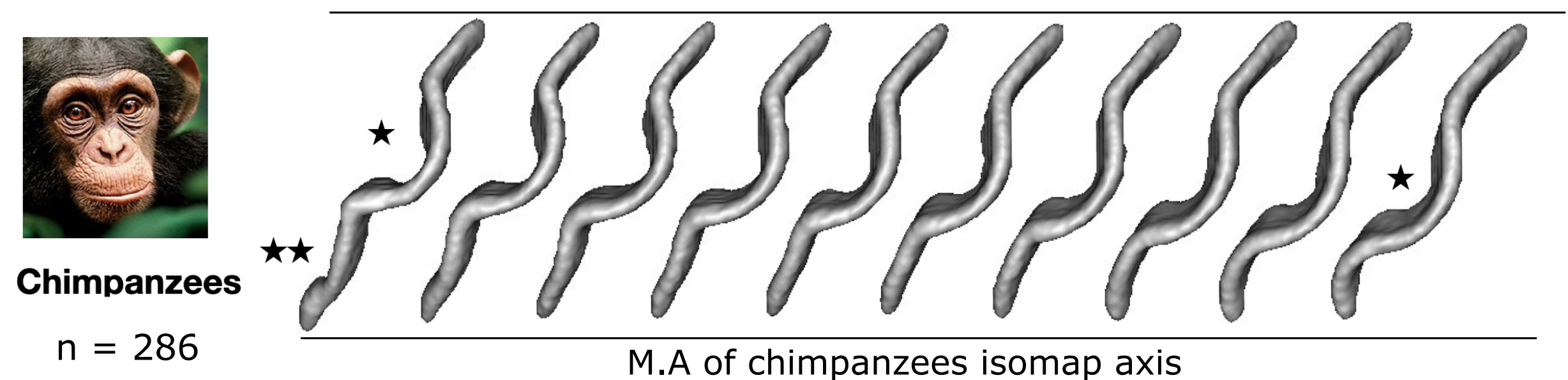
1. INTRA-SPECIES VARIABILITY:

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

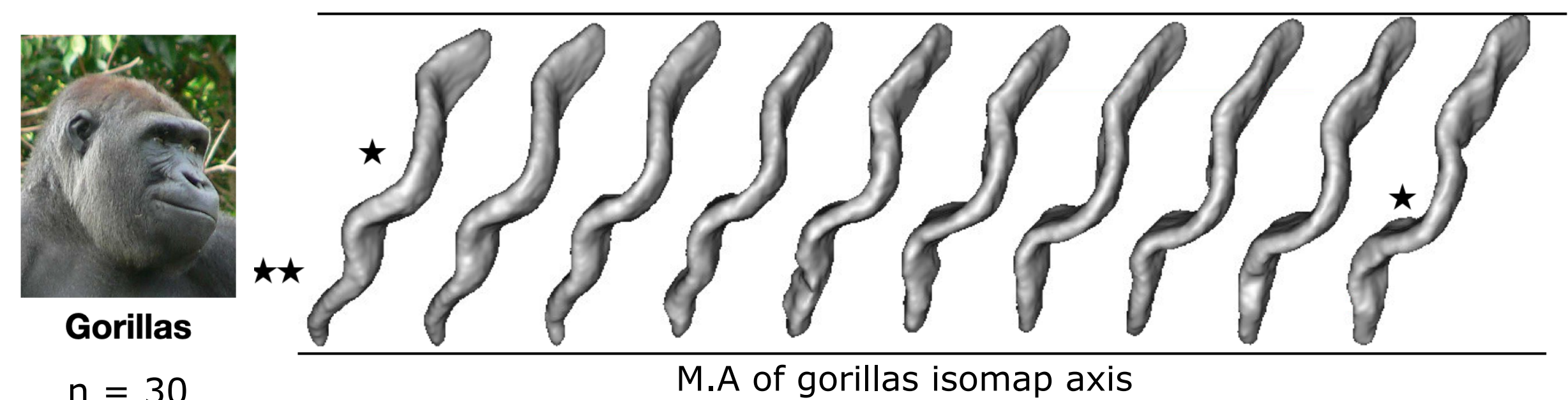
Humans: - similar to previous results on large human databases [5,6]
- shape variability trait ranging from a single motor hand knob (*) configuration to a double knob (**) configuration: the hand knob is shifted dorsally while a second knob appears ventrally.



