

Medial Parietal Cortex: Functional Properties in Normal Subjects and Schizophrenic Patients

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Introduction.

[18F] Fluoro-deoxyglucose positron emission tomography (PET-FDG) studies of normal human brain demonstrate that medial parietal and posterior cingulate (MP/PC) cortex have the highest glucose metabolic rates of any area of cerebral cortex when subjects are at rest. The activity of this region decreases, however, when subjects engage in a variety of cognitive tasks requiring attention¹. The function this area subserves during resting conditions, and the reasons for shutting down its metabolism during cognitive tasks, remain unknown. We propose that the activity of the medial parietal area at rest may be related to general information gathering, while reduction of metabolic activity may serve to filter out extraneous information during task performance.

A rat model of schizophrenia² posits widespread NMDA receptor hypofunction (NRH) as an underlying mechanism of the disease, yet the neuropathological changes seen in this model show selective degeneration of the posterior cingulate cortex. Can this animal model, however, be generalized to humans? We propose that dysfunction in human MP/PC cortex due to NRH in schizophrenia would disrupt mechanisms of general attention to the environment, such that this region would be unable to "turn off" its active state. This could result in the failure to filter out extraneous information from the surroundings, a deficit described by the filter hypothesis of schizophrenia. To examine this possibility, we conducted a functional magnetic resonance imaging (fMRI) study of cortical activity during working memory, encoding and recognition tasks in schizophrenic patients and controls. We predicted that schizophrenic patients would lack the decreases in activation normally seen in MP/PC cortex during cognitive tasks.

Methods.

Blood flow in the MP/PC cortex was examined in 22 schizophrenic patients and 14 healthy controls. Whole-brain functional images were acquired with a 1.5T Siemens VISION magnet, using an asymmetric spin-echo echo planar BOLD (T2*) sequence (TR=2500ms). Each functional run consisted of 102 frames of 16 contiguous 8mm thick axial slices.

A cognitive task was performed during each BOLD run. Three memory tasks, performed once using stimuli that were pictures of faces and once using stimuli that were words, yielded a total of six functional runs. The working memory task was a two-back version of the n-back task, in which the subject viewed a series of words or faces and indicated if the current word or face was the same as the one seen two stimuli before it. In the encoding task, the subject memorized a series of words or faces. During the recognition task, the subject indicated if the current stimulus was presented earlier in the testing session. Within a run, the subject received four blocks of the task, each block containing 16 trials (successive stimuli). Fixation blocks, in which a crosshair was displayed, alternated with the task blocks. Stimuli were shown for 2 sec, with 500 msec inter-trial intervals.

Processed signal values for the MP/PC cortex were examined with an ANOVA, treating subjects as a random effect, to test for a significant effect of condition (memory task v. fixation baseline) and assess the interaction between condition and group (patient v. control).

Results and Conclusion.

A significant main effect of condition was noted, as blood flow of the MP/PC cortex decreased during task blocks when compared to fixation. Both patients and controls, however, demonstrated a significant decrease in MP/PC blood flow during cognitive tasks compared to the fixation baseline (Figure 1). Patients did not show an attenuated decrease in MP/PC blood flow with cognitive activity as expected. Hence, the interaction between group and condition, collapsed across task and stimulus type, was not significant.

While we cannot exclude the possibility that the MP/PC cortex is selectively affected in schizophrenia as suggested by the NRH model, the effect does not appear to manifest as an abnormal blood flow change under these behavioral conditions. Perhaps the dysfunction occurs at a more cellular level, reflecting a selective vulnerability conferred by this region's high resting metabolic rate.

References.

- (1) G. Shulman et al.: J Cogn Neurosci 9:648-663, 1997.
- (2) J. Olney and N. Farber: Arch Gen Psychiatry 52:998-1007, 1995.