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GEOMETRIC MORPHOMETRICS APPROACH FOR PREDICTING OLFACTORY REGION ACCESSIBILITY.

Introduction

Variability in the nasal cavity impacts drug deposition.

Factors such as gender, age, ethnicity and climate adaptation contribute to significant inter-individual variability in nasal anatomy. This affects nasal airflow dynamics and drug deposition patterns, making effective nose-to-brain drug delivery challenging [1].

Challenges for Nose-to-Brain delivery.

Effective targeting of the olfactory region remains a major issue for direct Nose-to-brain delivery of neurodegenerative treatments.

Representative models are needed.

Due to this variability, a single nasal model cannot accurately represent the diversity of airflow or deposition outcomes across individuals.

Aim & Objectives

- Identify and characterise morphological variability patterns within the region of interest, using a clustering method based on 3D shape similarity.
- Investigate how the identified morphotypes may be related to differences in olfactory region accessibility.

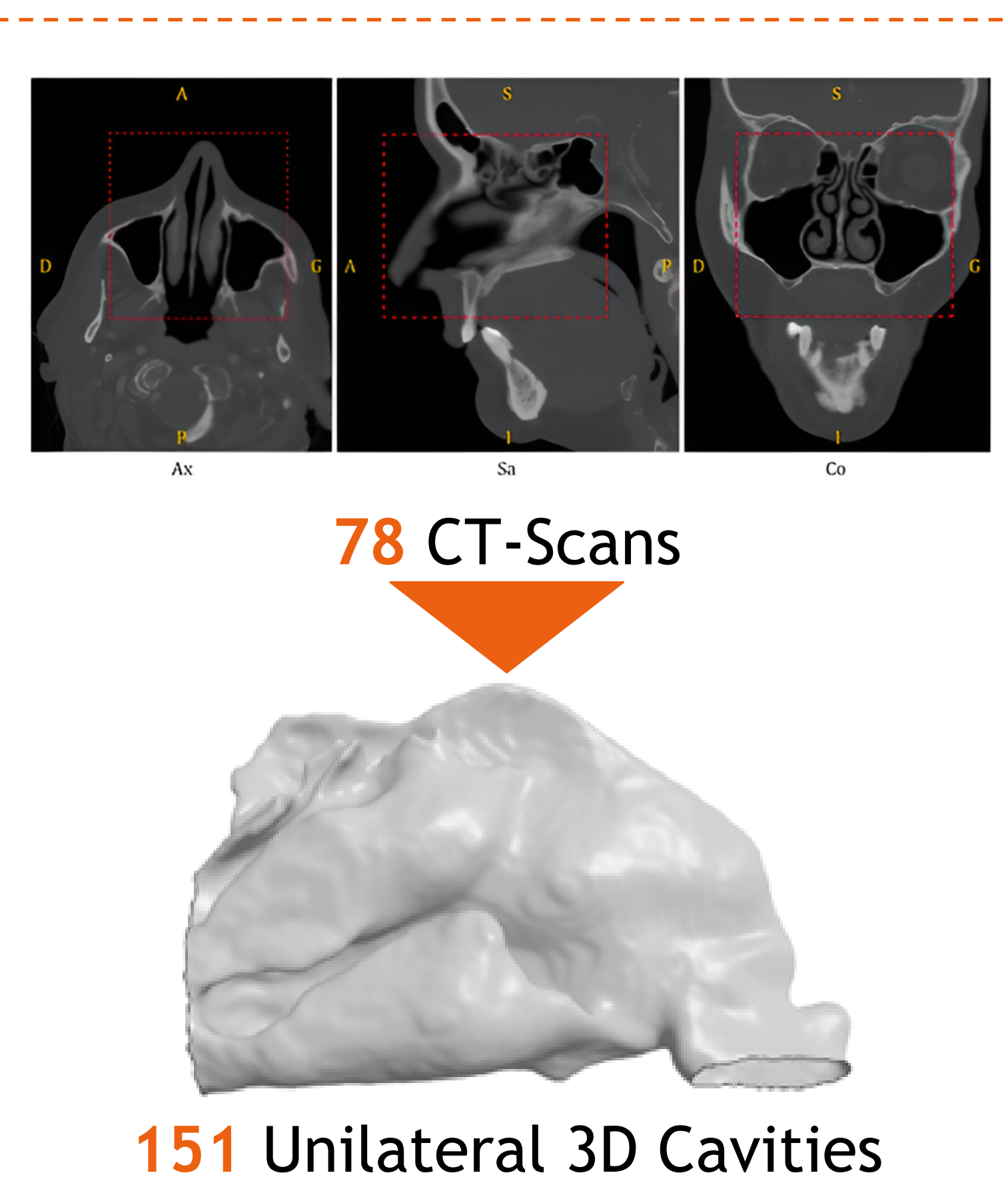


REGION OF INTEREST = Covers the trajectories for olfactory drug deposition

Methodology - Geometric Morphometrics Approach [2]

