



## Research report

# Gray matter deficits and altered resting-state connectivity in the superior temporal gyrus among individuals with problematic hypersexual behavior

Ji-woo Seok <sup>a,b</sup>, Jin-Hun Sohn <sup>c,\*</sup>

<sup>a</sup> Department of Counselling Psychology, Honam University, Gwangju, South Korea

<sup>b</sup> Bioimaging Research Team, Korean Basic Science Institute, Cheongju, South Korea

<sup>c</sup> Department of Psychology, Brain Research Institute, Chungnam National University, Daejeon, South Korea



## ARTICLE INFO

## Article history:

Received 17 February 2017

Received in revised form 10 January 2018

Accepted 30 January 2018

Available online 5 February 2018

## Keywords:

Problematic hypersexual behavior

Voxel-based morphometry

Functional connectivity

Superior temporal gyrus

Caudate nucleus

## ABSTRACT

Neuroimaging studies on the characteristics of hypersexual disorder have been accumulating, yet alternations in brain structures and functional connectivity in individuals with problematic hypersexual behavior (PHB) has only recently been studied. This study aimed to investigate gray matter deficits and resting-state abnormalities in individuals with PHB using voxel-based morphometry and resting-state connectivity analysis. Seventeen individuals with PHB and 19 age-matched healthy controls participated in this study. Gray matter volume of the brain and resting-state connectivity were measured using 3T magnetic resonance imaging. Compared to healthy subjects, individuals with PHB had significant reductions in gray matter volume in the left superior temporal gyrus (STG) and right middle temporal gyrus. Individuals with PHB also exhibited a decrease in resting-state functional connectivity between the left STG and left precuneus and between the left STG and right caudate. The gray matter volume of the left STG and its resting-state functional connectivity with the right caudate both showed significant negative correlations with the severity of PHB. The findings suggest that structural deficits and resting-state functional impairments in the left STG might be linked to PHB and provide new insights into the underlying neural mechanisms of PHB.

© 2018 Elsevier B.V. All rights reserved.

## 1. Introduction

Problematic hypersexual behavior (PHB) is characterized by excessive and maladaptive engagement in sexual activity despite serious negative consequences (Carnes, 2001, 2013; Goodman, 1993).

There is debate within the psychiatry and broader mental health fields whether PHB constitutes a psychiatric disorder or not. Clinicians and researchers maintain different opinions on the classification of the behavior. There also has been some ambiguity regarding terminology, definitional properties, symptomatology, and appropriate classification of individuals exhibiting PHB (Kingston and Firestone, 2008). Until now, the proposed terminology of the behavior includes compulsive sexual behaviors (Coleman, 1991; Goodman, 1993; Quadland, 1985), sexual addiction (Carnes, 1983), and hypersexual disorder (Kafka, 2010; Stein,

2008). However, all these terms are limited in their inclusion of various spectra of the behavior, such as hypersexuality, loss of control of sexual fantasies and urges, and compulsive sex seeking behaviors, as a specific psychiatric disorder (Kafka, 2010; Stein, 2008). Some researchers recommend using the term PHB that is descriptive of the behavior itself or the way the individual experiences it rather than implying etiology or pathology (Bancroft and Vukadinovic, 2004; Joannides, 2012). This term is also a comprehensive concept, which includes sexual addiction and hypersexuality (Bancroft and Vukadinovic, 2004; Joannides, 2012). Emerging studies suggest that PHB causes serious problems, such as loss of primary relationships, financial losses, emotional distress, and sexually transmitted diseases (Kuzma and Black, 2008; Schneider and Schneider, 1991). Given the potential personal and public health problems, investigations into the behavioral and neural characteristics of PHB are needed to identify the theoretical and clinical implications of this disorder and to improve its treatment.

Recent evidence from neuroimaging studies suggests that PHB might be linked to possible brain impairments (Kühn and Gallinat, 2014; Miner et al., 2009; Seok and Sohn, 2015; Voon

\* Corresponding author at: Department of Psychology, Chungnam National University, Daejeon 305-764, South Korea.