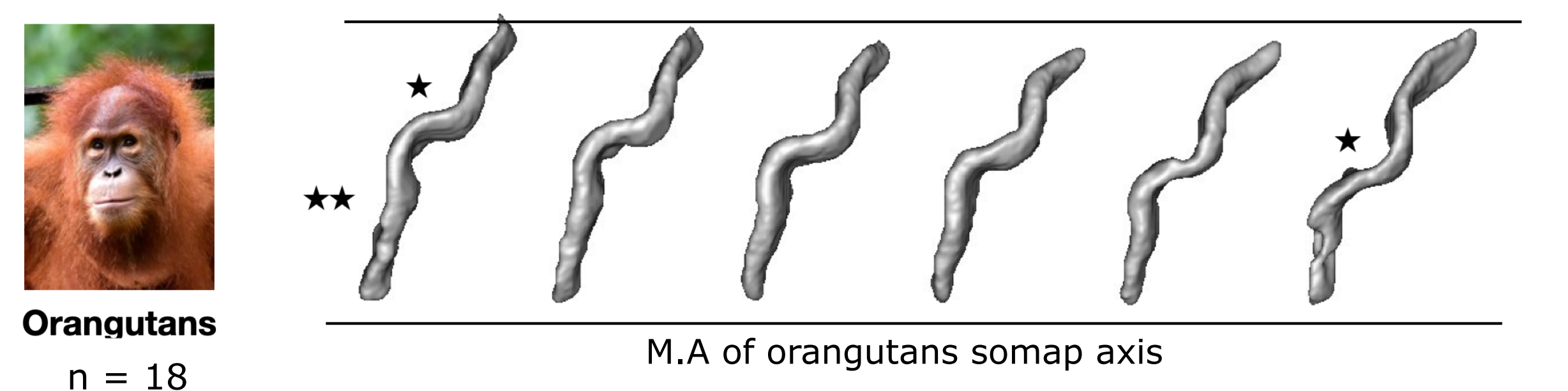
Chimpanzees: - single to a double knob configuration
- hand knob larger, deeper and more ventral than that of humans



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.

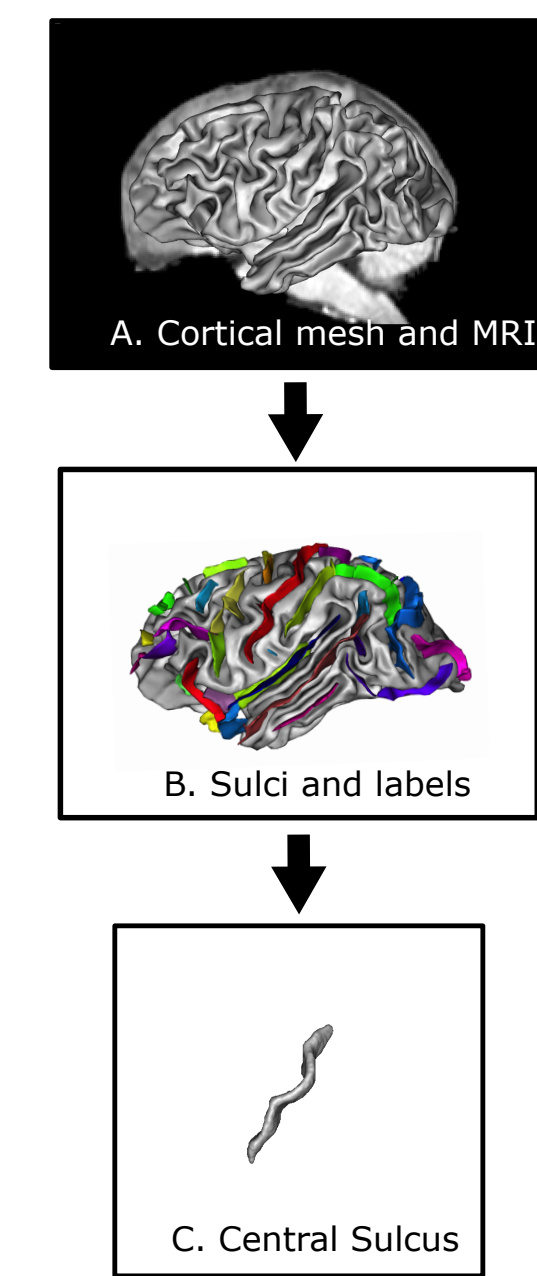


CONCLUSION 1:

