Decoding Region-specific Cortical Complexity with Multi-scale Morphometric Analysis

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INTRODUCTION

1. Recently, quantitative Magnetic Resonance Imaging (MRI) analysis has greatly contributed to detect the age-related anatomical changes [1].
2. However, little is known about the regional cortical complexity in the context of brain atrophy.

Objective:

To examine the age-related changes of the cortical complexity of bilateral dorsolateral prefrontal cortex (DLPFC).

METHODS

Participants:

Six hundred and eleven right-handed cognitively normal adults (aged from 18 to 88 years) drawn from the Cambridge Centre for Ageing and Neuroscience (Cam-CAN) were divided into four age groups: **young, middle-aged, young-old and old-old**.

Participants:

Details about the OASIS-2 MRI data acquisition protocol can be seen in OASIS official webpage (https://www.oasis-brains.org/). The structural MRI data of OASIS database was acquired on a 1.5T Vision scanner (Siemens, Erlangen, Germany) with a thermo-plastic face mask to minimize head movements.

Structural MRI and Analytic method:

Surface-based morphometry was addressed to decode the cortical complexity with multi-scale measurements [2], including cortical thickness (mm), surface area (mm^2), grey matter volume (mm^3) and cortical folding (Figure 1).

Statistical analysis:

The groupwise comparisons of the morphometric features were conducted by using the code (http://neuroimage.usc.edu/neuro/Resources/BST_SVReg_Utilities) embedded in MATLAB. Multiple comparison correction was performed by the above code using false discovery rate (FDR) estimation; 2-sided $p < 0.05$ is considered statistically significant

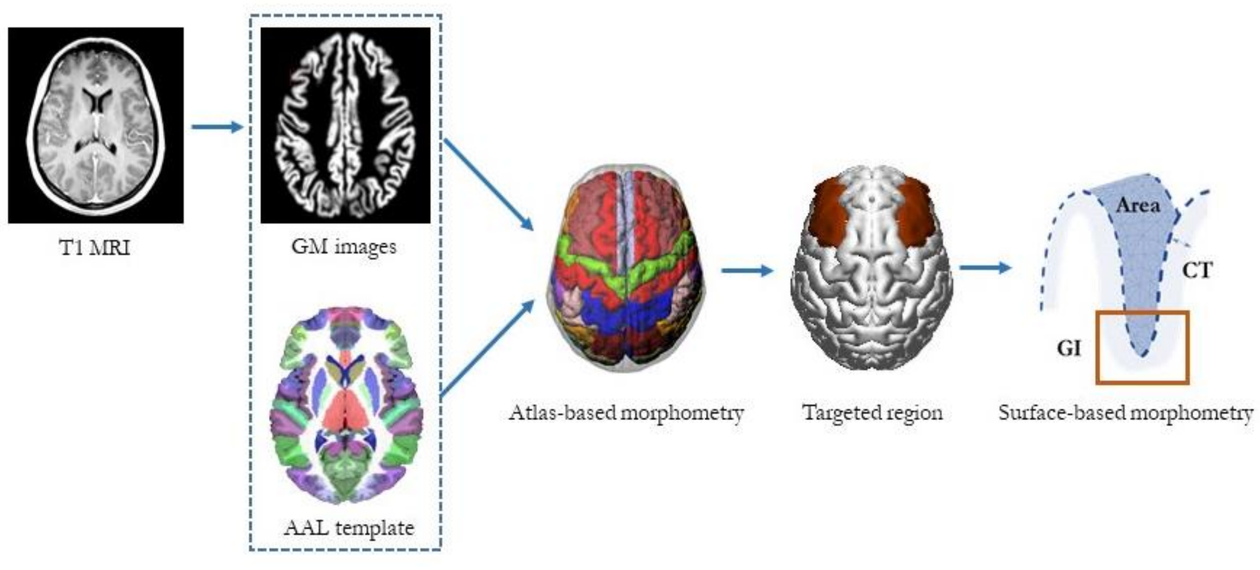

Figure 1. Illustrations of sMRI data and surface-based measures of cortical complexity. Cortical surface derived from BrainSuite 14a is labelled left and right DLPFC as regions of interest. The multiscale morphometric measures contain grey matter volume (mm3), pial surface area (mm2) and cortical thickness (mm) .

