Classification of ADNI Subjects Based on Longitudinal Analysis of the Hippocampal FDG-PET Signal

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Introduction
To support the development of new treatments for Alzheimer's disease (AD), it is important that patients in the early stages of the disease can be reliably identified, particularly those with amnestic mild cognitive impairment (aMCI).

We aim to classify subjects from the Alzheimer’s Disease Neuroimaging Initiative (ADNI), based on a regional analysis of their baseline and 12-month FDG-PET scans, as healthy controls (HC), or as having either aMCI or AD. The aMCI patients are further divided into those who have since progressed to AD (p-MCI) and those who have so far remained stable (s-MCI).

Methods

Patients
Image data were obtained from 208 patients (46 AD, 41 p-MCI, 69 s-MCI, 52 HC), for whom both MRI and FDG-PET scans were available at baseline and after 12 months.

Image Processing
Each patient’s follow-up MRI, baseline FDG-PET, and follow-up FDG-PET images were realigned into the space of their corresponding baseline MRI using affine transformations.

FDG-PET Sampling
The signal intensity per cubic millimetre was found in the hippocampus for both the baseline and 12-month FDG-PET scans.

FDG-PET Image Normalisation
Global variations in the cerebral metabolic rate of glucose between subjects were accounted for using the “reference cluster” method, in which areas of apparent hypermetabolism between patients and controls (relatively unaffected by the disease) are extracted from the image data and used for normalisation.

The normalisation cluster was located mostly in the cerebellum, but extended also to a small region of the brainstem.

Hippocampal Masks
Baseline and follow-up MRI were segmented simultaneously in the baseline MR-space using a 4D graph-cut method that has been previously applied for measuring hippocampal atrophy.

Classification
Classification rates were evaluated between pairs of clinical groups using a linear discriminant function. The mean accuracy, sensitivity, and specificity were evaluated over 1000 iterations, in which 75% of the patients were randomly selected for training, with the remaining 25% used for testing.

Results
Boxplots show the FDG-PET signal intensity per cubic millimetre in the hippocampus at baseline and after 12 months, as well as the difference between the two. The signal intensity in the hippocampus is normalised to the signal intensity per cubic millimetre in the reference cluster.

Classification rates were evaluated first using only baseline data, and then using both baseline and follow-up data together. The classification accuracy achieved for each pair of clinical groups is presented in the table as mean (standard error).

Conclusions
Classification rates achieved using the FDG-PET signal intensity in the hippocampus at baseline may be improved by the inclusion of follow-up data. We intend to continue this work by considering not only the hippocampus, but an 83-region anatomical segmentation, such that classification is based on the FDG-PET signal intensity across a combination of regions.

References

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