

Differing Default Mode Network Activities in Men with Homosexual or Heterosexual Preferences

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ABSTRACT

Introduction. Neuroimaging studies have reported differences in brain structure and function between homosexual and heterosexual men. The neural basis for homosexual orientation, however, is still unknown.

Aim. This study characterized the association of homosexual preference with measures of fractional amplitude of low-frequency fluctuation (fALFF) and functional connectivity (FC) in the resting state.

Methods. We collected echo planar magnetic resonance imaging data in 26 healthy homosexual men and 26 age-matched heterosexual men in the resting state.

Main Outcome Measures. Sexual orientation was evaluated using the Kinsey scale. We assessed group differences in fALFF and then, taking the identified group differences as seed regions, we compared groups on measures of FC from those seeds. The behavioral significance of the group differences in fALFF and FC was assessed by examining their associations with the Kinsey scores.

Results. Compared with heterosexual participants, homosexual men showed significantly increased fALFF in the right middle frontal gyrus and right anterior cerebellum, and decreased fALFF in the left postcentral gyrus, left lingual gyrus, right pallidum, right postcentral gyrus, left inferior parietal gyrus, right superior temporal gyrus, left cuneus, and left inferior frontal gyrus. Additionally, fALFF in the left postcentral gyrus and left cuneus correlated positively with Kinsey scores in the homosexual participants. When the seeds in the left cuneus, left cuneus, and left superior parietal gyrus also had reduced FC in homosexual participants, FC correlated positively with the Kinsey scores.

Conclusions. Differences in fALFF and FC suggest male sexual preference may influence the pattern activity in the default mode network. **Hu S, Xu D, Peterson BS, Wang Q, Lai J, Hu J, Wei N, Zhang M, and Xu Y. Differing default mode network activities in men with homosexual or heterosexual preferences. J Sex Med 2014;11:2474–2484.**

Key Words. Homosexuality; Default Mode Network; Fractional Amplitude of Low-Frequency Fluctuation; Functional Connectivity; Functional Magnetic Resonance Imaging

Introduction

The neural basis of sexual orientation is still unknown. Neuroimaging studies have considerably advanced our knowledge about the functional characteristics of the processing of sexually arousing stimuli in persons with differing sexual

preferences [1–4]. Hypothalamic activity during sexual arousal in men with a primarily homosexual orientation is lower than that in men with a primarily heterosexual orientation, and similar in pattern to that observed in heterosexual women [1,2]. However, the amygdala is more active during sexual arousal in men with a homosexual

orientation compared with men with heterosexual orientation [3]. A prominent limitation common to all of these studies is that the perceptual and cognitive processes identified in task-related studies can be the product of social learning and may not represent innate differences [5] that underlie sexual orientation. In addition, group differences in brain activity could be a cognitive or emotional response to the stimulus or to performance of the task, rather than a neural determinant of sexual orientation. Thus, assessing group differences in brain functioning at rest can be helpful in identifying the neural basis of sexual orientation in a manner relatively free of these potential confounds.

The default mode network (DMN) activity in the resting state has become a significant focus of research in cognitive neuroscience [6]. The DMN represents an intrinsic baseline state that is qualitatively different from states evoked by goal-oriented activity [7]. The level of neural activity in the resting state is substantial and functionally important, with changes produced by task demands representing just the “tip of an iceberg” [6]. The DMN is characterized by very low-frequency neuronal oscillations (<0.1 Hz) that likely reflect temporal synchrony between functionally specific and diverse brain regions [8]. The assessment of DMN using the blood oxygenation level-dependent (BOLD) response may be achieved by a number of methods. Regional homogeneity (ReHo) targets the identification of voxels where spontaneous activity is synchronous locally [9]. On the contrary, functional connectivity (FC) is investigated commonly by correlating the time course of a chosen “seed voxel” with the remaining voxel time courses in a voxel-by-voxel manner [10,11]. In addition, it has been reported that low-frequency oscillations in the range of 0.1 Hz or lower contribute most to the temporal structure of the auditory, visual, and sensorimotor FC map [12].

Our previous study showed that ReHo in the left inferior occipital gyrus of men correlated with a homosexual preference. Using the left inferior occipital gyrus as the seeding area, homosexual men showed decreased FC in the left middle temporal gyrus, left supra-marginal gyrus, left inferior occipital gyrus, and right cuneus. Additionally, FCs in the right thalamus and right cuneus correlated positively with a homosexual preference [13].

With regard to the analytical approach, Zang et al. introduced an amplitude measure of low-frequency fluctuations in resting state functional

magnetic resonance imaging (fMRI) data that was termed the ALFF (“amplitude of low-frequency fluctuation”) [14]. Zou et al. further developed this measure as the fALFF (“fractional amplitude of low-frequency fluctuation”), improving the sensitivity and specificity with which the regional resting state activity could be detected [15]. To our knowledge, no research work has been carried out to date on the characteristics of the fALFF in homosexual men.

Aims

The present study uses the fALFF and other FC measures to compare the characteristics of DMN activity in men with differing sexual preferences.

Methods and Materials

Participants

Twenty-six healthy men with a primarily homosexual preference and 26 men with a primarily heterosexual preference participated in the study. The mean age of the homosexual participants was 22.27 ± 3.50 years (range 18 to 31 years), and that of the heterosexual participants was 23.46 ± 2.79 years (range 18 to 33 years); these did not differ significantly ($P = 0.896$). The institutional review board of our institute approved the study. Written consent was obtained from each participant after the participant had been informed in detail about the nature of the study.

All the men with a primarily homosexual preference were recruited from a gay bar in Hangzhou, China. The age-matched heterosexual controls were recruited from Zhejiang University and two local communities. The common inclusion criteria were 18 to 35 years of age; male; right-handed; and no history of mental disorder, head trauma, epilepsy, psychoactive substance dependence, or physical disease. The common exclusion criteria included a history of sexual dysfunction, gender identity disorder, or paraphilia. The sexual preference of each participant was assessed and quantified using the Kinsey scale [16], which describes a person’s sexual history or episodes of sexual activity at a specific age. The Kinsey scale provides an overall index of sexual orientation ranging from 0 (exclusively heterosexual) to 6 (exclusively homosexual). Scores for all the men with a primarily heterosexual preference were 0, and those for the men with a primarily homosexual preference ranged from 3 to 6 (Table 1). A score of 3 is

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