Human studies of functional MRS at 7T with semi-LASER
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Introduction
In the last years, several functional MRS (fMRS) studies from our group1 and from other labs2,3 have consistently demonstrated small but significant variations in concentrations of few brain metabolites in the activated human visual cortex during prolonged visual stimuli. In particular, the levels of lactate, glutamate, glucose and aspartate have been observed to change within ±0.2 μmol/g during visual stimuli1-3. Concentration changes of glutamine, glutathione, glycine and GABA have also been reported during achromatic visual stimuli (i.e, white/black checkerboard).4 Given the small concentration changes, ultra-high magnetic fields and optimized acquisition strategies are critical for conducting fMRS studies. In our previous fMRS work1, we utilized STEAM at 7 T for spectra acquisition. Most recently, spin-echo-like sequence (SPECIAL) have been used to benefit from the full-intensity MRS signal and improve sensitivity of detection in fMRS studies3. The aim of the present study was to determine whether concentration changes of glutamine, glutathione, glycine and GABA2 are observed when using a full-intensity 1H MRS sequence at 7 T, namely semi-LASER4, during the presentation of the same chromatic visual stimuli that we used previously (i.e, red/black checkerboard).

Methods
Nine healthy volunteers were examined on a 7T/90cm actively shielded Agilent magnet interfaced to Siemens console. To obtain full-intensity spectra, we utilized an optimized semi-LASER sequence4, with TE = 26 ms, TR = 5 s. Spectra were acquired with a quadrature half-volume RF coil from a 8-ml voxel localized in the primary visual cortex, during the same block-design visual stimulation paradigm as used previously1. The stimulus consisted of a rotating red/black checkerboard covering the entire visual field and flickering at a frequency of 8 Hz, while the rest condition consisted of a uniform dark background. Single scan FIDs of each subject were corrected for small frequency and phase fluctuations, summed in nine blocks of 32 scans, corrected for residual eddy currents, and finally analyzed by LCModel with simulated basis set5. Group analysis of metabolite concentrations at different time-points were performed with two-side paired t-test.

Results and discussion
Semi-LASER spectra acquired during rest and stimulation conditions from a representative subject are shown in Fig.1. As expected, semi-LASER generally resulted in 2-fold increase of signal-to-noise (SNR) compared to STEAM. While such SNR gain could be leveraged for increased time-resolution of metabolite time-courses relative to our previous fMRS studies, we decided to use it for improving sensitivity of detection. The group analysis (Fig. 2) revealed metabolite time-courses strikingly similar to previous findings1,3. Significant concentration changes within ±0.2 μmol/g were indeed observed between stimulation periods and following rest periods (p<0.05) for lactate (+26%), glutamate (+3%), aspartate (-5%) and glucose (-18%). Notably, for all other 12 quantified metabolites, changes did not reach statistical significance, despite increased sensitivity. We conclude that concentration changes in glutamine, glutathione, glycine and GABA observed in other studies2 are likely to be ascribed to the particular settings of the visual stimulation paradigm (e.g., chromatic vs achromatic visual stimuli).

References