Reliability of cerebellar volumetry : a test / re-test study

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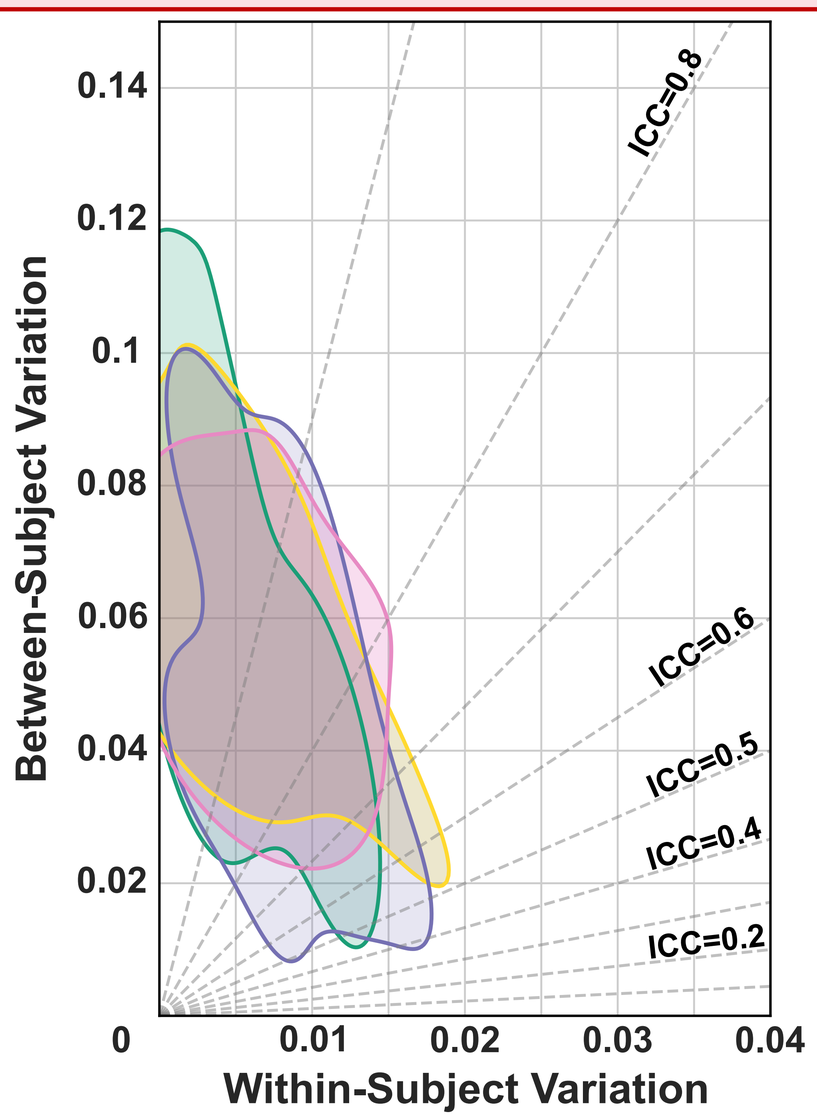
Introduction

Accurate and reliable quantification of the cerebellum's structure present significant challenges for automated parcellation because of its foliated structure and fine subregional organization. Several tools, including traditional atlas-based approaches and recent deep learning methods, have been developed to segment and parcellate the cerebellum. While these tools are typically evaluated based on segmentation accuracy, their test-retest reliability, essential for longitudinal and individual difference studies, has seen limited comparison.



