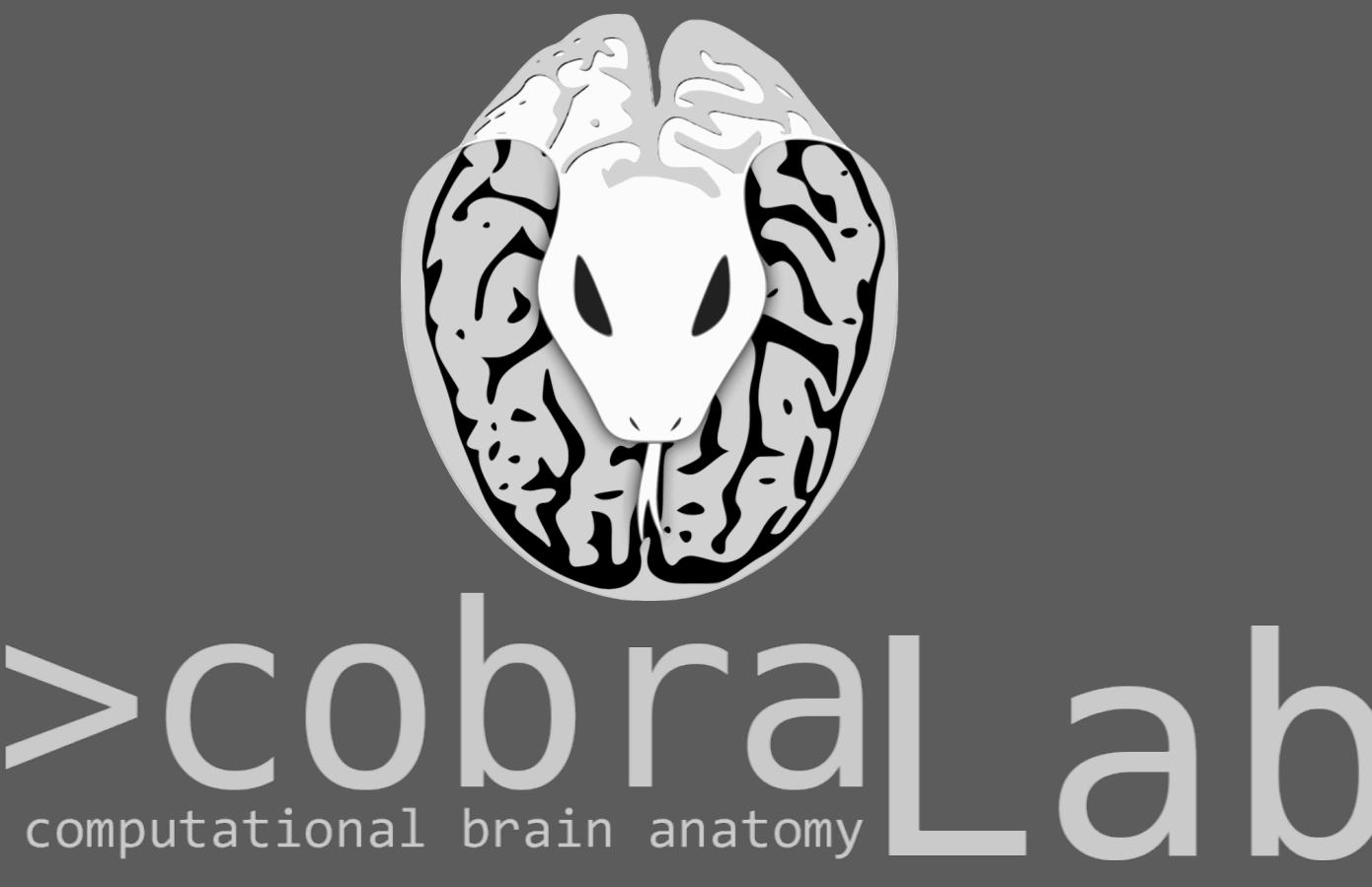


TOWARDS THE COMPLETE VOLUMETRIC ASSESSMENT OF THE HUMAN MEMORY CIRCUIT: Segmentation of medial temporal lobe, and subiculum cortices on high-resolution 3T images



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INTRODUCTION

- The human memory circuit begins with inputs to the perirhinal cortex (PRC), and parahippocampal cortex (PHC)¹
- Incoming information is re-routed to the entorhinal cortex (ERC) before entering the hippocampus via the preforant pathway^{2,3}
- Given that the ERC is the first area affected in Alzheimer's dementia, and that little is known about the PRC and PHC within the context of health and disease, a useful tool is needed to further investigate these structures *in vivo* while taking the entire memory network into consideration

Study Aim:

- Our primary aim was to create a detailed, anatomically-accurate protocol for the segmentation of all MTL and subiculum cortices on isotropic high-resolution magnetic resonance (MR) images.
- A secondary aim was to create a segmentation protocol that would compliment our previous hippocampal subfield⁴ and white matter atlases⁹.

METHODS

MANUAL SEGMENTATION

- Manual segmentation was completed on high-resolution MRI images (T1/T2-weighted, voxel size = 0.3mm isotropic) for 3 healthy controls (1 male, 2 female, aged 29-57 yrs; mean age = 37)⁴.
- Tracing was completed using MINC Display while employing a tri-planar segmentation approach in addition to the use of 3D reconstruction to aid segmentation in areas of obscurity.
- Multiple print, MR, and histological atlases, as well as existing publications outlining MTL anatomy were used to trace the entire anterior to posterior extent of the: ERC, PRC, PHC, presubiculum and parasubiculum^{5,6,7,8}.

RELIABILITY MEASURES

- Intrarater reliability** performed on three randomly selected hemispheres (right/left, male 34 yrs; right, female 57 yrs) and evaluated using Dice kappa overlap metric

Table 1. Intra-rater Reliability

Structure	Left Hemisphere	Right Hemisphere
ERC	0.89	0.87 (0.83-0.91)
PRC	0.90	0.87 (0.86-0.87)
PHC	0.94	0.91 (0.90-0.92)
Presubiculum	0.73	0.72 (0.65-0.78)
Parasubiculum	0.69	0.67 (0.62-0.71)

Average intra-rater reliability was calculated using Dice's volumetric Kappa. A score of 0 represents no overlap between test and retest labels, whereas a value of 1 represents a complete overlap.

RESULTS

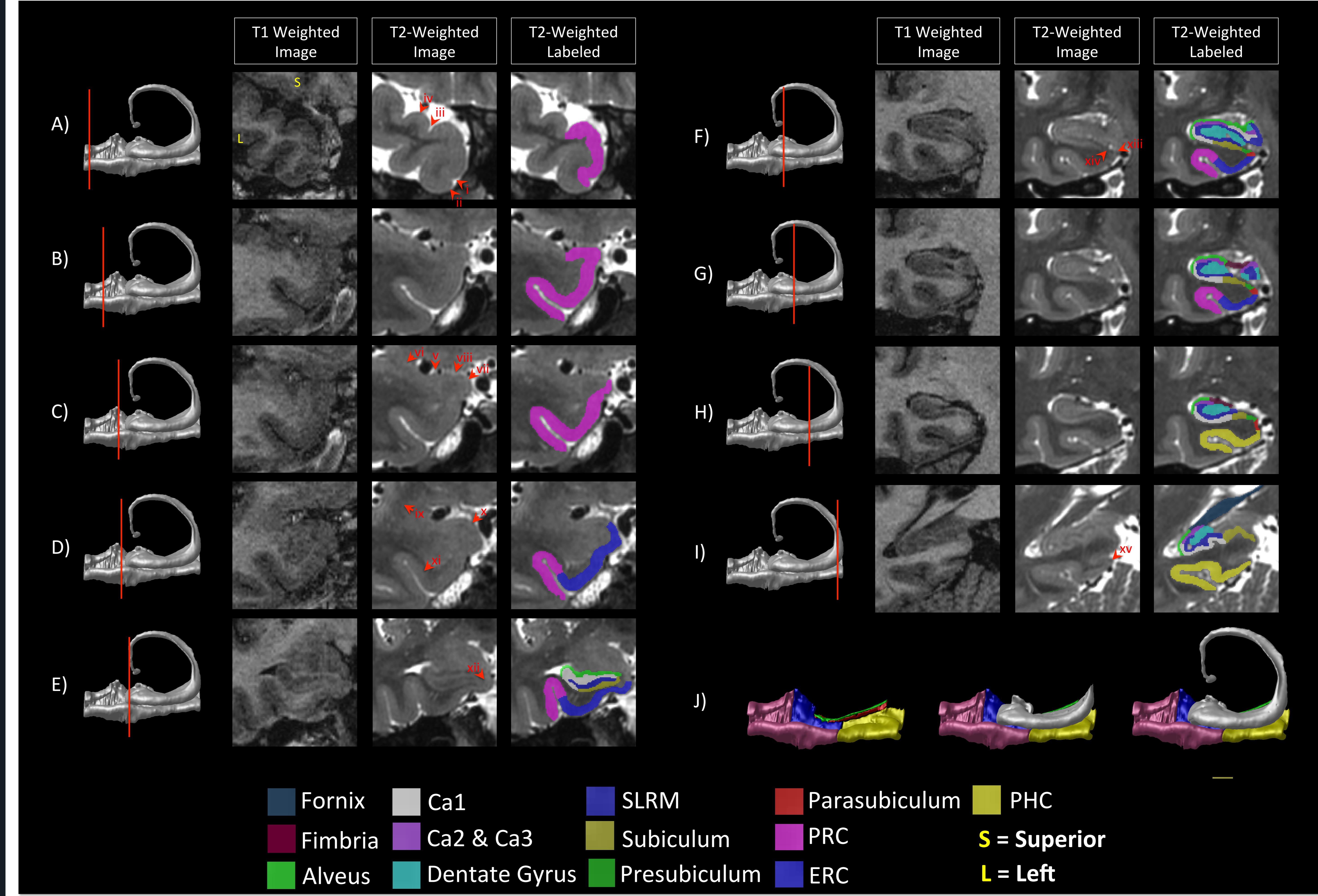


Figure 1. Sample of segmentation protocol for left medial temporal lobe (MTL) cortices. Rows A-I depict coronal sections of T1 and T2-weighted images. An additional column includes completed MTL tracings on T2-weighted images with both the Winterburn et al. (2013) subfield and Amaral et al. (in prep) hippocampal white matter atlases overlaid. 3D renderings depict the level at which each coronal slice occurs within the sagittal length of the MTL (red line). Labels i through xv correspond to specific anatomical landmarks involving protocol rules and/or guidelines.

SUMMARY

- While other protocols exist for the segmentation of the ERC, PRC and PHC, many do not segment structures at such a high isotropic resolution. In addition, many do not segment the presubiculum and parasubiculum.
- The present protocol also enables identification of both the presubiculum and parasubiculum and is tailored to compliment both the Winterburn et al. HC subfield atlas⁴ and the Amaral et al. extra-hippocampal white matter atlas⁹.

Here we present a comprehensive and anatomically accurate protocol for the volumetric assessment of the MTL and subiculum cortices. Given its close fit with the other available protocols from our group, their combined use can enable a more in-depth volumetric characterization of the memory circuit in various populations and disease states.

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FUNDING

M.M.C. is funded by the Canadian Institutes of Health Research (CIHR), Weston Brain Institute and Fonds de la recherche en santé Québec (FRSQ).