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]
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:

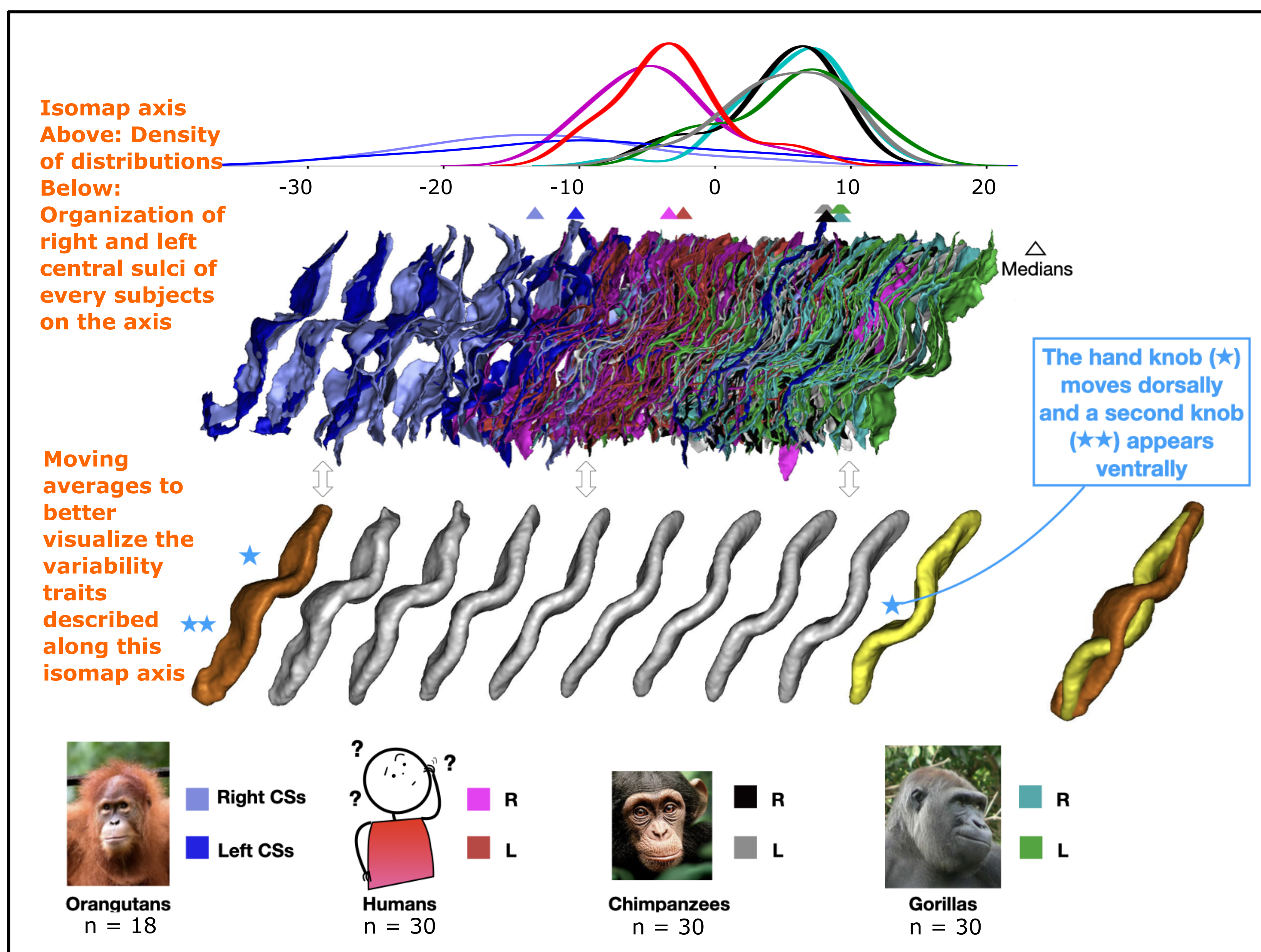
how different species are organised on the same isomap axis ?

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 ?

