Dynamics of fMRI intrinsic connectivity networks dissociate between pathology markers and symptom markers in major depressive disorder

Anja Ries1,2, Chun Meng1,2, Christian Sorg1,2,3, Afra Wohlschläger1,2

1 Department of Neuroradiology, Technical University of Munich TUM, Munich, Germany
2 TUM-Neuroimaging Center, Technical University of Munich TUM, Munich, Germany
3 Department of Psychiatry, Technical University of Munich TUM, Munich, Germany

Background: Interregional functional connectivity (FC) is viewed as a prerequisite (if not correlate) of large-scale communication of neuronal assemblies. FC is calculated as a measure reflecting signal covariance, i.e. synchronous signal development over time. This can only occur when dominant frequencies of the time courses are identical, because otherwise signal would naturally diverge at significant periods of time. We therefore investigated the functional orchestration of intrinsic connectivity networks (ICNs) in terms of frequency range covered by different ICNs in order to detect possible aberrant dynamics in major depressive disorder (MDD)

Methods: 10 min of fMRI resting-state data was acquired from 25 patients with recurrent MDD and 25 healthy controls. 24 ICNs were identified using independent component analysis and the spatial maps from Allen et al. (2011). The dynamic properties of the ICNs were investigated by means of spectral analysis. The center of gravity served as integral measure for each single component spectrum. A repeated-measures ANOVA was performed on the weighted frequency values (wF) with group and ICN as main factors. Pearson’s correlation was calculated between the wF of each ICN and the Beck Depression Inventory (BDI) score, which reflects the severity of depression symptoms.

Results: The ANOVA yielded a significant effect of ICN and a significant interaction between group and ICN. The interactions could be mainly attributed to the attentional salience network (SAL) and one of the visual networks (VIS). SAL showed dynamics on a significantly higher frequency range in MDD patients, whereas VIS had significantly lower frequent dynamics. Analysis of the FFT spectra showed that these shifts of wF could be attributed to a significant power loss at low frequencies of 0-0.025 Hz in SAL, and to power loss at higher frequencies of 0.075-0.15 Hz in VIS. BDI scores significantly correlated with the wF of the anterior and posterior subdivision of the default mode network (DMN) and the left attentional network.

Conclusions: Our results are the first to demonstrate a stable temporal structuring between ICNs, showing that each ICN has its own distinct dynamic profile. Furthermore, our findings indicate that altered dynamics of the VIS and SAL network are a hallmark of MDD, while depressive symptoms experienced by the patient relate to dynamic alterations in other networks possible in reaction to aberrant salience or visual processing.