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Research paper

Reduced resting-state functional connectivity of default mode network subsystems in patients with obsessive-compulsive disorder

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ABSTRACT

Objectives: Neuroimaging studies have reported extensive resting-state functional connectivity (rsFC) abnormalities in the default mode network (DMN) in patients with obsessive-compulsive disorder (OCD), but findings are inconsistent. DMN can be divided into three subsystems: core, dorsal medial prefrontal cortex (dMPFC), and medial temporal lobe (MTL). This study aimed to explore abnormalities in rsFC strength within and between DMN subsystems in OCD patients, and their relationship with clinical symptoms.

Methods: This study recruited 39 OCD patients and 45 healthy controls (HCs). OCD symptoms were assessed using the Yale-Brown Obsessive-Compulsive Scale (YBOCS). The seed-to-seed method was used to construct rsFC matrix. The rsFC strength within and between the three DMN subsystems were calculated.

Results: Compared to the HC group, the OCD group exhibited reduced rsFC strength within core subsystem ($F = 7.799$, $p = 0.007$, Bonferroni corrected $p = 0.042$). Further, this reduction was also observed in the unmedicated OCD group ($n = 19$), but not in the medicated OCD group ($n = 18$). In addition, rsFC strength within core subsystem was negatively correlated with the obsession subscale of YBOCS in the OCD group ($r = -0.512$, $p = 0.004$, Bonferroni corrected $p = 0.008$). Further, this correlation was also significant in the unmedicated OCD group, but not in the medicated OCD group.

Conclusions: Our findings suggest that reduced rsFC strength within core subsystem is a feature of OCD patients and may serve as a potential biomarker of obsession severity. Moreover, pharmacological treatments may affect rsFC strength in DMN.

1. Introduction

Obsessive-compulsive disorder (OCD) is a mental disorder characterized by recurrent obsessive thoughts and compulsive behaviors (Veale and Roberts, 2014), which usually occurs early in life with a lifetime prevalence rate of 2% ~ 3%, and can severely impair social functioning and overall quality of life (Kugler et al., 2013). The World Health Organization ranks OCD as one of the ten most disabling disorders (Kugler et al., 2013). However, the etiology of OCD remains complex and not yet fully understood (Jalal et al., 2023).

With advancements in neuroimaging technology, researchers have begun to unravel the neural mechanisms of OCD. Studies have found widespread abnormalities in resting-state functional connectivity (rsFC) in OCD patients (Liu et al., 2022a). The default mode network (DMN), characterized by activation at rest and inhibition during tasks (Raichle et al., 2001), plays an important role in cognitive functioning, such as self-reference, episodic memory and social cognition (Menon, 2023). The DMN consists of multiple brain regions, such as posterior cingulate cortex (PCC), medial prefrontal cortex (MPFC), and medial temporal lobe (MTL) (Menon, 2023; Raichle et al., 2001). The DMN in OCD patients exhibits abnormal rsFC (Gürsel et al., 2018). However, the results of previous studies are not very consistent. Most studies have shown reduced rsFC within DMN in OCD patients (Beucke et al., 2014; Jang et al., 2010; Peng et al., 2014; Posner et al., 2016; Stern et al., 2012). For instance, Stern et al. (2012) found reduced rsFC between the PCC and bilateral dorsomedial prefrontal cortex (dMPFC) in OCD patients, but this rsFC was not correlated with symptoms severity. Peng et al. (2014) found reduced rsFC within PCC and a negative correlation with obsession in OCD patients. Posner et al. (2016) found reduced rsFC between the anterior medial prefrontal cortex (aMPFC) and the right lateral

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parietal lobe. However, one study found increased rsFC between the right inferior parietal lobe (IPL) and the left ventral medical prefrontal cortex (vMPFC) in OCD patients (Koçak et al., 2012).