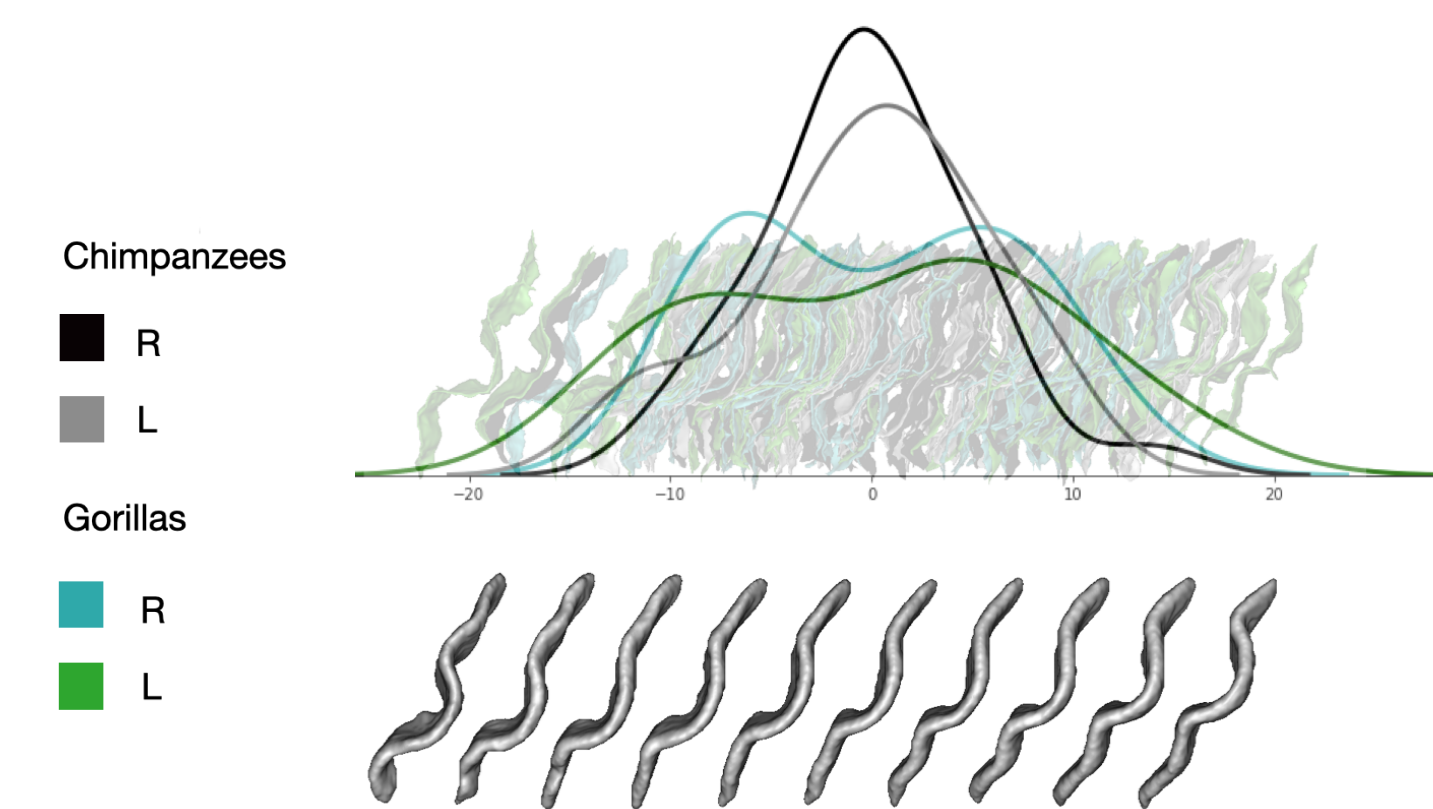


2° CHIMPANZEES AND GORILLAS

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.

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.

REFERENCES

- [1] Fischl B (2008), 'Cortical folding patterns and predicting cytoarchitecture.', Cereb Cortex 18:1973-1980.
- [2] Welker W (1988), 'Why does cerebral cortex fissure and fold?', Cereb Cortex 8B:3-135.
- [3] Hopkins W.D. (2014), 'Evolution of the Central Sulcus Morphology in Primates', Brain, behavior and evolution 84.1 (2014): 19-30.
- [4] Fischer C (2012), 'Morphologist 2012: the new morphological pipeline of BrainVISA.', In. HBM. Beijing.
- [5] Sun Z. Y. (2012), 'The Effect of Handedness on the Shape of the Central Sulcus', Neuroimage, 60(1):332-9
- [6] Sun Z. Y. (2016), 'Linking morphological and functional variability in hand movement and silent reading.', Brain Structure and Function 221(7):3361-71