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Subcortical Gray Matter Volumes Correlate with Regional Cortical Thickness in Healthy Adults

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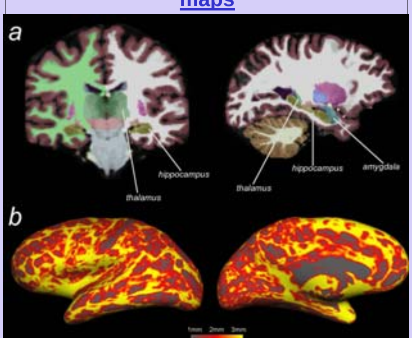
INTRODUCTION

The relationship between the volume of subcortical structures and the thickness of the cortical ribbon has received little attention from the basic and clinical neuroscience research communities. In this study, our primary goal was to investigate this relationship by identifying cortical regions where thickness is strongly correlated with subcortical volumes, focusing on the hippocampus, amygdala, and thalamus. By studying a sample spanning a wide age range, we also hope to identify changes in these correlations that are related to the normal aging process.

METHODS

- Subjects ranging from 15-95 years of age were imaged on a Siemens 1.5 Tesla scanner:
- **MPRAGE scan:** TR = 9.7, TE = 4ms, flip angle = 10°, T_1 = 20ms T_D = 200ms , resolution = 1 x 1 x 1.25mm
- **Subject Demographics:** 264 subjects with an average age of 50 years. 161 Female, 103 Male. All older participants have a Clinical Dementia Rating of 0.
- Reconstruction of cortical surfaces, measurements of cortical thickness, automatic labeling and volumetric measurements of the subcortical structures were performed using the FreeSurfer software [1,2,3,4]
- Using a general linear model, the entire cortical surface of each hemisphere was analyzed to identify regions where thickness was correlated with volumes of the amygdala, hippocampus, and thalamus. Subcortical volume was corrected for eTIV and the age of each subject was regressed out to control for it's effects.

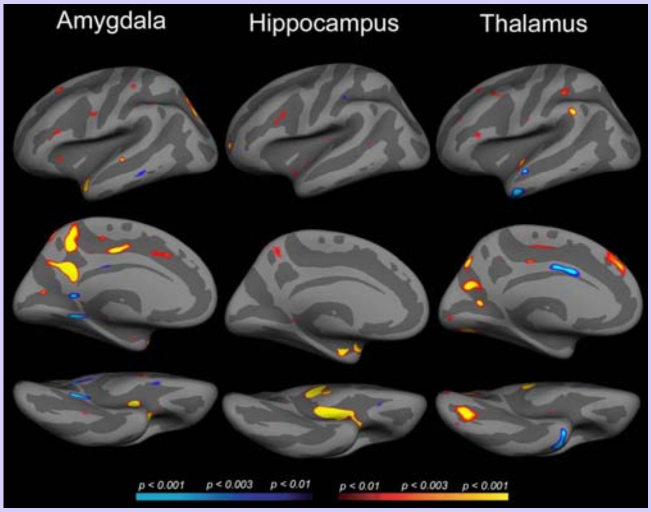
Subcortical labeling and thickness maps



Subcortical segmentations generated for each subject, as shown in **a** above, were used to determine the volumes of the amygdala, hippocampus and thalamus. Thickness maps, shown in **b** above, were also generated for each subject.

RESULTS

Maps of correlation between thickness and subcortical volume



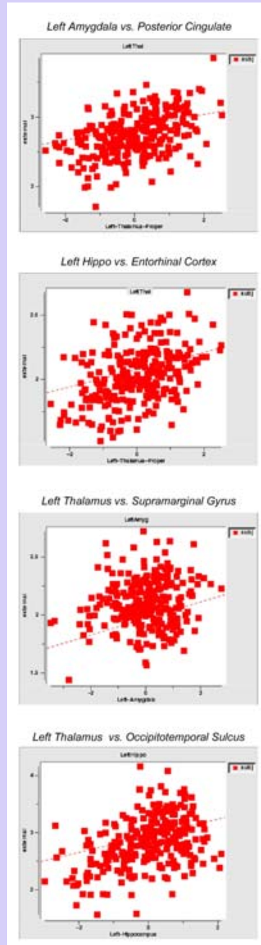
Maps of statistical significance show regions where the cortical thickness is correlated to the volumes of amygdala, hippocampus, or thalamus.

Regional Correlations

	Amygdala	Hippocampus	Thalamus
superior parietal	p= .0001	p= .021	p= .016
temporal pole	p= .0001	p= .096	p= .021
supramarginal gyrus	p= .992	p= .051	p= .002
occipitotemporal sulcus	p= .693	p= .668	p= .042
entorhinal cortex	p= .099	p= .0001	p= .148
posterior cingulate	p= .0002	p= .662	p= .410

Regions of significant correlation between mean cortical thickness within ROI and subcortical structure volume are shown above, structure-specific regions are shown in yellow, structure non-specific regions are shown in green. Left amygdala volume has shown a correlation to cortical thickness of superior parietal regions, regions on the temporal pole, and regions in the posterior cingulate. Left hippocampus volume has shown a correlation to thickness of superior parietal regions, and the entorhinal cortex. Left thalamus volume has shown a correlation to cortical thickness of superior parietal regions, regions on the temporal pole, regions on the supramarginal gyrus, and regions in the occipitotemporal sulcus.

Regression plots for structure-specific regions of cortical thickness



Scatter plots demonstrate the direct correlations seen in regions specific to the amygdala, hippocampus, and thalamus. In each case the volume of subcortical structure has been corrected for head size and the standardized residual is plotted on the x-axis. The cortical thickness, in mm, is plotted on the y-axis.

CONCLUSIONS

- There are strong correlations between the volumes of subcortical structures and the thickness of specific cortical regions, independent of age and head size.
- Further investigations of these correlations, including an exploration of the effect of aging and Alzheimer's disease on these relationships, are in progress.

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