

Analysis of first-episode schizophrenia patients' sMRI and fMRI BOLD activation during the Tower of London Task using cortical pattern matching

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The organization of the human neocortex creates a challenge for accurate co-registration of grouped functional brain imaging data. While primary sensory and motor areas are well defined by distinct anatomical landmarks, other areas (such as those involved in complex cognitive processes) are anatomically less well defined and also highly variable between individuals. In addition, data derived from common spatial normalization techniques can be further distorted by brain pathology when investigating clinical populations.

This study addresses some of these limitations by employing cortical pattern matching techniques to derive gyral pattern average (GPA) models of the cerebral cortex for the co-registration of structural and functional brain imaging data. Three objectives were pursued: (1) compare difficulty-dependent Tower of London blood oxygenation level dependent (BOLD) activation represented on an intensity average (IA) model and a GPA model of the cerebral cortex; (2) to compare the cortical BOLD response of 10 first-episode male schizophrenia patients with 10 age and gender-matched healthy control subjects; (3) to analyse regional differences of cortical grey matter thickness between the two groups and its association with BOLD response.

Our results suggest that (1) both models (IA and GPA) generally produce an equivalent representation of BOLD response across hemispheres, cortical regions and groups, when using a deformable Brodmann area atlas as an anatomical reference. However, some closer association of Brodmann areas with primary visual and auditory areas were seen using the GPA model. (2) Analysis of statistically thresholded and clustered BOLD data showed predominantly right-hemispheric activation in healthy control subjects, particularly for the dorsolateral prefrontal and frontal cortex as well as for the temporal lobe. However, more extensive clusters of left-hemispheric activation were confirmed for the occipital lobe. For patients, the hemispheric dominance pattern was significantly diminished or reversed in the temporal, parietal and occipital lobes. The most significant group difference was found for decreasing cortical BOLD response with increasing task difficulty in the left superior frontal and superior temporal gyrus. (3) The assessment of cortical grey matter thickness by group performed on the GPA model suggests predominantly right-hemispheric reduction of grey matter in patients in the prefrontal, frontal and parietal cortex as well as the anterior temporal lobe and the hippocampus. Also for patients, reduced BOLD activation correlated with reduced cortical grey matter thickness, predominantly in the left prefrontal and frontal, as well as bilateral parietal cortex. These findings suggest first-episode schizophrenia patients exhibit an association between the subtle reduction of regional grey matter thickness and impaired brain function when performing the Tower of London task.