In addition to dividing the DMN into individual brain regions, the DMN can be subdivided into three subsystems: core subsystem, dMPFC subsystem, and MTL subsystem (Andrews-Hanna et al., 2010). The DMN has been found to be a massively interacting brain system, with each subsystem having different characteristics (Andrews-Hanna et al., 2010). The core subsystem is associated with self-referential processing and affective decisions, the dMPFC subsystem is linked with social cognition, and MTL subsystem is associated with episodic memory (Andrews-Hanna et al., 2010, 2014). rsFC strengths within and between these three subsystems have been reported to be affected in a variety of psychiatric disorders such as schizophrenia (Fan et al., 2022), major depression disorder (Liu et al., 2022b), bipolar disorder (Fan et al., 2023) and autism (Bathelt and Geurts, 2021). For instance, patients with schizophrenia showed reduced rsFC strength within MTL and between dMPFC-MTL subsystems (Fan et al., 2022). Moreover, previous studies have consistently revealed that rsFC strength impairments within and between DMN subsystems are correlated with symptoms severity (Fan et al., 2022, 2023; Liu et al., 2022b). For example, Fan et al. (2023) found rsFC strength within core subsystem was negatively correlated with depression and anxiety severity in patients with bipolar disorder.

However, a comprehensive exploration of rsFC abnormalities within and between DMN subsystems in OCD patients is lacking. Only one study considered the DMN subsystems in OCD patients, but it still disaggregated the subsystems into individual brain regions rather than considering them as a whole (Beucke et al., 2014). Therefore, the aim of this study was to explore rsFC abnormalities within and between DMN, as well as their relationship with symptoms severity in OCD patients. Considering the potential impact of medication on DMN rsFC (Cui et al., 2021), the present study further divided OCD patients into medicated and unmedicated groups. Based on the results of previous studies, three hypotheses were proposed in this study: (1) OCD patients would exhibit reduced rsFC strength within core and dMPFC subsystem; (2) the strength of these abnormal rsFC would be negatively correlated with symptoms severity; (3) medication would significantly impact rsFC within DMN.

2. Methods

2.1. Participants

A total of 40 OCD patients were recruited for this study, but one patient was excluded due to large head motion, leaving 39 valid patients. All OCD patients were recruited through psychiatrist referrals and social media platforms. Inclusion criteria included the following patients: (1) aged between 16 and 55 years; (2) diagnosed with OCD by an experienced psychiatrist utilizing the Structured Clinical Interview for DSM-IV (SCID); and (3) Han Chinese. Exclusion criteria included patients who: (1) were pregnant or breastfeeding; (2) suffered from organic brain diseases or severe physical illness; (3) had a history of drug abuse or alcohol addiction; (4) had a high risk of suicide; and (5) had metallic implants in their bodies.

Forty-five healthy controls (HCs) were recruited from local community in Beijing. They met the following inclusion criteria: (1) had never been diagnosed with any psychiatric illness; (2) had no family history of psychiatric illness; (3) had no history of antipsychotic medications or drug or alcohol abuse. The HC group was matched to the OCD group for gender, age and education.

This study was conducted at the Institute of Psychology, Chinese Academy of Sciences. All participants signed an informed consent form. The study received approval from the Institutional Review Board of the Institute of Psychology, Chinese Academy of Sciences (H22099).

2.2. Clinical assessment

OCD patients underwent interviews conducted by psychological assessors to evaluate their symptoms severity through Yale-Brown Obsessive-Compulsive Scale (YBOCS), which is considered the gold standard for evaluating symptoms in OCD (Goodman et al., 1989). The scale contains two subscales: obsession (YBOCS-O) and compulsion (YBOCS-C). The psychological assessors were professionally trained, achieving an internal consistency of 0.865.

Insomnia severity was assessed using the Insomnia Severity Index (ISI), with higher scores indicating more severe insomnia. Anxiety and depression severity were assessed utilizing the State Anxiety Inventory (SAI) and Beck Depression Inventory (BDI), respectively. All participants completed the three scales.

2.3. MRI protocol

Images were acquired using a GE Discovery MR750 3 T scanner with an HD 8 channels head coil. The resting-state functional MRI images were acquired with the following parameters: voxel size = 3.5 mm × 3.5 mm × 3.5 mm; repetition time (TR) = 2000 ms; echo time (TE) = 30 ms; flip angle (FA) = 90°; field of view (FOV) = 224 mm × 224 mm; matrix = 64 × 64; scans time = 8 min. Participants were required to relax and close their eyes during the scanning process, while keeping awake at the same time.

2.4. Image preprocessing

The image preprocessing was conducted on DPABI V8.0_231111 (Yan et al., 2016). The preprocessing steps comprised: (1) normalizing T1 image to Montreal Neurological Institute template (MNI152) standard space; (2) removing the first 10 timepoints of functional image to ensure the stability of signal. (3) slice timing correction; (4) head motion correction; (5) realignment of images; (6) removing covariates; (7) normalizing functional image to T1 space, and then to MNI152 standard space; (8) bandpass filtering (0.01–0.1 Hz). The mean FD-Jenkinson with a threshold of 0.2 was set as the exclusion criteria of head motion (Lu and Yan, 2023), and one OCD patient were excluded due to large head motion.