E-mail address: [jhsohn@cnu.ac.kr](mailto:jhsohn@cnu.ac.kr) (J.-H. Sohn).

et al., 2014). Functional disturbances in individuals with PHB have been demonstrated using task based studies (Seok and Sohn, 2015; Voon et al., 2014). These studies demonstrated that individuals with PHB show heightened sexual desire compared to controls, and these behavioral characteristics might be linked to altered activation in the prefrontal cortex and subcortical regions. Although task-based studies using functional magnetic resonance imaging (MRI) can be used to investigate functional alterations in individuals with PHB, functional connectivity during the resting state may have different and potentially broader significance (Yuan et al., 2010a). Resting state functional MRI data are acquired without any explicit task, and therefore group differences in resting state connectivity are not related to differences in task processing strategies. Recently, a combined structural and functional MRI study (task-based and resting-state) reported a negative association between self-reported 'sexually explicit material' consumption and right striatal volume and functional connectivity between the right caudate and the left dorsolateral prefrontal cortex (Kühn and Gallinat, 2014). The study also suggested that these functional and structural alterations may reflect changes in neural plasticity as the result of an acute stimulation of the reward system (Kühn and Gallinat, 2014). Other imaging studies have explored the connections between PHB and cortical atrophy and the degeneration of white matter tracts (Biundo et al., 2015; Chan et al., 2009; Miner et al., 2009; Schmidt et al., 2017). Miner et al. (2009) showed that individuals with PHB have poor inhibition control during a go/no-go task, and they display significantly higher superior frontal region mean diffusivity than controls (Miner et al., 2009). Schmidt et al. (2017) demonstrated that compulsive sexual behavior was associated with increased volumes in the limbic system, and impaired functional connectivity between prefrontal and limbic areas. In addition, previous studies have suggested that reduced brain volumes in the temporal lobe, frontal lobe, amygdala, and hippocampus are related to hypersexuality in patients with dementia or Parkinson's disease (Biundo et al., 2015; Chan et al., 2009). Specifically, among the regions where gray matter atrophy was observed, the temporal lobe is a key brain area related to the symptoms of hypersexuality (Chan et al., 2009). Nevertheless, relatively little is known about functional and structural disturbances in individuals with PHB.

Previous studies have found that the temporal lobe is a crucial structure in the regulation of human sexual arousal (Baird et al., 2007). Although the mechanisms by which the temporal lobe mediates sexual arousal are poorly understood, symptoms of hypersexuality after temporal lobectomy confirm the role of the temporal lobe in the regulation of sexual behavior (Baird et al., 2003, 2007; Bladin, 1992; Blumer, 1970; Christianson et al., 1995). Most studies on brain atrophy associated with hypersexuality have recruited patients with dementia, Parkinson's disease, or epilepsy, and have not used healthy controls. In addition, previous studies have failed to examine the link between altered temporal volume and functional connectivity in hypersexual individuals. Integrating measures of structural and functional brain connectivity provides profound insights into brain function and malfunction and may lead to the development of clinically useful biomarkers for psychiatric disorders. However, only few studies on PHB have focused on the relationship between structural characteristics and functional brain connectivity (Kühn and Gallinat, 2014; Schmidt et al., 2017). In addition, these studies on PHB did not eliminate the influence of behavioral characteristics on the relationship between PHB and brain alterations, even though persistent behavior may change brain structure (Hyde et al., 2009). Therefore, in this study, to strengthen the attribution of 'hypersexuality' and 'sexual addiction' to brain alteration, we controlled the influence of sexual activity (i.e., the frequency of sexual intercourse and masturbation per week) on the changes in brain structure and

functional brain connectivity among individuals with PHB. We used 3 T MRI to identify alterations in brain structure and functional connectivity among individuals with PHB. We specifically focused on the temporal area. The aims of this study were to examine 1) whether gray matter volumes of various areas, including the temporal lobe, are altered in individuals with PHB, 2) whether reduced gray matter is linked to altered functional connectivity, and 3) whether these alterations in structure and functional connectivity would be maintained after controlling for sexual activity.

