The relationship between Glutamate and oscillatory activity in a repetition suppression paradigm – a combined MR-spectroscopy and EEG study

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Introduction

The formation and sharpening of cortical object representations requires the activation of neuronal cell assemblies and has been correlated to synchronized neuronal activity in the gamma band range using the repetition suppression paradigm [1]. There is also evidence that magnetic resonance spectroscopy (MRS) can be used to measure the relationship between synchronised oscillatory activity and neurometabolites [2]. However, the temporal relationship between MRS and gamma band activity has not yet been investigated. We present here event-related MRS (ER-MRS) from the lateral occipital cortex and simultaneously acquired electroencephalography (EEG) results collected during a repetition suppression paradigm [1] in ten healthy subjects.

Methods

All MR data were collected using a PRESS single voxel acquisition (vox = 15x15x20 mm^3, TE /TR = 40/3000 ms, 128 or 256 averages) with CHESS water suppression, in the lateral occipital cortex with an 8 channel sense head coil in a 3T Acheiva MR system (Philips Medical, Best, The Netherlands). Subjects were presented repeatedly with line drawings of real and abstract objects. The EEG data were acquired continuously at 5 kHz inside the MR scanner, using MRI compatible EEG BrainAmp MR amplifiers (BrainProducts, Munich, Germany) and a compatible BrainCap electrode cap (Falk Minow Services, Herrsching-Breitrunn, Germany) containing 64 Ag/AgCl electrodes. The data was recorded using brain vision recorder software package (Brain Products). To allow gradient artifacts to be properly synced and removed from the EEG data, the MR scanner clock and EEG recording software were synced using Brain products sync box, and TTL pulses for each spectra where sent to the EEG acquisition computer. High resolution T1 weighted images were used for voxel planning.

ER-MRS data was collected using a PRESS sequence with a 40 ms TE on a Philips 3T after each stimulus, and averaged to produce one set of MRS data per stimulus type. jMRUI software [3] was used to provide concentration estimates for Glutamate (Glu) as well as the other major neurometabolites

Results

MRS data acquired simultaneously with EEG data was of similar quality to that normally acquired on our system (Figure 1a). EEG data was acquired continuously at 5 kHz and analyzed using custom routines in MATLAB. EEG data was of sufficient quality to allow decreasing evoked gamma band activity (eGBA) with increasing repetition of real stimuli and the opposite pattern for abstract stimuli to be seen. Average Glu levels were found to be lower after real stimuli presentation compared to abstract stimuli (p=0.02). A significant correlation between Glu levels and the eGBA was also found (figure 1b).

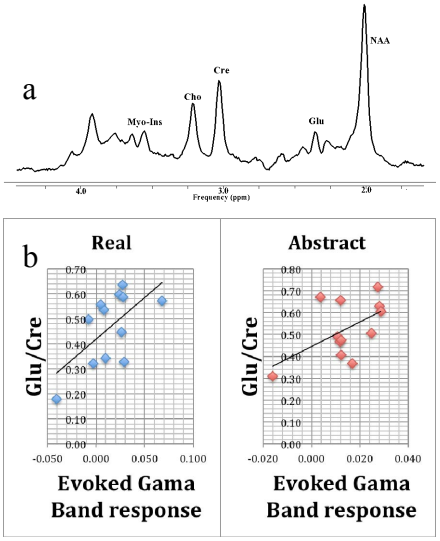

Figure 1 a) representative MRS data used in the analysis, b) relationship between Glu levels and evoked Gama band responses for both conditions.

Conclusions

These results provide the first simultaneously recorded in-vivo evidence of changes in neuronal electrical activity with related changes in Glu concentrations, and provide a window into the underlying neurochemical substrates of neuronal network activity.

References

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