2.5. rsFC strength

To construct the rsFC matrix, 11 seed regions defined by a previous study (Andrews-Hanna et al., 2010) were selected as regions of interest (ROIs). Each ROIs were defined as a sphere with a radius of 4 mm. Detail MNI coordinates of ROIs can be found in Supplementary Table 1. These ROIs were categorized into three subsystems: core subsystem (including aMPFC and PCC), dMPFC subsystem (including dMPFC, temporal parietal junction [TPJ], lateral temporal cortex [LTC], temporal pole [TempP]), and MTL subsystem (including vMPFC, posterior inferior parietal lobule [pIPL], retrosplenial cortex [Rsp], parahippocampal cortex [PHC], hippocampal formation [HF+]). Consistent with previous studies (Fan et al., 2022), only left-lateralized ROIs were utilized for analysis to avoid the effects of brain lateralization.

The seed-to-seed method was employed to construct an rsFC matrix of the 11 ROIs for each subject. Fisher'z transform was applied to normalize the correlation coefficients and construct a standardized rsFC matrix. Consistent with the previous study (Fan et al., 2022), only positive correlations were considered in subsequent analyses in order to eliminate spurious correlations. Strength within subsystem refers to the mean value of all rsFCs between the internal ROIs. Strength between subsystems refers to the mean value of all rsFCs between the ROIs from different subsystems.

2.6. Statistical analysis

Two-sample *t*-tests and x^2 tests were used to detect group differences on demographic and clinical variables. GRETNA version 2.0.0 (Wang et al., 2015) was used to compare the rsFC matrices between the HC and OCD groups, corrected by the false discovery rate (FDR), with a significance threshold of $p < 0.05$. One-way analyses of covariance (ANCOVA) were performed to detect the group differences in rsFC strength within or between subsystems. Gender, age, years of education, and head motion were considered as covariates. Partial correlation analyses were conducted to detect associations between rsFC strength and clinical symptoms in OCD patients, using age, gender, years of education and head motion as covariates. Bonferroni correction was employed to correct the multiple comparisons. Stepwise multiple regression analyses with backward selection were conducted to determine independent correlations between symptoms severity and rsFC strengths within and between DMN subsystems. Unless otherwise stated, all statistical analyses were performed using SPSS version 25.0 and R version 4.3.1. *P*-values <0.05 (two-tailed) were considered statistically significant.

3. Results

3.1. Demographic and clinical characteristics

The demographic and clinical characteristics of the HC and OCD groups are shown in Table 1. There were no significant differences between the HC and OCD groups in gender, age, years of education and ISI scores (all $p > 0.05$). Compared to the HC group, the OCD group showed lower SAI ($t = 4.558$, $p < 0.001$) and BDI ($t = 2.571$, $p = 0.012$) scores.

3.2. rsFC strength of DMN subsystems

The rsFC matrices of the HC and OCD groups are shown in Fig. 1. There were no significant differences between the two groups on any edge rsFC in DMN after correction (all FDR $p > 0.05$).

Compared to the HC group, the OCD group exhibited lower rsFC strength within core subsystem ($F = 7.799$, $p = 0.007$, Bonferroni corrected $p = 0.042$). There were no significant differences between the two groups on rsFC strength within dMPFC subsystem, within MTL subsystem, between core-dMPFC subsystems, between core-MTL subsystems, and between dMPFC-MTL subsystems (all $p > 0.05$). For details, please refer to Table 2 and Fig. 2a.

3.3. Effect of medication

The OCD patients were divided into two subgroups based on their medication use: the medicated OCD group (OCDm, $n = 18$, stable medication for two months), and the unmedicated OCD group (OCDum, $n = 19$, stop medication for two months or drug naive). Two OCD patients were excluded due to unstable medication. There were no significant differences among the three groups (two OCD subgroups and HC group) on gender, age and years of education (Supplementary Table 2).

There were no significant differences between the HC and OCDm groups in any rsFC strengths within and between DMN subsystems (all $p > 0.05$). However, compared to the HC group, the OCDum group exhibited lower rsFC strength within core subsystem ($F = 7.554$, $p = 0.008$, Bonferroni corrected $p = 0.048$). There were no significant differences between the OCDm and OCDum groups in any rsFC strengths within and between DMN subsystems (all $p > 0.05$). See Table 3 and Fig. 2b for details.

Table 1
Demographic and clinical characteristics.

			HC vs OCD
	HC ($n = 45$)	OCD ($n = 39$)	t/x^2 (*p*-value)
Gender (M/F)	26/18	23/16	0.012(0.912)
Age	28.32 ± 9.586	30.7 ± 9.083	−1.168(0.246)
Years of education	15.33 ± 3.912	15.5 ± 2.766	−0.238(0.813)
ISI	14.48 ± 4.86	12.38 ± 5.408	1.854(0.068)
SAI	45.95 ± 11.69	34.28 ± 11.72	**4.558(<0.001)**
BDI	8.50 ± 6.864	4.90 ± 5.977	**2.571(0.012)**
YBOCS		20.21 ± 6.182	
YBOCS-O		10.56 ± 3.152	
YBOCS-C		9.64 ± 20.21	

Note: BDI = Beck Depression Inventory; ISI = Insomnia Severity Index; SAI = State Anxiety Inventory; YBOCS = Yale-Brown Obsessive-Compulsive Scale; YBOCS-O = obsession subscale of Yale–Brown obsessive-compulsive scale; YBOCS-C = compulsion subscale of Yale–Brown obsessive-compulsive scale. Bold font indicates statistical significance.

3.4. Relationship between rsFC strength of DMN subsystems and clinical symptoms

In the OCD group, a strong negative correlation was found between rsFC strength within core subsystem and YBOCS-O ($r = -0.512$, $p = 0.004$, Bonferroni corrected $p = 0.008$). This correlation was also significant in the OCDum group ($r = -0.579$, $p = 0.024$, Bonferroni corrected $p = 0.048$), but not in the OCDm group ($r = -0.240$, $p = 0.409$, Bonferroni corrected $p = 0.819$). No significant correlations were found between rsFC strength within core subsystem and YBOCS, as well as YBOCS-C, in any OCD group (all $p > 0.05$). For details, please refer to Fig. 3.

In the further multiple regression analyses, YBOCS-O was defined as the dependent variable, and other demographic and clinical characteristics, as well as rsFC strength within and between DMN subsystems were included as independent variables. Results revealed that rsFC strength within core subsystem ($\beta = -0.531$, $t = -3.439$, $p = 0.002$), rsFC strength between core-MTL subsystems ($\beta = 0.355$, $t = 2.294$, $p = 0.029$), and BDI ($\beta = 0.308$, $t = 2.108$, $p = 0.044$) were independently associated with YBOCS-O. The adjusted R^2 was 0.30 for the regression model.

4. Discussion

This study examined rsFC strength within and between DMN subsystems in OCD patients compared to HCs. The results of the study showed that rsFC strength within core subsystem was significantly lower in OCD patients. This rsFC strength was strongly negatively correlated with the YBOCS-O subscale, indicating a strong association with obsessive thoughts. In addition, medication may affect rsFC strength in the DMN. Specifically, rsFC strength within core subsystem was reduced in the OCDum group compared to HC group, but not in the OCDm group.

The core subsystem contains midline cortical regions, including the aMPFC and PCC. This study revealed only rsFC strength within core subsystem showed abnormality in OCD patients. This finding is also supported by the evidences from structural brain abnormalities in OCD. Previous meta-analyses have consistently found that OCD exhibit decreased gray matter volume (GMV) in MPFC (Norman et al., 2016; Picó-Pérez et al., 2020; Yang et al., 2024). Additionally, many studies reported decreased GMV in PCC in OCD patients (Fouche et al., 2017; Hou et al., 2013; Okada et al., 2015; Tang et al., 2013).