For this study, we recruited 17 individuals with PHB and 17 age-matched healthy controls. We performed structural and resting-state functional magnetic resonance imaging (rs-fMRI) to find brain alterations in individuals with PHB over approximately 15 min. To test our hypothesis, we performed voxel-based morphometry (VBM) on the structural images and functional connectivity analysis on the rs-fMRI images.

## 2. Results

### 2.1. Sample characteristics

Individuals with PHB and healthy controls did not differ significantly in age ( $t = 1.28$ ,  $p > 0.05$ , Cohen's  $d = 0.44$ ) or education duration ( $t = 0.08$ ,  $p > 0.05$ , Cohen's  $d = 0.03$ ). However, relative to healthy controls, individuals with PHB scored higher on measures of their weekly frequency of viewing 'sexually explicit material' ( $t = 3.76$ ,  $p < 0.01$ , Cohen's  $d = 1.29$ ), weekly frequency of sexual behavior ( $t = 4.92$ ,  $p < 0.001$ , Cohen's  $d = 1.69$ ), the revised version of Sexual Addiction Screening Test (SAST-R) ( $t = 15.87$ ,  $p < 0.001$ , Cohen's  $d = 5.23$ ), and Hypersexual Behavior Inventory (HBI) score ( $t = 15.20$ ,  $p < 0.001$ , Cohen's  $d = 5.21$ ). Individuals with PHB also had their first sexual intercourse at an earlier age than controls ( $t = 5.98$ ,  $p < 0.001$ , Cohen's  $d = 2.05$ ).

### 2.2. VBM analysis

VBM analysis was performed to find structural alterations in individuals with PHB. As shown in Table 2 and Fig. 1a, individuals with PHB had reduced gray matter volume in the right middle temporal gyrus ( $t = 4.75$ ,  $p < 0.05$ , Cohen's  $d = 1.63$ ) and the left STG ( $t = 4.52$ ,  $p < 0.05$ , Cohen's  $d = 1.55$ ). After controlling for the effect of sexual activity, significant differences in volume between groups were shown in the left STG ( $F(1, 32) = 7.65$ ,  $p < 0.01$ ,  $\eta^2 p = 0.20$ ) and the right middle temporal gyrus ( $F(1, 32) = 7.58$ ,  $p < 0.01$ ,

**Table 1**  
Demographic and clinical characteristics of the PHB and control groups.

Variables (mean $\pm$ SD)	PHB	HC	<i>t</i>
Age (years)	26.92 $\pm$ 4.73	25.08 $\pm$ 3.53	1.28
Education (years)	13.35 $\pm$ 2.60	13.42 $\pm$ 2.24	0.08
Age of first sexual intercourse (years)	16.26 $\pm$ 2.31	22.82 $\pm$ 3.89	5.98***
Weekly frequency of viewing 'sexually explicit material'	5.00 $\pm$ 3.08	2.08 $\pm$ 0.86	3.76**
Weekly frequency of sexual behavior	10.62 $\pm$ 6.53	2.62 $\pm$ 1.50	4.92***
BIS-II score	52.54 $\pm$ 6.14	50.23 $\pm$ 6.02	1.11
BDI score	7.34 $\pm$ 4.50	4.97 $\pm$ 3.10	1.79
BAI score	8.25 $\pm$ 5.84	6.27 $\pm$ 4.12	1.14
SAST-R score	12.12 $\pm$ 2.45	1.50 $\pm$ 1.50	15.24***
HBI score	63.76 $\pm$ 7.73	25.84 $\pm$ 6.79	15.20***

Abbreviations: BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; BIS, Barrett's Impulsiveness Scale II; HBI, Hypersexual Behavior Inventory; HC, healthy controls; PHB, problematic hypersexual behavior; SAST-R, Sexual Addiction Screening Test.

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$  for group comparisons.

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات