Detecting Modifications of the Default Mode Network in Mild Cognitive Impairment (MCI) by fMRI using Blind Source Separation (BSS)

Wohlschläger AM[123], Sorg C[4], Riedl V[1], Drzezga A[3], Stangier I[3], Gruber P[5], Keck I[5], Theis F[5]

[1]Department of Neurology, [2]Department of Neuroradiology,
[3]Department of Nuclear Medicine, [4]Department of Psychiatry, TU Munich, Germany
[5]Physics Department, University of Regensburg, Germany

1. Introduction: The diagnostic tool to detect early stages of Alzheimer's Disease (AD), a progressive neurodegenerative disease, is lacking until today. FDG-PET (Fluorodeoxyglucose-Positron Emission Tomography) shows hypometabolic areas in the brains of pre-demented, i.e. MCI patients. The reduced activity may be attributed to disrupted connectivity of the resting-, or default-mode network of the brain. Here we will present the advantages of a hypothesis-free namely BSS (Blind Source Separation) analysis on fMRI data in this context. Results are compared to FDG-PET data.

2. Methods: Presented here are preliminary results of two MCI patients and two healthy controls. 4 min of fMRI scanning (TR=3sec, No. of Scans: 77) was performed using a Siemens Symphony 1.5T-scanner. a) Data were analysed after preprocessing (skull-stripping, slice-mean-normalisation, realignment, smoothing) using MELODIC(SPM), b) data of one of the control subjects were analyzed using the MF_TOOLBOX for SPM. This software was developed at the University of Regensburg. An extensive description is given in [1,2]. The interface is designed to integrate well with the standard SPM analysis Software and hence im- and export features for the analyze format are available.

3. Results: Comparison of default mode network component with **FDG-PET** maps determined within one and the same patient show common features in the two patients investigated up to now (Fig.1). Hypometabolic areas determined with FDG-PET agree well with the parietal areas of the default mode network as determined with fMRI. The comparison of **MCI patients and healthy controls** in this preliminary analysis indicates that in MCI patients larger parts of the frontal lobe are integrated into the default mode network than in healthy controls (Fig.1). Ordering of ICA-components (independent component analysis) according to **hierarchical** criteria (Fig. 2) may help identifying and classifying default mode components within a subject.

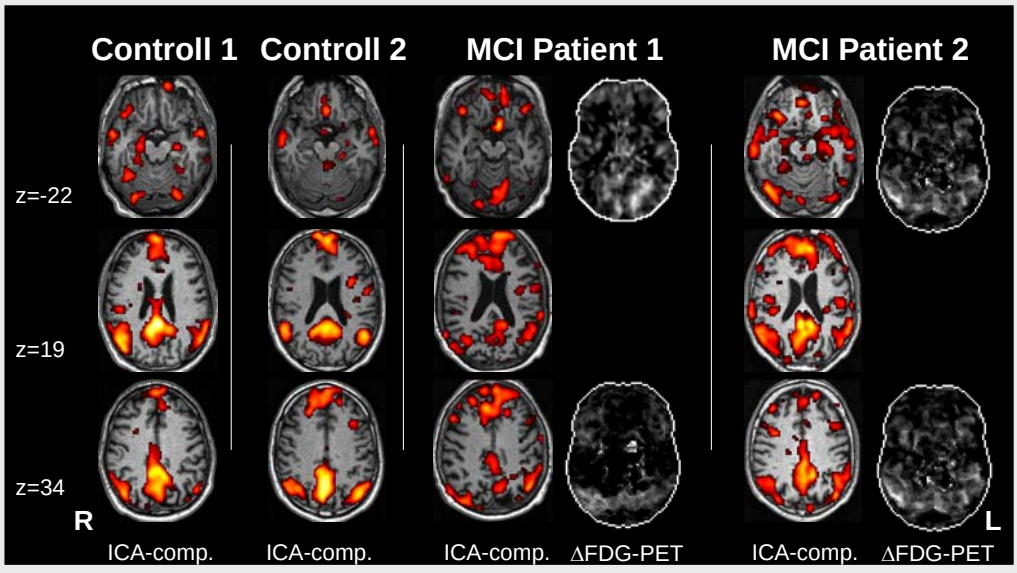
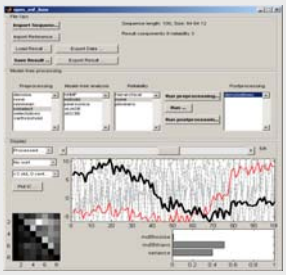


Fig.1: Comparison of default mode network and hypometabolic areas: The default-network-components as defined from ICA(MELODIC)/fMRI in health control subjects and in MCI-patients superimposed onto the patients/subjects anatomical images are shown. For the patients plots of areas in which the individual FDG-PET signal deviates (ΔFDG-PET) from the signal measured in a collective of healthy control subjects are added. All images were normalized to a template. Z-coordinates in MNI-space for the slices are indicated. Note that ΔFDG-PET images were only coregistered manually.

2a)



2b)

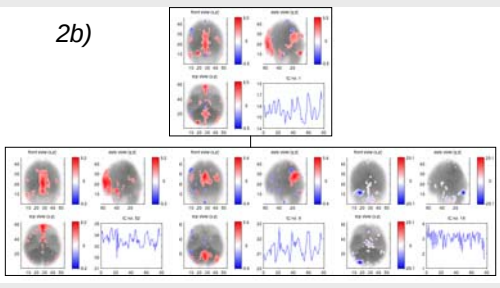


Fig.2: a) Screenshot of the MF_TOOLBOX, b) ICA-Analysis of resting state fMRI of control subject 1: hierarchical levels of ICA results containing the relevant component.

6. Conclusion: We have introduced our spatiotemporal BSS algorithm for the classification of fMRI data. ICA of MCI patients indicates modifications in the default networks in early stages of Alzheimer's Disease. The model free approach is the most viable technique for this task since default-mode and its disease modifications do not provide a well defined activation pattern.

1. F.J. Theis, P. Gruber, I.R. Keck, A.M. Tomé, and E.W. Lang. A spatiotemporal second-order algorithm for fMRI data analysis. In Proc. CIMED 2005, 194-201, Lisbon, Portugal, 2005.
2. F.J. Theis, P. Gruber, I.R. Keck, A. Meyer-Bäse, and E.W. Lang. Spatiotemporal blind source separation using double-sided approximate joint diagonalization. In Proc. EUSIPCO 2005, Antalya, Turkey, 2005.