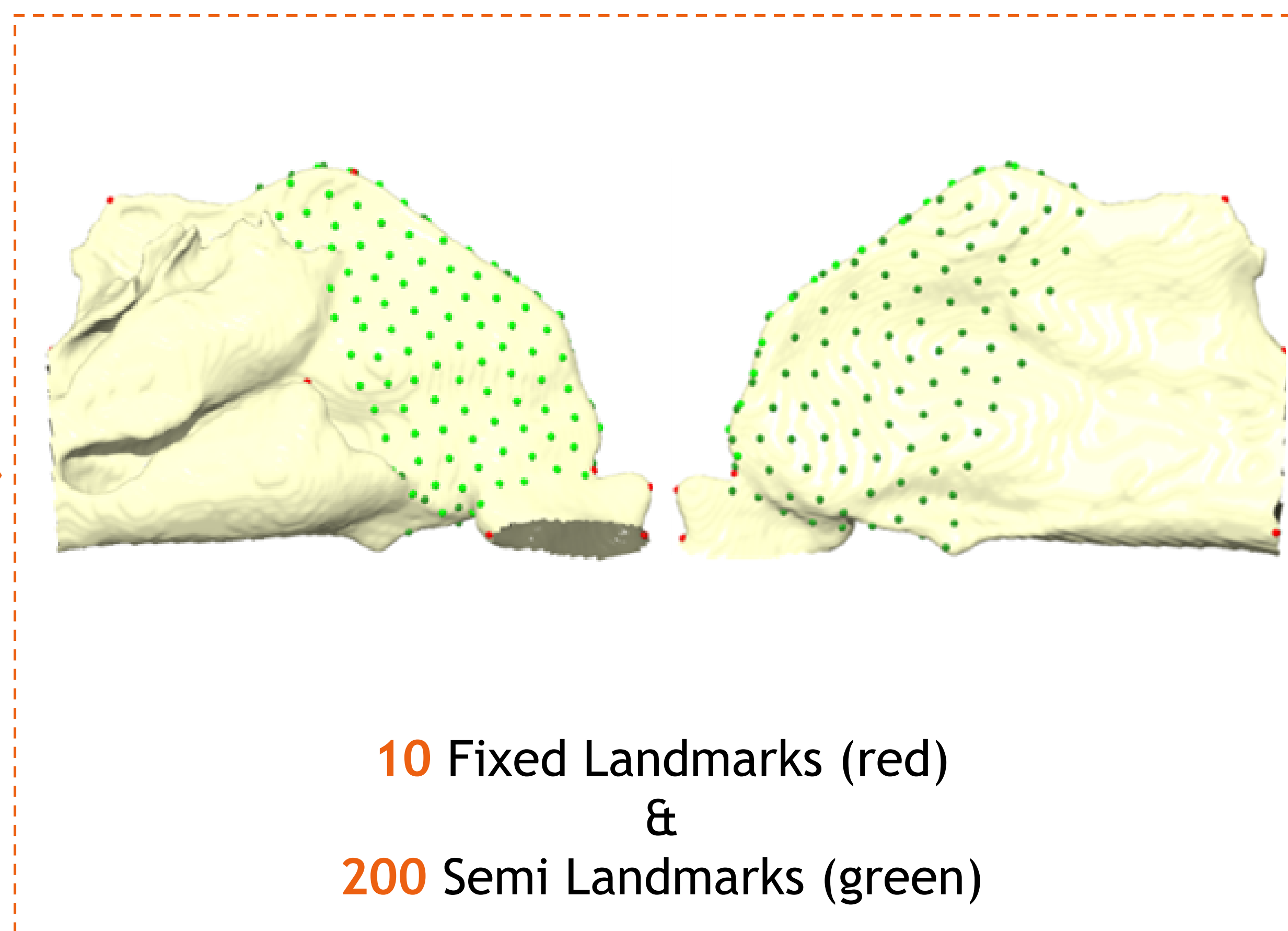
SEGMENTATION AND CLEANING

Using ITK-Snap & StarCCM+