The core subsystem is associated with self-referential processing (Andrews-Hanna et al., 2014), in which the MPFC playing an important role (Gusnard et al., 2001). Self-referential processing involves individuals responding to stimulus based on their own experiences and self-awareness. Moran et al. (2006) found that activity in the MPFC and PCC was positively correlated with personal relevance ratings of personality traits, suggesting that activity in these regions is enhanced when processing self-relevant information. A previous study has indicated that psychopathological symptoms may be associated with abnormalities in self-referential processing (Northoff, 2014). The present study found that OCD patients showed deficits in rsFC strength within core

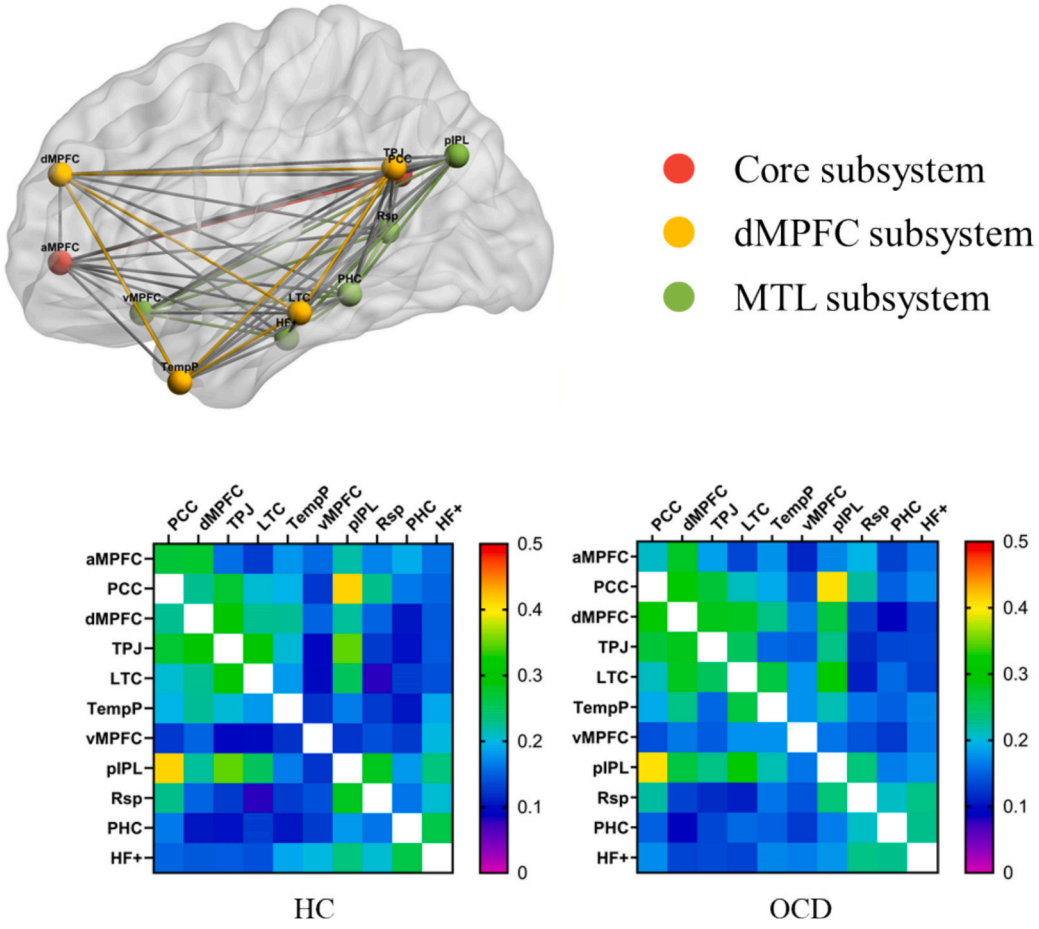

Fig. 1. ROIs of default mode network and resting-state functional connectivity matrix.
Note: Red edges refer to resting-state functional connectivity (rsFC) within core subsystem; Yellow edges refer to rsFC within dMPFC subsystem; Green edges refer to rsFC within MTL subsystem; Gray edges refer to rsFC between the three subsystems. aMPFC = anterior medical prefrontal cortex; dMPFC = dorsomedial prefrontal cortex; HF+, hippocampal formation; LTC = lateral temporal cortex; MTL = medial prefrontal cortex; PHC = parahippocampal cortex; pIPL = posterior inferior parietal lobule; Rsp = retrosplenial cortex; TempP = temporal pole; TPJ = temporal parietal junction; vMPFC = ventral medial prefrontal cortex. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 2
Resting-state functional connectivity strength within and between DMN subsystems.

			HC vs OCD
	HC (n = 45)	OCD(n = 39)	*F* (p-value)
Within subsystem			
Core	0.28 ± 0.146	0.21 ± 0.142	**7.799(0.007)**
dMPFC	0.26 ± 0.097	0.25 ± 0.129	0.240(0.625)
MTL	0.18 ± 0.063	0.19 ± 0.077	0.003(0.958)
Between subsystems			
Core-dMPFC	0.22 ± 0.077	0.23 ± 0.098	0.321(0.573)
Core-MTL	0.20 ± 0.054	0.20 ± 0.064	0.803(0.373)
dMPFC-MTL	0.15 ± 0.051	0.17 ± 0.065	0.878(0.352)

Note: dMPFC = dorsomedial prefrontal cortex; MTL = medial temporal lobe. Bold font indicates statistical significance.

subsystem. This finding is consistent with a previous study that also reported reduced rsFC between the MPFC and PCC in OCD patients (Beucke et al., 2014). The self is a necessary condition for consciousness, and individuals are particularly alert when processing self-relevant stimuli (Northoff, 2014). Northoff (2014) proposed the hypothesis that increased resting state activity in the midline regions may lead to increased focus on the self. Thus, increased self-focus may be also a characteristic feature of OCD patients. Moreover, OCD patients commonly exhibit abnormalities in self-referential processing, including fear of self-beliefs and self-ambivalence (Godwin et al., 2020).

Our study revealed a strong negative correlation between rsFC strength within core subsystem and obsession severity. A previous study also indicated that higher obsession severity was associated with decreased rsFC in the DMN (Lee et al., 2021). Obsession was found to be associated with self-awareness (Seo and Kwon, 2013). Several previous studies have suggested that intrusive thoughts may develop into obsessions as a result of abnormal self-evaluation, and obsessions are more likely to emerge in self-domains where individuals feel incompetent (García-Soriano et al., 2012; Llorens-Aguilar et al., 2022). As self-awareness is a component of metacognition, and obsessive thoughts are believed to be associated with metacognitive processes (Purdon and Clark, 1999). According to the metacognitive therapy model of OCD, irrational metacognitive beliefs can lead individuals to interpret intrusive thoughts as dangerous and use compulsive behaviors to alleviate anxiety (Atmaca, 2022). For example, an individual with OCD may have catastrophic thoughts about overestimating the body's susceptibility to viruses and bacteria and experience more intense anxiety when exposed to money. This may explain why rsFC strength within core subsystem is strongly correlated with obsession. Moreover, according to the results of the regression analysis, rsFC strength within core subsystem may serve as a potential biomarker of obsession severity in OCD patients.

Selective serotonin reuptake inhibitors (SSRIs) are commonly used in

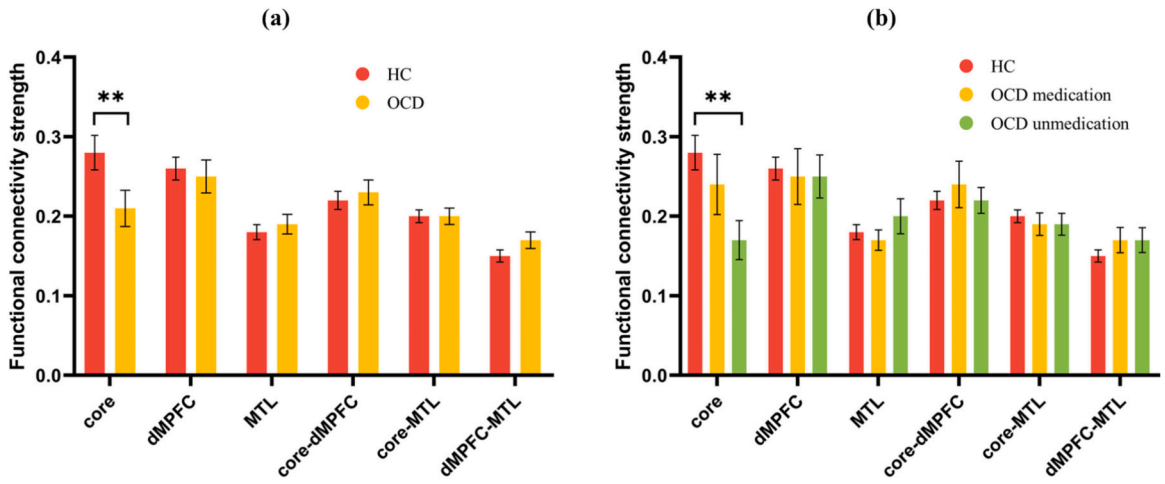

Fig. 2. Resting-state functional connectivity strength of DMN subsystems.
Note: (a) Difference on resting-state functional connectivity within core subsystem was significant between HC and OCD group ($p = 0.007$); (b) Difference on resting-state functional connectivity within core subsystem was significant between HC and medicated OCD group ($p = 0.008$). dMPFC = dorsomedial prefrontal cortex; MTL = medial temporal lobe.

Table 3
Medication effect on resting-state functional connectivity strength within and between DMN subsystems.

				HC vs OCDm	HC vs OCDum	OCDm vs OCDum
	HC (n = 45)	OCDm (n = 18)	OCDum (n = 19)	*F* (p-value)	*F* (p-value)	*F* (p-value)
Within subsystem						
Core	0.28 ± 0.146	0.24 ± 0.161	0.17 ± 0.107	1.138(0.291)	**7.554(0.008)**	2.831(0.103)
dMPFC	0.26 ± 0.097	0.25 ± 0.149	0.25 ± 0.118	0.422(0.519)	0.102(0.751)	0.048(0.828)
MTL	0.18 ± 0.063	0.17 ± 0.054	0.2 ± 0.096	1.136(0.291)	0.835(0.365)	2.495(0.124)
Between subsystems						
core-dMPFC	0.22 ± 0.077	0.24 ± 0.124	0.22 ± 0.071	0.377(0.542)	0.788(0.379)	0.988(0.328)
core-MTL	0.2 ± 0.054	0.19 ± 0.06	0.19 ± 0.06	1.039(0.313)	0.407(0.526)	0.213(0.647)
dMPFC-MTL	0.15 ± 0.051	0.17 ± 0.067	0.17 ± 0.068	2.050(0.158)	0.777(0.382)	0.584(0.450)

Note: OCDm = medicated OCD; OCDum = unmedicated OCD; dMPFC = dorsomedial prefrontal cortex; MTL = medial temporal lobe. Bold font indicates statistical significance.

the treatment of OCD patients and work by modulating neurotransmitters (Del Casale et al., 2019). DMN function is modulated by neurotransmitters (Conio et al., 2020). Hahn et al. (2012) found that rsFC of the DMN can be forecasted by individual variations in the 5-HT 1A receptor. Helmbold et al. (2016) found that serotonin modulates rsFC in the DMN. Furthermore, a recent study found significant increases in rsFC strength within core subsystem in patients with major depressive disorder after treatment with escitalopram, a type of SSRIs (Cui et al., 2021). Our study revealed that rsFC strength within core subsystem was reduced in the OCDum patients, but not in the OCDm group. Based on these findings, we can speculate that medication may have a potential effect on rsFC in the DMN of OCD patients. In addition, our study further revealed that rsFC within core subsystem was correlated with obsession in the OCDum group, whereas the correlation was not significant in the OCDm group. Cui et al. (2021) also found that changes in rsFC in the DMN did not significantly correlate with the improvement of clinical symptoms in patients with major depressive disorder. Therefore, we can further speculate that medication, especially SSRIs, may also affect the relationship between rsFC in the DMN and clinical symptoms in OCD patients. Future studies should further explore the effects of medication.

There are some limitations of this study. First, the sample size was relatively small, especially when further subgroups were delineated, thus a large sample study is necessary to ensure robustness of future results. Second, the heterogeneity of OCD patients may potentially affect the results. The present study found that rsFC strength within core subsystem was only correlated with obsessive thoughts, suggesting that results may be different for those OCD patients who have predominantly compulsive behaviors. Moreover, obsession can be further divided into autogenous and reactive types (Lee and Kwon, 2003). Third, the OCD group showed lower anxiety and depression than the HC group, which contradicts common assumptions. After reviewing the data and demographic information of the participants, we speculate that the higher academic and work pressures experienced by the HC group may account for this unexpected finding. In future studies, we should place greater emphasis on sampling to ensure that the basic characteristics of the two groups are more consistent. Forth, the cross-sectional design limits the generalizability of the results of this study. For example, it was unable to clearly elucidate the effects of medication on rsFC strength within and between DMN subsystems. Future studies must address this limitation using a longitudinal design with a large sample size.

In summary, we conducted a cross-sectional study to explore the abnormalities in rsFC strength within and between DMN subsystems. Our findings suggest that reduced rsFC strength within core subsystem is a feature of OCD patients and may serve as a potential biomarker of obsession severity in OCD patients. Moreover, medication may affect rsFC strength in the DMN. Future studies are needed to further clarify the effects of medication, as well as the findings of this study using a longitudinal design with a large sample size.

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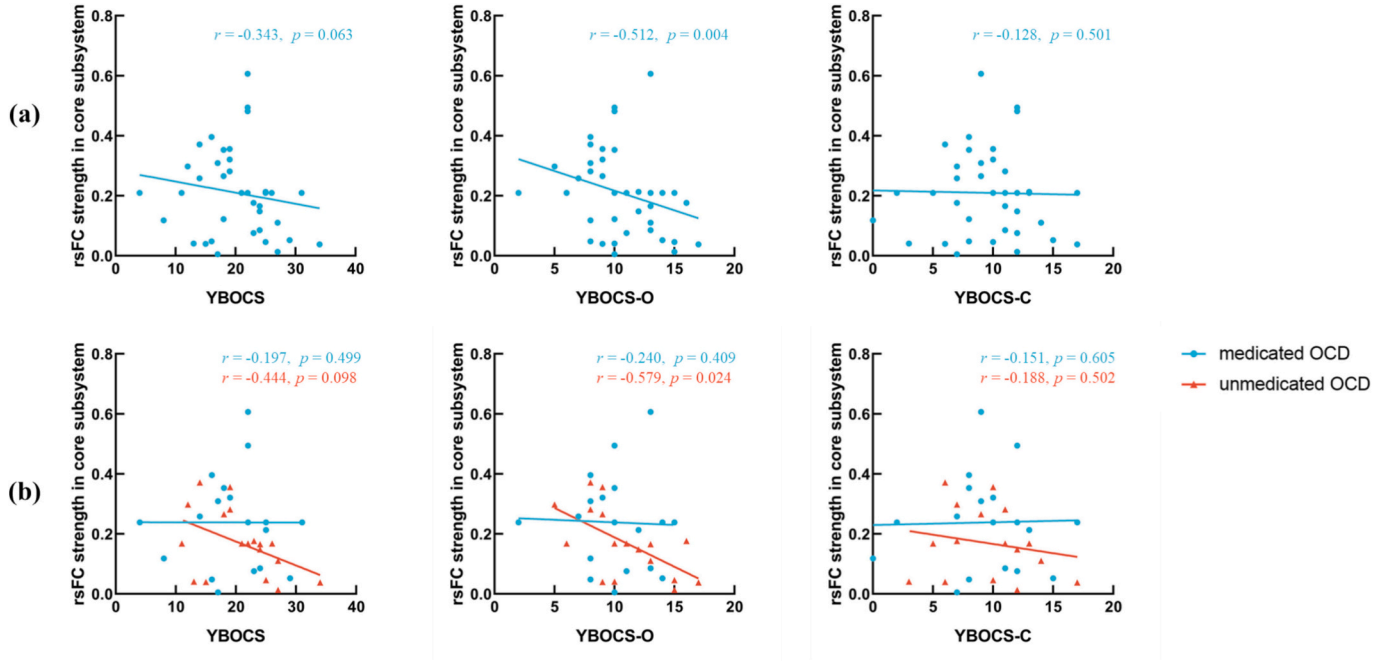

Fig. 3. Partial correlations between rsFC strength within core subsystem and clinical symptoms.
Note: (a) Partial correlations in OCD group; (b) Partial correlations in medicated OCD and unmedicated OCD groups. YBOCS = Yale-Brown Obsessive-Compulsive Scale; YBOCS-O = obsession subscale of Yale–Brown obsessive-compulsive scale; YBOCS-C = compulsion subscale of Yale–Brown obsessive-compulsive scale.

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CRediT authorship contribution statement

Qihui Guo: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Rongrong Zhu:** Data curation, Conceptualization. **Huixia Zhou:** Methodology. **Zheng Ma:** Data curation. **Ying He:** Data curation. **Dongmei Wang:** Writing – review & editing, Project administration. **Xiangyang Zhang:** Writing – review & editing, Project administration, Funding acquisition.

Ethical statement

The authors declare that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Declaration of competing interest

The authors report no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2024.10.109.

Data availability

The data that support the findings of this study are publicly available. The corresponding author can be contacted upon reasonable request.

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