Altered brain-network properties in patients with anorexia nervosa

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Background: Patients with anorexia nervosa (AN) deprive themselves of food despite severe undernutrition, have an intense fear of weight gain, a distorted body image, and often lack insight about their illness. However, the exact underlying neurobiological mechanisms remain to be clarified. The study of resting-state functional connectivity offers a standardized, easily performed procedure, which could potentially overcome inconsistencies between paradigm-based studies. In contrast to previous resting-state functional connectivity studies in AN using independent component analysis or seed based connectivity analysis to probe specific brain networks (Favaro et al. 2012; Kim et al. 2012; Cowdrey et al. 2014), we model the entire brain as a complex network allows determination of graph-theoretical metrics, which describe global and local properties of how brain networks are organized and how they interact (Bullmore & Sporns 2009).

Methods: The study includes fMRI resting state data of 35 adolescent female patients with acute AN and 35 age-matched healthy females. FMRI data were preprocessed within the nipype framework using SPM8. Then by using the DPARSFA toolbox we parcellated the volumes were into 160 spherical regions of interest (ROIs, Dosenbach et al. 2010). The pair-wise Pearson correlation coefficients of the extracted ROI time courses were used to construct weighted, undirected graph networks with 160 nodes on individual subject level. We computed well-established global metrics (clustering coefficient, characteristic pathlength, small-worldliness index, assortativity, efficiency) and local graph metrics (degree, strength, average pathlength, betweenness centrality, participation index, local efficiency) across a range of network densities.

Results: The group comparison of the global functional network structure revealed increases in both characteristic pathlength (longer average paths between nodes) and assortativity (nodes with a similar connectedness tend to link together) in AN. Furthermore, we found locally increased pathlength and decreased connectivity strength in the posterior insula and thalamus.

Conclusions: This study demonstrates AN-related changes in the network configuration by using resting-state fMRI and a graph-theoretical approach for the first time. Our findings revealed an altered global brain network architecture accompanied by local degradations indicating wide-scale disturbance in information flow across brain networks of acute AN patients. Reduced local network efficiency in the thalamus and posterior insula may reflect a mechanism that helps explain the impaired integration of visuo-spatial and homeostatic signals in AN, which is thought to be linked to abnormal representations of body size and hunger.