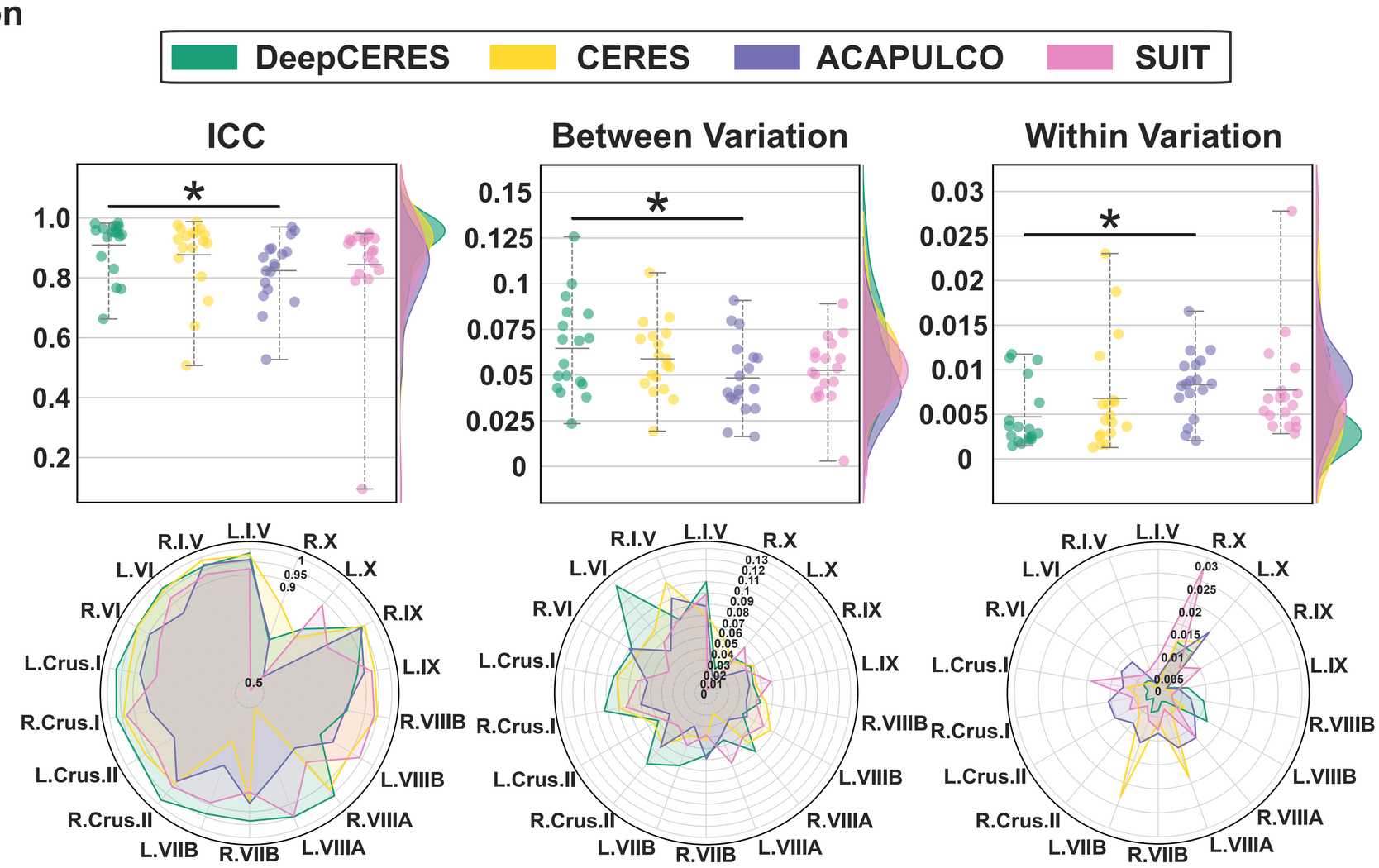
Methods

We assessed the test-retest reliability of four cerebellar segmentation pipelines : **SUIT-VBM** [1], **ACAPULCO** [2], **CERES** [3], and **DeepCERES** [4]. We used high-resolution T1-weighted images from the **Hangzhou Normal University open dataset (HNU)** [5], which includes 10 MRI sessions for healthy participants scanned every three days over one month. We selected **11 participants**, including 5 females and 6 males of mean age 24.1 ± 2.7 years.

Volumes of cerebellar subregions were extracted with each method, normalized by intracranial volume to account for head size, and scaled across lobules to correct for size differences. We then computed **intra-individual variability, inter-individual variability, and Intraclass Correlation Coefficients (ICC)** using the **ReX toolbox** [6].

Results

- **All pipelines exhibited strong test-retest reliability**, with average ICC values above 0.8.
- **DeepCERES was the most robust method**, significantly more reliable than ACAPULCO ($p < 0.05$), showing high ICC values, high inter-individual variability, and low intra-individual variability.
- **Lobules X and VIIIB displayed lower reliability** across all methods.



Conclusion

Our results inform the state-of-the-art in cerebellum parcellation. We provide guidance for selecting the most reliable parcellation method and point out the most challenging lobules for this analysis.

References

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