Task-specific glucose metabolism and functional connectivity assessed with simultaneous PET/MR imaging

A. Hahn1, G. Gryglewski1, L. Nics2, M. Hienert1, L. Rischka1, C. Vraka2, M. Hartenbach2, W. Wadsak2, M. Mitterhauser2, M. Hacker2, S. Kasper1, R. Lanzenberger1

1Department of Psychiatry and Psychotherapy, Medical University of Vienna, Austria, 2Department of Biomedical Imaging and Image-guided Therapy, Division of Nuclear Medicine, Medical University of Vienna, Austria

Background: Non-invasive imaging enables a thorough characterization of human brain function across various modalities, including local metabolism and interregional associations. However, most investigations were carried out at baseline conditions, whereas associations during task performance are largely missing. We combined recent methodological advances to increase the sensitivity for the assessment of task-specific changes in glucose metabolism and functional connectivity.

Methods: Eighteen healthy subjects underwent one 95min PET/MR examination (24.1±4.3 years, 8 female). During the scan, subjects opened their eyes (10-20min and 60-70min) or tapped the right thumb to the fingers (35-45min and 85-95min). A novel approach of \([18F]FDG\) constant infusion enabled the assessment of baseline and task-specific glucose metabolism (CMRGlu) in a single measurement (3MBq/kg, 36ml/h). After separation of baseline and task-specific radioligand uptake, quantification was carried out with the Patlak plot.

Continuous resting-state functional MRI was acquired during baseline and the task conditions (TE/TR=30/2440ms, 5min each). Potentially confounding signals were removed by linear regression (white matter, cerebrospinal fluid, movement parameters) and data were bandpass filtered. Functional connectivity was then computed from seeds showing task-specific changes in CMRGlu and compared between rest and task.

Results: Task-specific increases in CMRGlu up to 1.5µmol/100g/min were observed in the left motor cortex during finger tapping. Furthermore, the task elicited decreased CMRGlu in regions of the default mode network (all p<0.05 FWE corrected). Compared to rest, motor cortex connectivity decreased in the supplementary motor area and contralateral motor cortex, but increased connectivity was observed with brainstem regions such as the red nucleus (all p<0.05 FWE corrected).

As expected, baseline functional connectivity was higher for within network connections (motor-SMA and motor-contralat. motor, z-score=0.70 and 0.69, respectively) than for the non-network connection (motor-brainstem, z=0.16, p<0.001). Importantly, this difference between the connections disappeared during the task (all z=0.41-0.46, p>0.1).

Conclusions: Task-specific changes in glucose metabolism are accompanied by widespread changes in functional connectivity even during simple tasks. Here, decreases and increases in functional connectivity may reflect the involvement of different regions in the task. The combined assessment of metabolism and connectivity may offer novel strategies to investigate human brain function also during task performance.