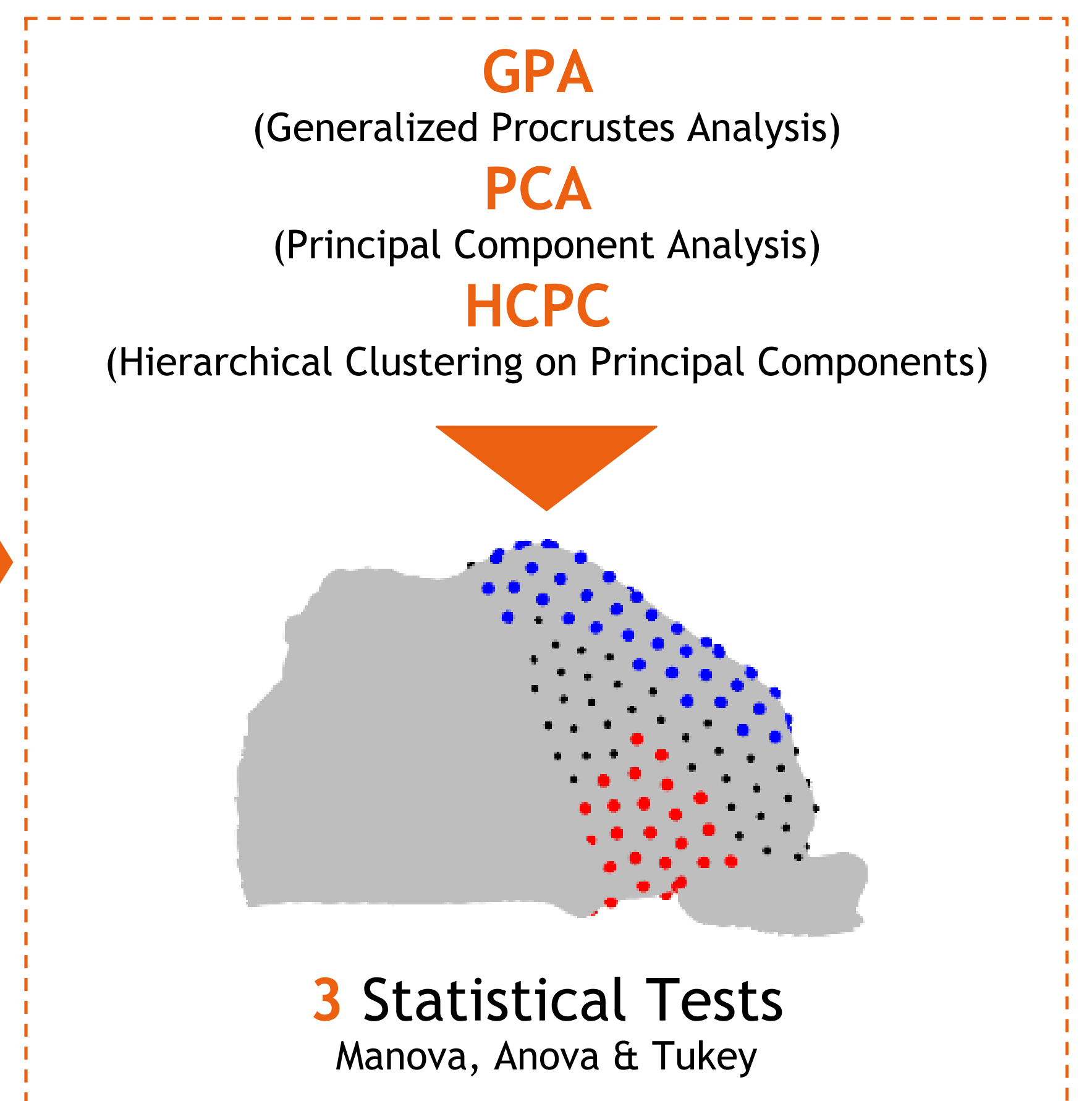
LANDMARK DIGITIZATION

Using Viewbox 4.0



CLUSERING AND CHARACTERISATION

Using geomorph & FactoMineR packages in R



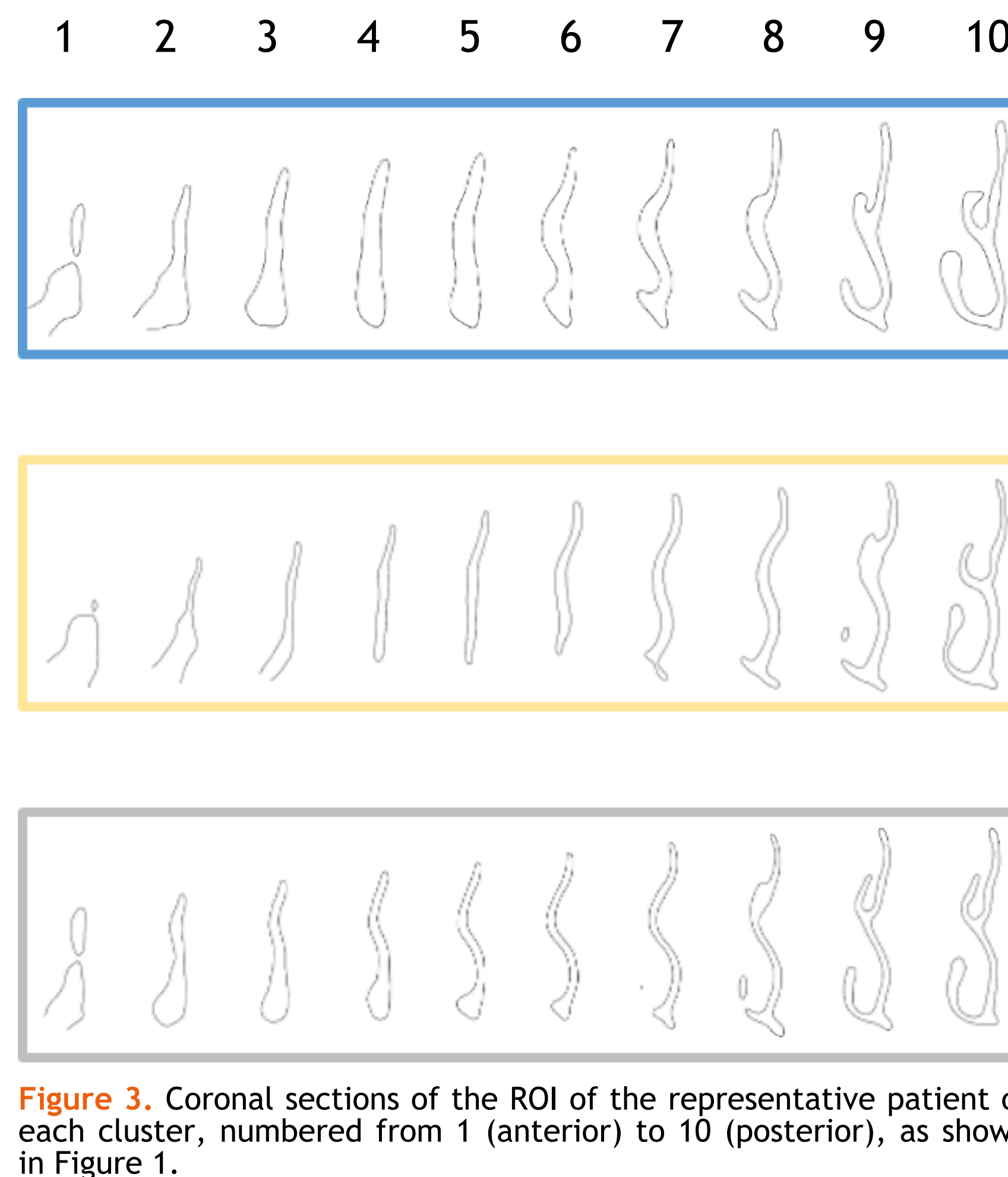
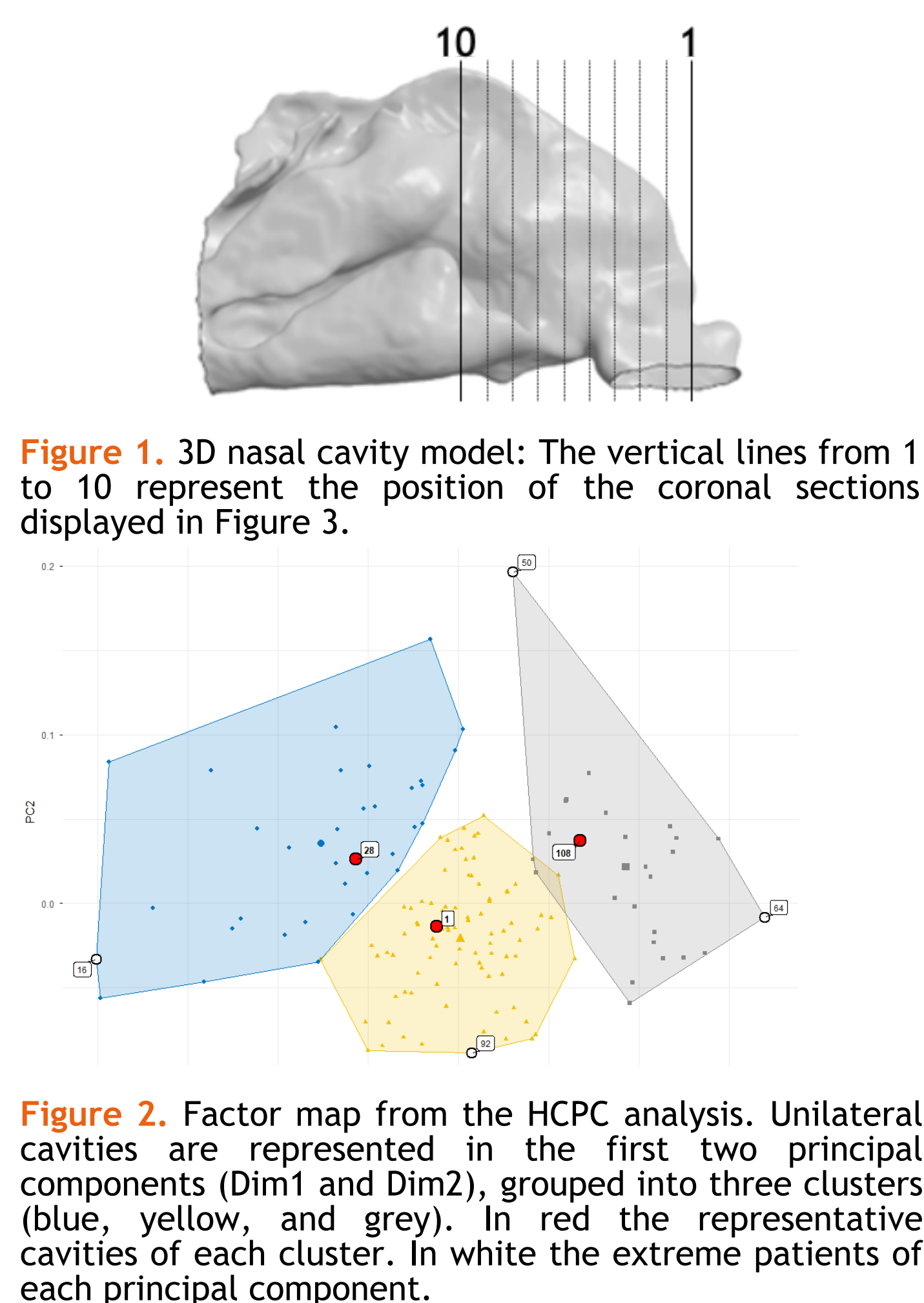
Results

