



Cortical Gray Matter Loss, Augmented Vulnerability to Speech-on-Speech Masking, and Delusion in People With Schizophrenia

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People with schizophrenia exhibit impairments in target speech recognition (TSR) against multiple-talker-induced informational speech masking. To date, the underlying neural mechanisms and its relationships with psychotic symptoms remain largely unknown. This study aimed to investigate whether the schizophrenia-associated TSR impairment contribute to certain psychotic symptoms by sharing underlying alternations in cortical gray-matter volume (GMV) with the psychotic symptoms. Participants with schizophrenia (N = 34) and their matched healthy controls (N = 29) were tested for TSR against a two-talker-speech masker. Psychotic symptoms of participants with schizophrenia were evaluated using the Positive and Negative Syndrome Scale. The regional GMV across various cortical regions was assessed using the voxel-based morphometry. The results of partial-correlation and mediation analyses showed that participants with schizophrenia, the TSR was negatively correlated with the delusion severity, but positively with the GMV in the bilateral superior/middle temporal cortex, bilateral insular, left medial orbital frontal gyrus, left Rolandic operculum, left mid-cingulate cortex, left posterior fusiform, and left cerebellum. Moreover, the association between GMV and delusion was based on the mediating role played by the TSR performance. Thus, in people

INTRODUCTION

Patients in special outpatient programs have
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MATERIALS AND METHODS

Participants

Participants were recruited from
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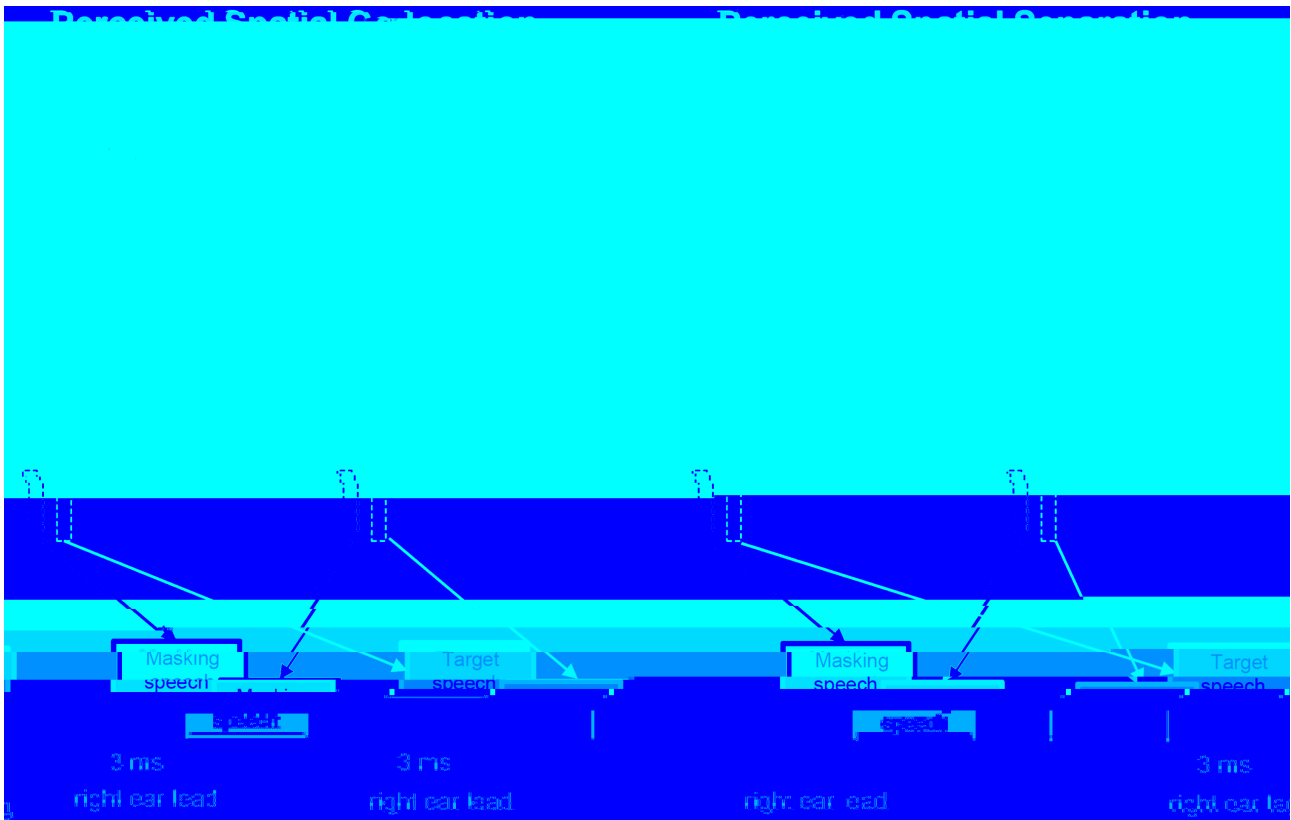


FIGURE 1 | Based on the auditory precedence-effect paradigm and the head-related transfer function (HRTF), the target speech and masking speech were simulated as being presented by each of the two spatially separated “loudspeakers” in the frontal field with the inter-source interval of 3 ms. Under the perceived spatial co-location (PSC) condition (left panel), both the onset of the target sound and that of the masker sound presented from the right headphone led those from the left headphone by 3 ms, leading to a perceptually fused target sound “image” and a perceptually fused masker “image” as coming from the same right location. On the other hand, under the perceived spatial separation (PSS) condition (right panel), when the onset of the target sound presented from the left headphone led that from the right headphone by 3 ms, and the onset of the masker sound presented from the left headphone lagged behind that from the right headphone by 3 ms, due to the precedence effect, the perceptually fused target image was perceived as coming from the left location and the perceptually fused masker image was perceived as coming from the right location.

