Simultaneous multislice fMRI improves the physiological noise removal in resting-state fMRI

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**Background:** In functional MRI studies physiological noise can induce changes in the blood-oxygen level dependent signal. There is a broad consensus on that the temporospatial pattern of breathing and heartbeat related artefacts overlap with resting state network fluctuations. Identification of the components is challenging: due to the low sampling rate of conventional fMRI acquisitions and spectral overlap of the signals. Simultaneous multislice (SMS) imaging – with high temporal resolution and direct measure of physiologic signals promise to overcome these limitations. We investigated the capabilities of the advanced fMRI technique with sub seconds sampling to identify and remove the physiological artefacts using a model free approach.

**Methods:** 25 subjects were selected from the International Neuroimaging Data-sharing Initiative (INDI) database. Each subject were scanned with 3 different acquisition sampling rate (TR) to measure resting-state network activity. Two scans (TR = 645ms, and 1400ms) required SMS technique, another was acquired with traditional gradient EPI sequence (TR=2500msec). Beside standard SPM based preprocessing, latest version of RETROICOR/RVHR was used to calculate and regress out artefacts related respiratory variation and heart beats. We performed single-subject and group-level spatial-, and temporal independent component analysis (ICA) before and after the physiological noise regression. We also compared the physiologic regressors to the time courses of the artefact components identified by ICA.

**Results:** Resting-state network-, and physiological components were identified via temporal and spatial ICA analysis at every acquisition rates. The performance of physiological noise regression showed significant differences between different sampling rates at subject level. The resting-state networks were more accurately delineated with less spatially scattered activity, however we still found components that the relevant literature identifies as typical physiology related noise based either on the spatial pattern and/or the spectral features. Moreover, the time course of the noise components did not show any correlation with the regressors assessed by RETROICOR. At the group-level, directly recorded physiology artefact removal has only subtle effect on the network components. The ICA identified artefact related components were not reduced substantially via physiologic regression, independently from the sampling rate.

**Conclusions:** fMRI acquisition with sub-second sampling rate improve the clean-up process of resting-state measurements at the subject level. One should be cautious labelling and handling suspicious ICA components as physiological noise, since other than spatial overlap we were not able to prove that the time-course of these components are related to the directly measured physiologic signals even using high sampling rate.