Unfolding age-related measures of distinct hippocampal surface area and thickness

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INTRODUCTION

- The hippocampus may be especially vulnerable to damage by metabolic insults or disease processes[1]
- With accumulation over age, these lead to volume and surface area reduction, and loss of hippocampal-dependent memory processes sometimes seen over the course of healthy aging[2,3]
- Here, we apply a recently developed BIDS App 'HippUnfold' to allow automatic separation of distinct hippocampal folds and decomposition into thickness and surface area[4].
- These two measures are shown to be dissociable in the neocortex[5], but has not been explored in detail in the hippocampus.
- This is in part due to its thinner, archicortical structure which makes it more challenging to reliably extract such measures.

OBJECTIVE

In this study, we perform a detailed morphometric analyses of the hippocampus using the Human Connectome Project Aging (HCP-A) dataset and novel 'unfolding' methods

METHODS

- HCP-A MRI data (N=656) were obtained using a whole-body 3T Prisma MRI scanner (Siemens Healthineers) with a 32-channel Prisma head-coil.
- Multiecho T_1w MPRAGE, T_2w SPACE and TSE data were acquired as specified in Harms et al. (2018)[6].
- Both T_1w and T_2w were used for automatic unfolding of the hippocampal cortex into a two dimensional coordinate system.

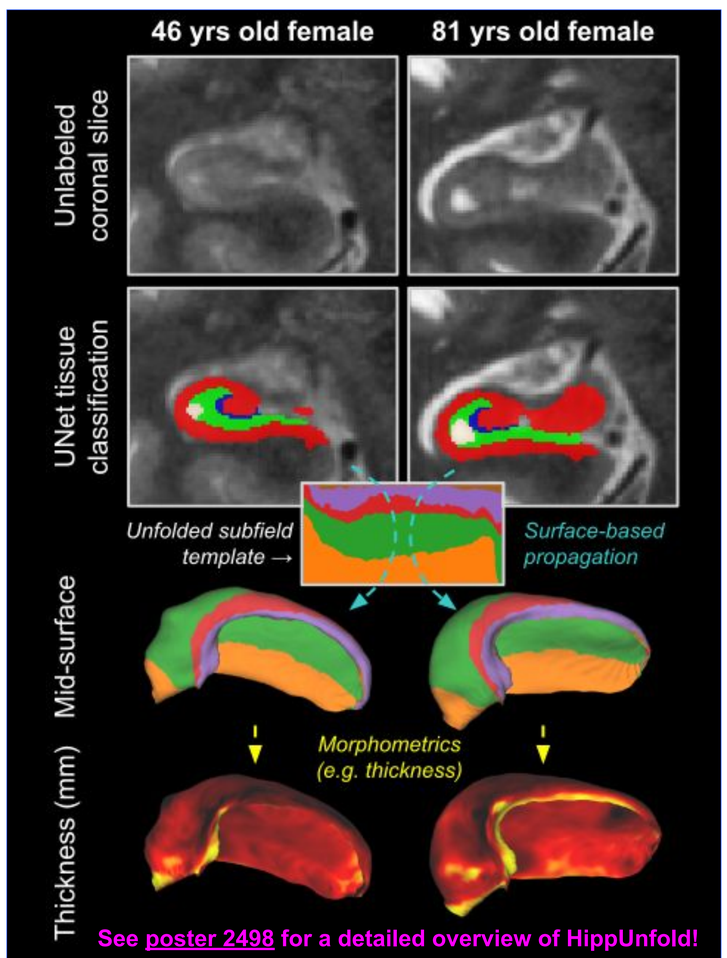

Figure 1. HippUnfold workflow. Automatic unfolding of the hippocampus based on T_1w and T_2w data

RESULTS

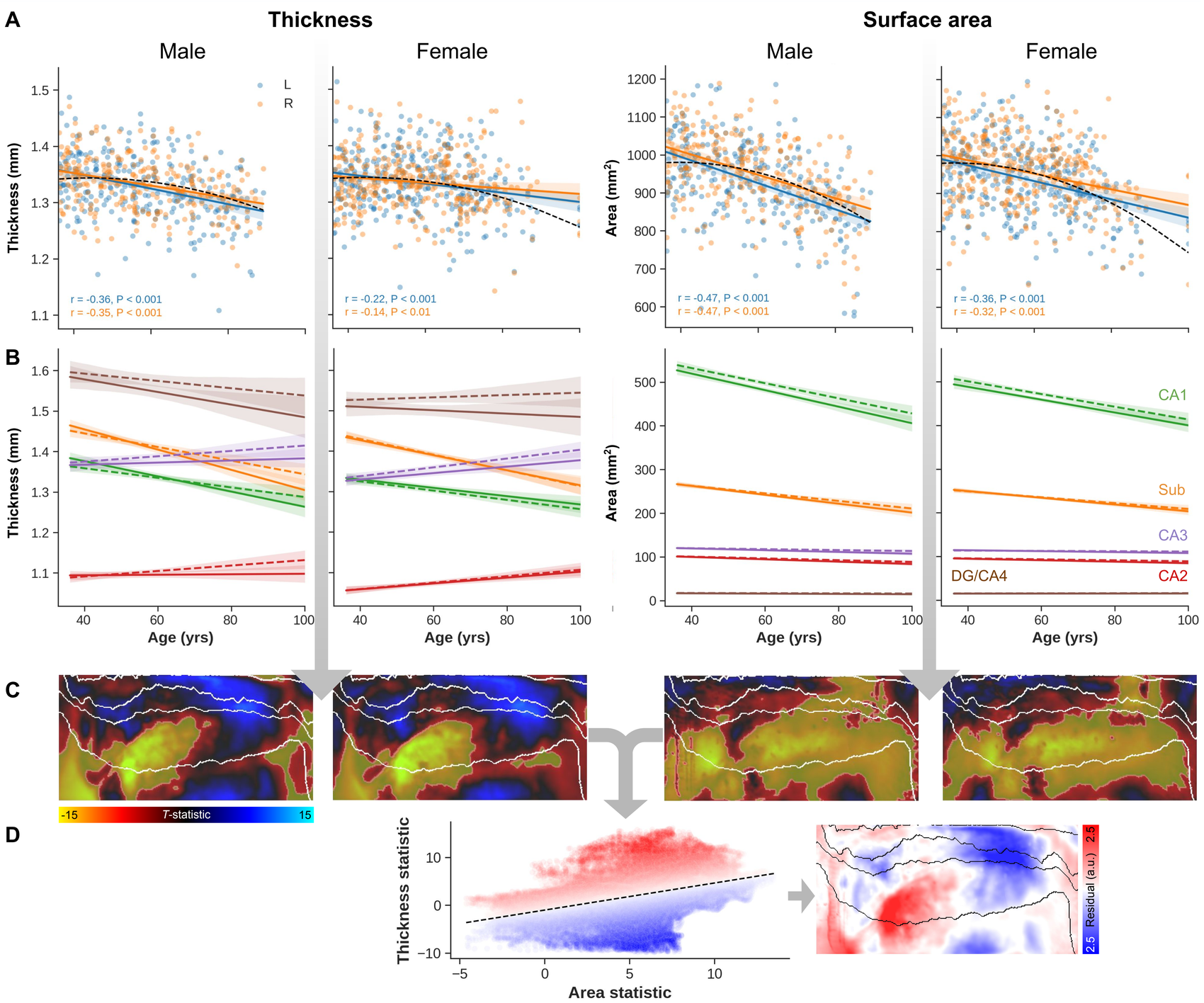

Figure 2. Hippocampal thickness (left) and area (right) changes with age across HCP-A subjects. (A) Average GM thickness and total area plotted against age for left (blue) and right (orange) hemispheres, and males (1st and 3rd columns) and females (2nd and 4th columns) separately. (B) Similar to A but stratified and color-coded (see Figure 1) based on subfields for left (solid) and right hemisphere (dashed). (C) *T*-statistical values in unfolded space for thickness and area vs. age per hemisphere. Vertices characterized by significant change in thickness and/or area with age are delineated using a semi-transparent green overlay. (D) Left: vertex-wise correlational analysis between area and thickness changes with age color-coded for standardized residuals. Right: standardized residuals mapped into unfolded space.

DISCUSSION

- A negative linear relationship between age and surface area and age and thickness was observed, which was stronger for surface area (Figure 2A).
- Polynomial curve fitting revealed that both measures peaked near age 40.
- Splitting the hippocampus into subfield ROIs (Figure 2B), and by mapping the data to unfolded space (Figure 2C), revealed a significant cluster in anterior CA1 (with some overlap with neighbouring anterior subiculum).
- Furthermore, concurrent analyses of thickness and area (Figure 2D) might improve our understanding of the morphological changes occuring over the course of aging.
- Future work aims to examine the physiological characteristics of CA1 to test the hypothesis that its metabolic and vascular properties may contribute to the unique vulnerability of this brain region[6].

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CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

Western BrainsCAN Transforming brain research.

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