Simultaneous MR-flumazenil-PET imaging in a rest-task-test design in humans

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Background: Switching between resting state networks and task related activity is a salient characteristic of the human brain. How quickly does the neuronal network return from task back to rest? We performed a pilot measurement investigating the feasibility of this simultaneous flumazenil-PET-MR approach targeting the GABA-ergic system and investigated the resting state networks via fMRI in a rest-task-rest design.

Methods: Data acquisition: fMRI and flumazenil-PET were recorded in 4 healthy male volunteers (mean age = 25 ± 2.5 years) in a 3T hybrid MR-BrainPET system (Siemens, Germany). The MPRAGE sequence was used to acquire structural MR images (TR2250/TE3.03/GRAPPA 2). Resting state fMRI data were acquired before and after an auditory paradigm (T2*-weighted EPI sequence (TR2.2/TE30ms/FOV200mm/6 minutes/eyes closed)). PET data: Approx. 400 MBq 11C-flumazenil via bolus injection & constant infusion (kBol=1.8/h), list mode, iteratively reconstructed (30 frames, 253 slices, voxel 1.25 mm3 isotropic, MR-template-based attenuation correction).

Data Processing: Regional homogeneity (ReHo) was computed for pre- and post-task resting state conditions for every voxel and its 26 neighbouring voxels (Zang et al., 2004). Smoothing (Gauss 3 mm) was done and ReHo measures were converted to standard Z scores. PET images were smoothed (Gauss 3 mm), motion corrected and registered to standard MNI template; time-activity curves were extracted from the precuneus and PCC (PMOD software package, version 3.5).

Results: The preliminary analysis of 4 subjects shows a slight increase in ReHo measures in the post-task resting state compared to the pre-task resting state in precuneus and PCC. The time-activity curves of 11C-flumazenil over these regions show no significant change over time in this first explorative approach.

Conclusions: The simultaneous bimodal approach proved to be feasible; inclusion of further volunteers is necessary to assess statistical significance of the obtained results and to validate it. fMRI data point into the direction that resting state networks might not switch fully back to “rest” immediately after the task despite the low cognitive demand of the auditory paradigm (loudness dependent evoked potentials). PET data show at this analysis stage no clear change.