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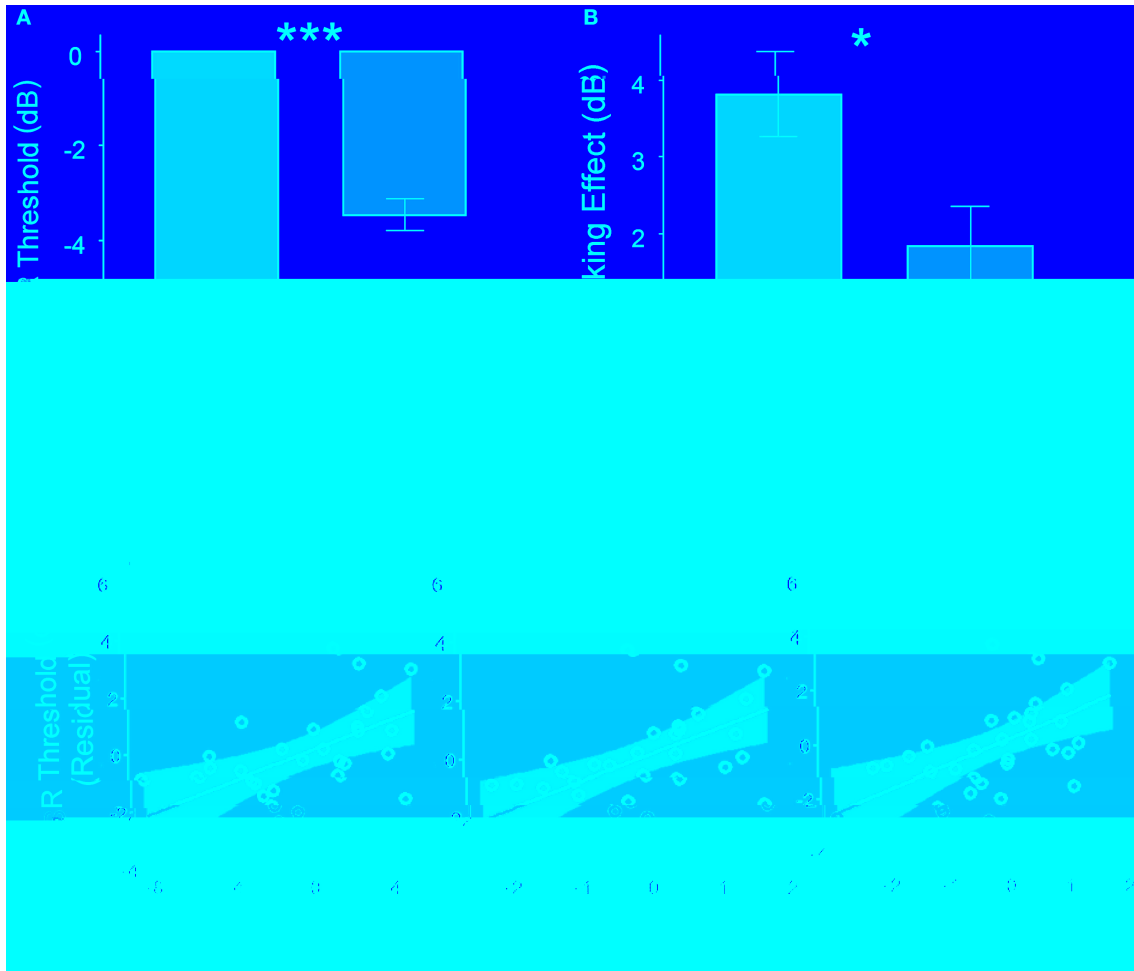


FIGURE 2 | (A) The group-mean target-speech-recognition threshold (μ) was significantly higher (the higher the μ is, the poorer the speech recognition is) in the group with schizophrenia (SCH) than that in the group of healthy controls (HC). (B) The unmasking effect ($\Delta\mu$) induced by the perceived spatial separation in the SCH group was significantly smaller than that in the HC group. In the SCH group, the bottom panels illustrate the partial regression plots for the significant correlations between the TSR threshold and the CMV-PANSS positive syndrome (C), CMV-PANSS-P1 (delusion) (D), and CMV-PANSS-G9 (unusual thought content) (E) with the statistical controls for age, sex, education, illness duration, medication dosage, and CMV-PANSS-total. $\dagger p < 0.05$; *** $p < 0.001$.