Three clusters identified:

Cluster 1
Wide and shallow.
Potential good accessibility to the olfactory region.

Cluster 2
Intermediate profile.
Accessibility undetermined.

Cluster 3
Narrow and deep.
Potential reduced accessibility to the olfactory region.



Pairs of cluster	% of total patients
1-1	15.1
1-2	13.7
1-3	2.7
2-2	45.2
2-3	11.0
3-3	12.3

Table 1. Distribution of patients for each cluster pair formed by the right and left cavities, independent of laterality.

Cluster	% of patients with at least one cavity in the cluster
1	31.5
2	69.9
3	26

Table 2. Distribution of patients with at least one cavity assigned to each cluster.

Conclusion & Perspectives

Identification of morphotypes

This study identifies three distinct morphotypes in the region leading to the olfactory zone, which may influence the performance of targeted drug delivery to the olfactory region.

Investigation of the link between morphotypes and drug deposition

Computational Fluid Dynamic studies will be performed on the representative cavities from each cluster to quantify the drug deposition in the olfactory region using Nemera's "Guided Stream Technology" (cf. poster #108).

References :

- [1] Calmet, H., Kleinstreuer, C., Houzeaux, G., Kolanjiyil, A. V., Lehmkuhl, O., Olivares, E., & Vázquez, M. (2018). Subject-variability effects on micron particle deposition in human nasal cavities. *Journal of Aerosol Science*, 115, 12-28. <https://doi.org/10.1016/j.jaerosci.2017.10.008>
- [2] Vishnumurthy, P., Radulesco, T., Bouchet, G., Regard, A., & Michel, J. (2025). A Geometric Morphometrics Approach for Predicting Olfactory Region Accessibility: Toward Personalized Nose-to-Brain Drug Delivery. *Journal of Personalized Medicine*. <https://doi.org/10.3390/jpm15100461>