RESULTS

1. Advancing age was associated with reduced grey matter volume, white matter volume and pial surface area of bilateral DLPFC but correlated with increased cortical thickness and GI (Figure 2).
2. Volumetric measures, CSF volume in particular, showed better performance to discriminate young-old adults from old-old adults; while cortical thickness and GI can differentiate young-old adults from middle-aged adults and old-old adults.

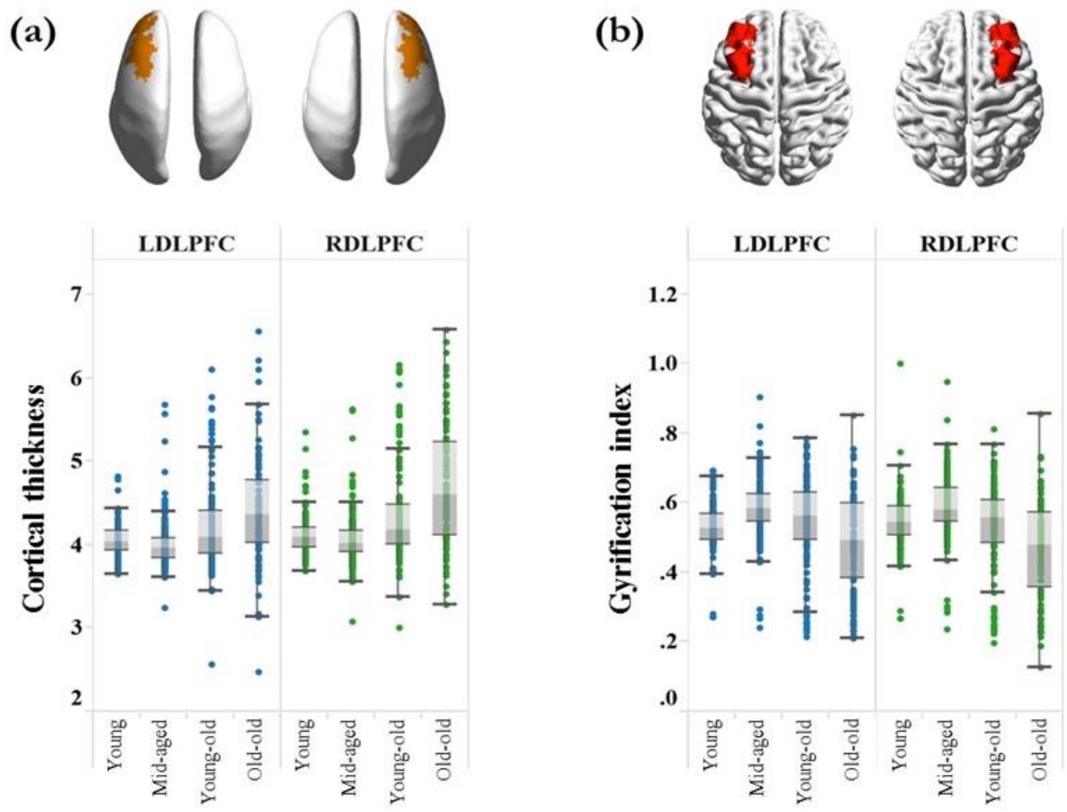

Figure 2. Group-wise differences of the surface-based measures of left and right DLPFC, including cortical thickness (a) and cortical folding (b).

CONCLUSIONS

1) This is the first demonstration that chronological age has a pronounced and differential effect on the cortical complexity of bilateral DLPFC.
2) Our findings suggest that surface-based measures of cortical region, thickness and gyrification in particular, could be considered as valuable imaging markers for the studies of ageing brain and neurodegenerative diseases.

Reference:

1. Madan CR, Kensinger EA (2016) Cortical complexity as a measure of age-related brain atrophy. NeuroImage 134, 617-629.
2. Lu H. Quantifying age-associated cortical complexity of left dorsolateral prefrontal cortex with multiscale measurements. J Alzheimers Dis. 2020;76:505–12.

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