Analysis of brain networks evoked during an executive function task in schizophrenia patients

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INTRODUCTION

Executive functions are described as complex cognitions and behaviors that are involved in higher order processes such as memory, planning, action and attention. Previous research has evidenced that individuals with schizophrenia exhibit impairments in executive functioning. These impairments can manifest themselves as deficits in attention and information processing. The present investigation aims to identify the brain networks evoked during an executive function task known as the task-switch inertia task. The functionality of the evoked brain networks are compared between healthy controls and schizophrenia patients.

METHODS

Task-Switch Inertia Task (TSI)

- Participant either reads the word presented or names the colour of the font (i.e., green, red, yellow or blue).
- Stimuli is (1) neutral: no conflict between semantic meaning of text and font colour, and (2) incongruent: semantic meaning of the text is incongruent with the font colour.
- There are 4 task conditions: (1) colour-naming, neutral stimulus, (2) colour-naming, incongruent stimulus, (3) word-reading, neutral stimulus, (4) word-reading, incongruent stimulus.
- Participants included healthy controls (n=27) and schizophrenia patients (n=23).

Analysis

- Functional brain networks were extracted using Constrained Principal Component Analysis for fMRI (fMRI-CPCA).
- Component loadings were classified by correlating positive and negative loadings in select brain slices with previously established prototype brain networks.
- Analysis of estimated hemodynamic response (HDR) was performed using mixed model analysis of variance (ANOVA).

RESULTS

- Five functional brain networks were retrieved using fMRI-CPCA.
- Significant differences were observed between schizophrenia patients and healthy controls in the response network (component 1) and default-mode network (component 3).

Component 1 – Two Hand Response

- Schizophrenia patients do not exhibit post-response suppression of this network during the word-reading condition as displayed by healthy controls.
- Schizophrenia patients display sustained activation of this network.

Component 3 – Default-Mode A

- Main group effect of the TSI task.
- Schizophrenia patients display less deactivation of the default-mode network across all task conditions.
- The default-mode network is believed to be associated with mind wandering and in healthy individuals it is usually suppressed when engaged in a particular task.

CONCLUSIONS

- Results suggest:
  i. The decreased suppression of the response network and less deactivation of the default-mode network may contribute to some of the impairments in executive function in schizophrenia patients.
  ii. Less deactivation of the default-mode network in schizophrenia patients suggests greater mind wandering and less focus during task participation.

- The lack of significant differences between healthy controls and schizophrenia patients in the focus on visual features, cognitive evaluation and primary auditory networks suggests that patients still retain normal functioning in these networks. In other words, schizophrenia does not result in all-around cognitive dysfunction.
- Understanding the specific brain networks impaired in schizophrenia enables the development of targeted and effective therapies. One prospective intervention involves neuromodulation of impaired brain networks using transcranial alternating current stimulation (tACS).

REFERENCES


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