Abnormal Causal Connectivity of Left Superior Temporal Gyrus in Drug-naïve First-episode Adolescent-onset Schizophrenia: A Resting-state fMRI Study

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Background

Functional brain abnormalities have been studied in AOS cases. However, the alterations of causal connectivity between brain regions in AOS remains unclear.

Method

Thirty-two first-episode drug-naïve AOS patients and 27 healthy controls (HC) were recruited for resting-state functional MRI scanning. The brain region with the between-group difference in Regional homogeneity (ReHo) values was chosen as a seed to perform the Granger causality analysis (GCA) and further detect the alterations of causal connectivity in AOS. Both receiver-operating characteristic analysis and probabilistic neural network were applied to test the possibility of using abnormal brain connectivity for distinguishing cases from controls.

Table1 Brain regions showing significant effective connections difference both to and from left STG between AOS patients and HC.

Brain regions	Side	Brodmann Area	MNI coordinates			Peak	Cluster
			X	Y	Z	T-value	size
Left STG → other regions							
Superior frontal gyrus	R	BA8/9	15	27	33	-3.77	91
Angular gyrus	R	BA39	39	-75	36	-3.51	99
Insula	R	BA13	48	-12	12	4.87	97
Other regions → left STG							
Middle occipital gyrus	R	BA17/18	9	-87	-3	5.03	125

STG, Superior Temporal Gyrus; MNI, Montreal Neurological Institute; AOS, adolescent-onset schizophrenia; HC, healthy control

Results

AOS patients exhibited increased ReHo values in left superior temporal gyrus (STG) compared with HC. Significantly decreased values of outgoing Granger causality from left STG to right superior frontal gyrus and right angular gyrus were observed in GC mapping for AOS. Significantly stronger causal outflow from left STG to right insula and stronger causal inflow from right middle occipital gyrus (MOG) to left STG were also observed in AOS patients. Based on assessments of the two strengthened causal connectivity of the left STG with insula and MOG, a cross-validated probabilistic neural network model could discriminate all patients from controls with remarkable accuracy at 94.9%.

Figure 2 ROC curves of discriminations between adolescent-onset schizophrenia patients and healthy controls using Granger causality values of different brain regions.

ROC, receiver operating characteristic; MOG, right middle occipital gyrus; SFG, right superior frontal gyrus; AUC, area under the curve. The average AUC of all ROC curves is 0.829.

Conclusions

Patients with drug-naïve first-episode AOS exhibit brain functional connectivity abnormalities in left STG. The alterations of directional connections in left STG may play an important role in the pathogenesis of AOS and serve as potential biomarkers for the disease.

Figure 1. Brain regions showing effective connectivity alterations in AOS patients compared with HC

AOS, Adolescent onset schizophrenia; HC, healthy control.

Significant lower outgoing Granger causality (GC) values from left superior temporal gyrus (STG) to right superior frontal gyrus (SFG) and right angular gyrus (Ag) were detected in GC mapping for AOS (corrected $p < 0.05$). Significant stronger causal outflow from left STG to right insula and stronger causal inflow from right middle occipital gyrus (MOG) to left STG were also observed in AOS patients (corrected $p < 0.05$).

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