

GENDER DIFFERENCES IN BRAIN STRUCTURE AND RESTING STATE ACTIVITY: A STUDY IN A LARGE COHORT OF YOUNG HEALTHY SUBJECTS

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Introduction. Previous functional MRI (fMRI) studies have shown that cortical activations differ between males (M) and females (F) when performing the same tasks [1]. Using voxel-based morphometry (VBM), gender-related differences of gray matter (GM) volume have also been demonstrated [2].

Objective. To assess, in a large group of young healthy subjects, gender-related differences in the resting state (RS) activity in all RS networks (RSNs) with a possible functional relevance, and to investigate their correspondence with GM volume differences assessed with VBM.

Methods. Using a 3.0 Tesla scanner, RS fMRI scans and 3D high-resolution T1-weighted images were acquired from 104 right-handed healthy controls (48 male [M]/56 female [F], mean age=23.5/22.8 years). Independent component analysis was used to decompose resting fMRI data into spatially independent components (ICs) using the GIFT software (Group ICA of FMRI Toolbox) [3]. This analysis produced 41 ICs. A frequency analysis of IC time courses and correlation with custom-made templates based on previous studies [4] was used to identify RSNs with potential functional relevance. VBM analysis was performed using SPM8 and Diffeomorphic Anatomical Registration using Exponentiated Lie algebra (DARTEL) [5]. Between-gender differences of RSNs and GM volumes were analyzed using SPM8 and two-sample t-tests.

Results. The analysis of RS data detected 11 networks with potential functional relevance, which are shown in Figure 1.

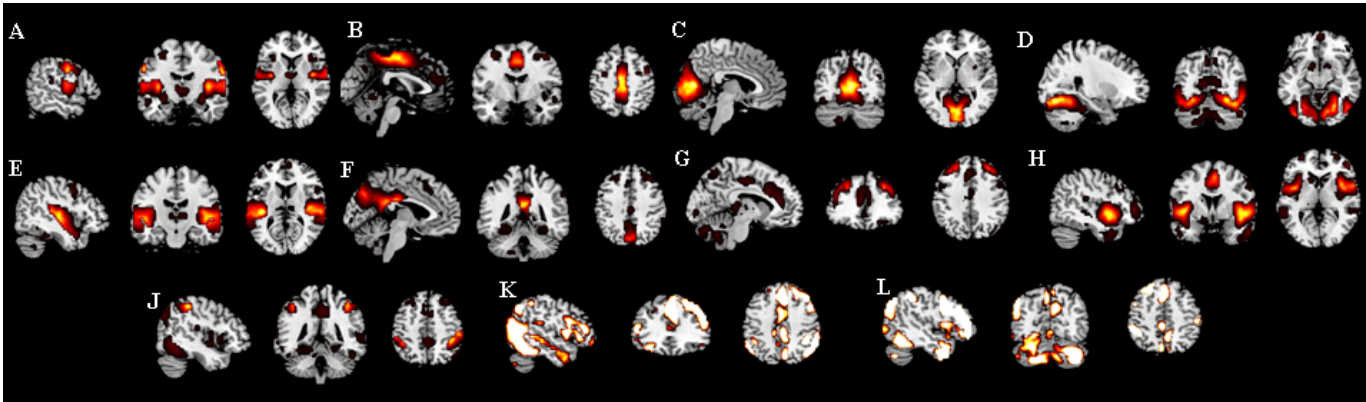


Figure 1. RSNs with potential functional relevance detected in healthy subjects: A,B: sensorimotor networks; C,D: primary and secondary visual networks; E: auditory network; F: default mode network (DMN); G: executive control network (ECN); H: salience network (SN); J: bilateral fronto-parietal network; K,L: right and left working memory networks.

Gender differences of RS activity. Differences in the entity of RS activity were found in the majority of the detected RSNs. In summary, M had higher RS fluctuations than F in several regions of the temporal and parietal lobes, including the bilateral middle temporal gyrus (MTG), the right (R) insula, the R postcentral gyrus and the bilateral paracentral lobule. Conversely, F had higher RS activity than M in several regions of the frontal lobes (the middle frontal gyrus [MFG], the inferior frontal gyrus [IFG] and the anterior cingulate cortex [ACC]), the bilateral cerebellum, and some visual and auditory regions (See Table 1 for further details).

	Sensory and motor RS networks					Cognitive RS networks					
	Sensori-motor RSN (A)	Sensori-motor RSN (B)	Primary visual RSN (C)	Secondary visual RSN (D)	Auditory RSN (E)	DMN (F)	ECN (G)	SN (H)	Fronto-parietal RSN (J)	R working memory RSN (K)	L working memory RSN (K)
M vs. F	R postcentral gyrus; Bilateral paracentral lobule; L cerebellum	-	-	-	-	-	L MTG	R insula	R insula; R MTG	-	L supplementary motor area (SMA).
F vs. M	-	-	L precuneus; Bilateral fusiform gyrus	R cerebellum	R cerebellum; R MTG	R precuneus	L MFG	L ACC; L IFG	-	L cerebellum	Bilateral cerebellum.

Table 1. Gender-related differences in the entity of RS activity for the RSNs of interest.

Voxel-based morphometry. Compared to F, M had an increased GM volume in the R occipital cortex. Conversely, F showed an increased GM volume than M in the L superior orbitofrontal cortex, the bilateral precuneus, the R ACC and the L caudate.

Conclusions. Gender-related differences were found in the majority of the brain RSNs. Functional differences had only a minimal overlap with volumetric GM differences.

References. [1] Bell et al., Neuroimage 2006;30:529-538; [2] Good et al., Neuroimage 2001;14:21-36; [3] Calhoun et al., Hum Brain Mapp 2001;14:140-151; [4] Damoiseaux et al., PNAS 2006;103:1384-53; [5] Ashburner J. Neuroimage 2007;38:95-113.