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Putamen volume correlates with obsessive compulsive characteristics in healthy population

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ABSTRACT

Obsessions and compulsions (OCs) are frequent in healthy subjects; however neural backgrounds of the subclinical OCs were largely unknown. Results from recent studies suggested involvement of the putamen in the OC traits. To investigate this issue, 49 healthy subjects were assessed using structural magnetic resonance imaging (MRI) and the Maudsley Obsessive Compulsive Inventory (MOCI). Anatomical delineation on MRI yielded the global volume and local shape of the putamen. Other striatal structures (the caudate nucleus and globus pallidus) were also examined for exploratory purpose. The relationship between volume/shape of each structures and MOCI measure was analyzed, with sex, age, state anxiety, trait anxiety, and full-scale Intelligence Quotient regressed out. The volume analysis revealed a positive relationship between the MOCI total score and the bilateral putamen volumes. The shape analysis demonstrated associations between the higher MOCI total score and hypertrophy of the anterior putamen in both hemispheres. The present study firstly revealed that the volume changes of the putamen correlated with the manifestation of subclinical OC traits. The dysfunctional cortico-anterior striatum networks seemed to be one of the neuronal subsystems underlying the subclinical OC traits.

1. Introduction

Obsessive-compulsive disorder (OCD) is a complex and disabling mental condition characterized by obsession (i.e., recurrent thoughts) and compulsion (i.e., repetitive behaviors) (OC). Little is known about neurobiology and etiology of OCD; however, evidences for strong genetic basis were reported (Pauls et al., 1995; Nestadt et al., 2000; Hanna et al., 2005). Most patients with OCD endure chronic courses, accompanied with severe subjective distress and interference. A prevalence of OCD has been estimated from 1.2% to 3%, although clinical recognition of the disorder in community level is quite low (Karno et al., 1988; Fullana et al., 2009; Ruscio et al., 2010).

Healthy individuals experience intrusive thoughts that are comparable to the obsessions found in OCD in form (e.g., repetitive cognitive intrusion) and content (e.g., negative emotions) (Rachman, 1978; Purdon and Clark, 1993; Langlois et al., 2000). Consistent with these findings, the spectrum view of OCD was recently proposed, which assumed that OC characteristics were normally distributed in general population covering clinical and non-clinical individuals (Mataix-Cols et al., 2005). In support of this, a recent study that examined a community sample identified relatively frequent prevalence of OCs (13%–17%) among individuals without mental disorders (Fullana et al., 2009). They also underlined significant degree of distress/interference, reporting that 25% of subjects were bothered by the obsessions for more than 1 hour a day and periods of over 2 weeks, and 15% reported being emotionally upset by them. Given relatively high rate of the prevalence and the significant amount of distress, it is clinically important to correctly identify OC characteristics in healthy subjects. Moreover, neurocognitive profile of these OC traits need to be examined, so as to explore their neuropathological grounds possibly common with the clinical OCD.

OC characteristics in healthy individuals have been shown to be measured reliably and validly using psychological questionnaires (Valleni-Basile et al., 1994; Stein et al., 1997; Fullana et al., 2009).

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Table 1
Demographic and psychological rating data and their correlations.

	Variable	*M/n*	*SD*	Range	Correlation							
					3[a]	4	5	6	7	8	9	10
1	Subject	49										
2	Handedness (left:right)	0:49										
3	Sex (female:male)	23:26										
4	Age	22.4	4.4	19–43	−0.04							
5	Full-scale IQ	121.2	8.6	101–140	−0.11	−0.02						
6	MOCI-total	12.9	4.3	3.0–21.5	−0.17	−0.28	−0.09					
7	MOCI-clearing	3.1	1.9	0.0–7.0	−0.08	−0.13	0.02	0.61				
8	MOCI-checking	2.1	1.3	0.0–5.0	−0.16	−0.12	−0.16	0.78	0.25			
9	MOCI-doubting	3.5	1.6	0.0–6.0	−0.28	−0.30	−0.08	0.82	0.31	0.73		
10	STAI-state	39.2	5.9	27–57	0.17	−0.16	−0.08	0.40	0.12	0.46	0.40	
11	STAI-trait	46.5	8.7	24–65	−0.22	−0.14	−0.15	0.51	0.27	0.45	0.51	0.28

IQ=Intelligence Quotient; MOCI=Maudsley Obsessive Compulsive Inventory; STAI=State-Trait Anxiety Inventory.

[a] Sex is dummy-coded as female (1) or male (0).

The Maudsley Obsessive Compulsive Inventory (MOCI) (Hodgson and Rachman, 1977) is one of such questionnaires most commonly used (Chan, 1990; Tadai et al., 1995). MOCI consisted of four subscales yielded by factor analysis, such as checking, cleaning, doubting, and slowness. Several studies investigated OC characteristics of healthy population by using the MOCI (Hosoba et al., 1992; Chan, 1990; Ishikawa et al., 2014). For example, Hosoba et al. (1992) included 600 healthy university students in their study using a Japanese version of MOCI, and identified factors comparable to clinical OCD: cleaning, checking, and doubting, but not to slowness. The authors reported that these factors were differently correlated with scores that assessed anxiety related to time perception, which indirectly supported the independency of these factors as in OCD patients.

