Functional connectivity alterations between the DMN and occipital cortex in patients with OCD

Introduction

OCD (Obsessive Compulsive Disorder) is disabling psychiatric condition, with a prevalence of 2%-3% in the general population. OCD is characterized by obsessions (persistent and intrusive thoughts) and compulsions (rituals or repetitive behaviors performed to reduce the anxiety caused by obsessions). The pathophysiology of OCD was often conceptualized via the cortico-striato-thalamo-cortical model (Milad and Rauch, 2012), many studies presented volumetric and connectivity changes in those regions among OCD patients. A meta-analysis focusing on resting-state functional MRI (rs-fMRI) seed analysis (Gürel et al., 2018) found altered connectivity inside the Default Mode Network (DMN), Salience Network (SN), and Fronto-Striatal-Parietal (FSPN) networks as well as hyperconnectivity between these three networks. Additionally, the Fronto-Striatal-Circuitry presented general dysconnectivity (no specific direction of connectivity change).

We aimed to test the replicability of the meta-analysis findings in OCD patients.

Methods

A total of 64 participants completed 13 minutes of resting-state fMRI 3T with eyes open (27 OCD patients and 37 age, sex, and education matched healthy controls, HC). Seed to voxel (whole brain) analyses were conducted for 30 seeds based on the reported findings in Gürel’s meta-analysis (figure 1, table 1). Five seeds were created with five-diameter spheres based on the coordinates of the significant group-difference clusters. In addition, 15 seeds were constructed to represent FPN, DMN, SN from the CONN ICA network (Whitfield-Gabrieli et al., 2012), and ten seeds to represent the thalamus and the striatum based on the Harvard-Oxford Atlas sub-Cortical Structural Atlas (Caviness et al., 1996). For each seed-to-voxel analysis, we performed separate second-level GLMs to compare OCD with controls, including maximum motion as a covariate via the CONN toolbox v13c. We considered findings significant at FWE corrected p-values ≤ 0.05 at cluster and voxel level. Moreover, we probes the robustness of our findings using two different parcellation approaches 1) utilizing the DiFuMo functional atlas (Dadı et al., 2020) and 2) using the Independent Component Analysis (ICA) as data-driven network parcellation to use as seeds.

Highly significant connectivity alterations in OCD

Significant connectivity alterations in OCD: Significant connected clusters to LP_r (OCD controls) after correction for multiple comparisons and number of ROIs (p < 0.05 FWE; |z| > 2.4). [44 – 64] < 0.01. [24 – 64] 0.44 connectivity indicated a pattern of stronger positive connectivity in the OCD group [34 – 44] 0.04 (LP_r, LDC) connectivity indicated a pattern of stronger negative (i.e., inverse) connectivity in the OCD group. MRI Coordinates (results were similar to bilateral seed LP_r).

Group effect size for the highly significant clusters

The effect size for OCD and HC: connectivity measures between LP_r and [34 – 64] left occipital pole and [24 – 64] 0.44 OCC lateral right. In this study, we aimed to assess positive connectivity in the OCD group vs. controls, and our findings show a significant increase in connectivity in the occipital pole cluster (LP_r) compared to the control group, which could indicate an altered neural network in patients with OCD. This altered connectivity might be related to the cognitive and sensory processing deficiencies observed in patients with OCD.

Discussion

Our findings replicated partly the meta-analysis findings of Gürsel et al., specifically SN and DMN hyperconnectivity, by using seeds based on the meta-analysis. We identified alternation between the SN and, in particular, the DMN to the visual network. This raises the question about the visual system’s involvement in OCD symptoms and the abnormal connectivity of a unimodal region as the visual network to the multimodal DMN. Previous studies found evidence for decreased metabolic activity, increased connectivity, and volumetric changes in the left inferior parietal and parietal-occipital junction, suggesting the possible existence of visual processing deficits in OCD (Gonçalves et al., 2010). Our findings support those previous discoveries. Several studies (Ravindran et al., 2020; Stern et al., 2016) presented significant hyperconnectivity among OCD patients between DMN-related seeds and the visual cortex primary regions V1 and V2 after viewing or imagining an OCD related stimulus to evoke stress. Since the regions in which we found abnormal connectivity in our study during resting-state are similar, this raises the question of whether the abnormal emotion-related visual-to-DMN connectivity might point towards cognitive occupation with symptoms, also during our rest measure, in the absent of OCD threatening stimuli.

References


