



EDITORIAL  
COMMENTS

## Does the Brain Work While Resting? Resting State fMRI

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Since the beginning of time, humankind has wondered about what happens in the brain. The human brain works even while relaxing or at rest (1). Functional magnetic resonance imaging (fMRI) has rapidly grown and has got applications in a wide variety of fields such as neuroscience, psychology, clinic medicine, and political science in the past several years.

Functional magnetic resonance imaging (fMRI) is rooted in oxygenated and deoxygenated hemoglobin for paramagnetic properties to show images of changing blood flow in the brain linked with neural activity (2). During the performance of different tasks or at resting state, it offers the generation of images that reflect the activated brain structures (3). fMRI is an increasingly gaining popularity because of being a noninvasive technique for brain functions such as emotion, memory, language, etc. (1).

Since the invention of fMRI, studies on resting-state fMRI (rs-fMRI) have become widespread in the past two decades. rs-fMRI allows the mapping of regional interactions in the brain at resting state in other words when an explicit task is not being performed (4, 5).

Ogawa et al (6) was the first person to demonstrate the potential importance of blood oxygenation level-dependent (BOLD) contrast. Task-based fMRI and rs-fMRI use BOLD contrast. Rs-fMRI display spontaneous low-frequency oscillations arising from spatiotemporal correlations, continuously communicating functionally linked networks of anatomical regions (1). Biswal proposed seed-based analysis in which a seed is selected and the linear correlation of this seed region with all the other voxels in the entire brain is found to get the seed-based functional connectivity (FC) map (1). Spontaneous low-frequency fluctuations are resting-state signals in the range of 0.01-0.08 Hz. When resting state fMRI scan is obtained, volunteers are instructed to relax and not to think of anything in particular during these experiments (7). rs-fMRI protocol can be applied in the following three ways: eyes open, eyes closed, and eyes open while focusing on a dash bar on the screen. The subjects must not fall asleep during the eyes-closed protocol (7). In literature, most studies were performed on a 1.5 T or 3 T MR scanners. During a resting-state fMRI scan, both structural imaging and gradient-echo echo-planar imaging T2\* weighted sequences are taken to measure to brain activity (8). A time series of 3D images is collected for fMRI data.

Brain connectivity is divided into the following two general networks: anatomical connectivity (FC) and functional connectivity. (7). Functional connectivity analysis techniques comprise independent component analysis (ICA) and seed-based and graph theory analyses. ICA yields rs-fMRI networks by deriving spatially and temporally independent components from whole brain voxels. ICA examines multiple simultaneous voxel-to-voxel interactions of distinct networks in the brain (1). Using these methods, some common neurologic and psychiatric brain disorders including schizophrenia (9), attention deficit hyperactivity disorder, Alzheimer's disease (AD) (10), depression (11), Parkinson disease (PD), and multiple sclerosis (12) were studied. Default mode functional connectivity were decreased in AD (10). According to van den Heuvel, a decrease was found between medial frontal cortex and precuneus in schizophrenic patients using default mode functional connectivity analysis. (7). In the early stage of Parkinsonism, the overall organization of the brain network was disrupted, which decreased global efficiency and disconnected modularity and hub distribution (13).

For rs-fMRI analyses, software such as statistical parametric map (SPM), REST, FSL, CONN are used for pre and post-processing analysis (1). For analysis, head motion correction is done, the functional images are co-registered to structural images using a six-parameter rigid-body transformation and a 12-parameter affine transformation (8). The preprocessing steps include slice timing, realignment to correct head motion, co-registration to anatomical images, and normalization to a standard template. After these processes, the images are smoothed (8). A general

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linear model (GLM) is commonly used for statistical assumptions of brain activation maps that convert a voxel time series into a space defined in the design matrix spanned by a set of basis vectors (3).

There are the different networks in the brain: the default mode, auditory, salience, visuospatial, executive, language, precuneus, primary visual, sensory motor networks, etc. (1). The most commonly used is the default mode network which involves the medial prefrontal cortex and the posterior cingulate cortex and lateral parietal cortex. The default mode network performs only when the individual is in the resting state (1).

Resting-state fMRI (rs-fMRI) may be used in the diagnosis and prognosis of certain brain diseases affecting brain activity, thereby offering a promising option in the treatment in the resting state using brain connectivity analysis. rs-fMRI may provide important information to be used for many potential clinical applications as well as fundamental cognitive neuroscience investigations. We can understand the mechanisms underlying human brain function using rs-fMRI.

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