The neural mechanisms for OCD have been investigated in clinical populations using magnetic resonance imaging (MRI). For example, Pujol et al. (2004) found increased gray matter (GM) volume in the ventral putamen and cerebellum, as well as decreased GM volume in some cortical regions, including the medial orbitofrontal and dorsomedial prefrontal cortices. Zarei et al. (2011) reported that adolescents with OCD had increased GM volume in the caudate bilaterally and right putamen. A recent meta-analysis of voxel-based morphometry (VBM) studies on OCD highlighted increased regional grey matter volumes in bilateral caudate nuclei and putamen (Radua and Mataix-Cols, 2009), and this findings were found even when compared with other anxiety disorders (Radua et al., 2010). Another meta-analysis of GM changes based on VBM demonstrated that OCD patients exhibit larger volumes in the putamen compared with normal controls (Rotge et al., 2010). Furthermore, several studies reported striatal shape abnormalities in OCD. Choi et al. (2007) observed outward deformities in the superior, anterior portion of the bilateral caudate, and an outward deformity in the inferior, lateral portion of the left putamen in patients with OCD (Choi et al., 2007). Zarei et al. (2011) observed hypertrophy in the putamen, caudate nuclei, and globus pallidus in pediatric OCD (Zarei et al., 2011). Based on these data, several researchers proposed that the cortico-striatal loops play an important role in in the manifestation of OC symptoms (Saxena et al., 1998; Remijnse et al., 2006; Mataix-Cols and van den Heuvel, 2006).

However, whether the above-mentioned subcortical structures involved in the cortico-striatal loops may also play a role in the mediation of OC characteristics in healthy individuals remains unclear. As far as we know, no structural MRI study investigated neural correlates of subclinical OC symptoms in healthy subjects. As a line of studies suggestive for this issue, some recent VBM studies highlighted abnormalities especially in the putamen in mild form of OC in the first-degree relatives of OCD patients. Gilbert et al. (2008) found greater gray matter density in the right putamen of OCD patients as compared to their unaffected siblings. Menzis et al. (2007) investigated structural brain changes in unaffected first-degree relatives of people with OCD and reported increased gray matter in the striatum. Based on these findings, we hypothesized that OC characteristics in healthy population might show correlation between the volume of striatal structures, specifically the putamen.

To investigate this hypothesis, here we examined the relationship between OC characteristics and the putamen structure in healthy participants. We assessed subclinical OC characteristics using MOCI, as well as anxiety states and traits. We acquired structural MRI, performed anatomical delineation using a semi-automated subcortical segmentation tool (Patenaude et al., 2011) and measured the global volume and local shape of the putamen. We also conducted exploratory analyses on the volume of the other striatal structures including the caudate nucleus and the globus pallidus.

2. Materials and methods

2.1. Subjects

Forty-nine healthy Japanese volunteers (23 females; mean ± SD age, 22.4 ± 4.4 years) recruited by local advertisement (Table 1). The psychiatric status of all participants were assessed by an experienced psychiatrist through short, structured diagnostic interviews using the Japanese version of Mini-International Neuropsychiatric Interview (M.I.N.I.) (Otsubo et al., 2005). None of participants showed any psychiatric symptoms at clinical level, including those of OCD. After the procedures were explained fully, all participants provided informed consent for participation. This study was approved by the local ethics committee of Primate Research Institute, Kyoto University, and conducted in accord with the Declaration of Helsinki.

2.2. Psychological assessment

The MOCI is a self-report questionnaire of 30 items (Hodgson and Rachman, 1977). In a Japanese version of MOCI (Hosoba et al., 1992), all items are rated on a three-point scale: 0 (disagree), 0.5 (undecided), or 1 (agree). The total score for a subject will range between 0 (absence of symptoms) and 30 (maximum presence of symptoms). The Japanese version has three subscales: Checking (8 items: no. 6, 12, 20, 21, 22, 23, 28, and 30), Cleaning (8 items: item no. 1, 5, 9, 13, 16, 17, 24, and 26), and Doubting (6 items: no. 2, 8, 10, 12, 18, and 30) (Hosoba et al. 1992).

The State-Trait Anxiety Inventory (STAI) is a 40-item self-report scale, with 20 items assessing state anxiety (e.g., I am presently worrying over possible misfortunes) and 20 assessing trait anxiety (e.g., I am a steady person) (Spielberger et al., 1970). All items are rated on a four-point scale: 0 (almost never) to 3 (almost always). The Japanese version of the STAI was developed and validated (Hidano. et al., 2000). A previous study reported that the MOCI correlated with trait anxiety