Structural Brain Features Associated with Mild Cognitive Impairment in the Elderly: A VBM Study

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Abstract

Understanding differences in structural brain features associated with cognitive performance during aging is crucial for development of diagnostic tools for conditions like dementia and Alzheimer’s. The objective of this study is to investigate gray matter volume differences (GMV) between participants with mild cognitive impairment (MCI) and age-matched typical participants.

Methods

VBM
• The images were preprocessed using:
  1. generalized template
  2. customized prior probability maps
  3. normalization of the original MR images,
  4. segmentation of tissues
  5. cleaning of images
  6. smoothing of images.

• Comparisons between conditions were conducted with an uncorrected P value of .005 and a cluster size threshold of 145; this corresponds to a per-voxel false-positive probability of .041, determined by the Monte Carlo simulation.

Participants

22 Elderly Participants aged 63-90 (M = 77.6, SD = 8.1)
Two age-matched groups

Typical Group
CDR = 0, N = 11

MCI Group
CDR = 0.5, N = 11

Source
• OASIS- or Open Access Series of Imaging Studies (Marcus, 2007).
• In both cohorts, the testing consisted of measurement of CDR, age, gender, social economic status, and education.

Results

Areas with significantly less GMV in the MCI than the typical group:

Hippocampus
• Plays an important role in the consolidation of information from short-term memory to long-term memory, and in spatial memory.

Thalamus
• Several functions such as relaying of sensory and motor signals, to the cerebral cortex, and the regulation of consciousness, sleep, and alertness.

Paper Circuit
• Neural network associated with memory.
  • As AD is characterized by loss of episodic memory, previous research focused on hippocampal function. In addition, recent studies point toward the initial degradation in the anterior thalamic nucleus and the retinasepineal complex found in the Paper circuit.

# of
Structures
Associated with Cluster

253 Hippocampus
129 Thalamus
112 Limbic Lobe
106 Parahippocampus Gyrus
76 Pulvinar

Discussion

• We observed that individuals with MCI have lower GMV in the left medial temporal lobe and the thalamus.
• These findings fit comfortably into hierarchical distribution of AD pathology.
• The results are aligned with the recent research that support atrophy of the thalamus and hypothalamus as critical markers for MCI.

Application

• The American Academy of Neurology reviewed several studies and, even though these studies had used various criteria for MCI, they pointed to an annual conversion rate of 6%–25% from MCI to Alzheimer’s disease (Pennanen, 2005).
• By looking for correlations with these markers in MCI, researchers can more accurately diagnose patients with early-onset AD.

References


Marcus, DS, Wang, TH, Parker, J, Csernansky, JG, Morris, JC, Buckner, RL. Journal of Cognitive Neuroscience, 19, 1498-1507

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