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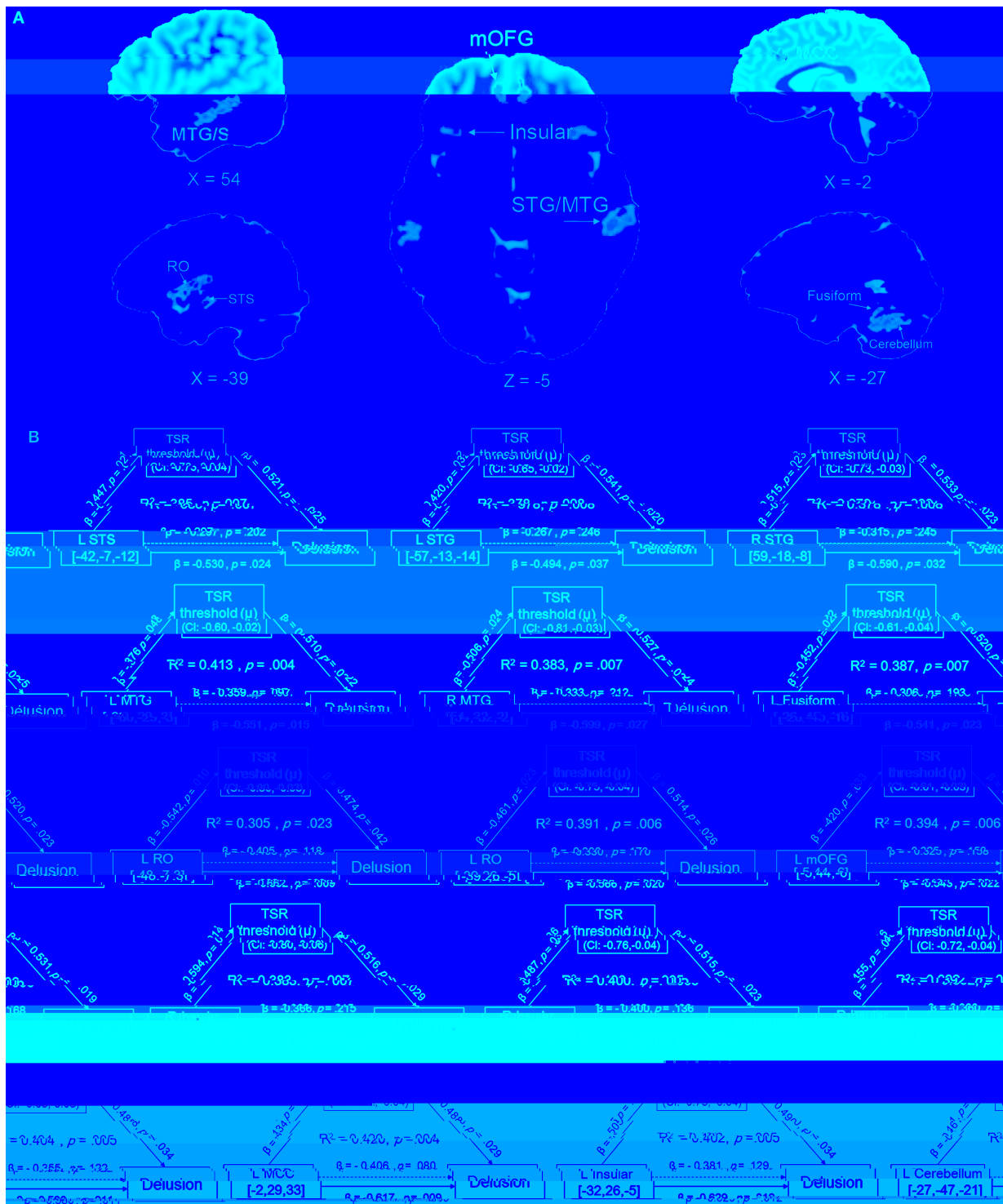


FIGURE 3 | (A) Brain regions with reduced gray-matter volume (GMV) in participants with schizophrenia, compared to their demographically-matched healthy controls. A cluster-defining threshold (CDT) of $D < 0.001$; $T > D > 3.23$ and a cluster based FWE-corrected threshold of $p < 0.05$ was used. The map was overlaid on the template from the Mango software (<http://rii.uthscsa.edu/mango/index.html>). (B) The mediating effects of the impaired target-speech recognition (TSR) on the relationships between the decreased GMV and the delusion symptom in participants with schizophrenia. Adjusted R^2 , standardized regression coefficients, p-values and bias-corrected confidence interval (95% CI) for the mediation effect were shown. Arrows with solid lines indicate that the effects were significant, and arrows with dashed lines indicate that the effects were not significant. MCC, mid-cingulate cortex; mOFG, medial orbital frontal gyrus; RO, Rolandic operculum; STG, superior temporal gyrus; STS, superior temporal sulcus, MTG, middle temporal gyrus; MTS, middle temporal sulcus.

TABLE 2 | Coefficients of Spearman partial correlation between gray matter volume of rois, target-speech-recognition threshold (μ), and P1/G9 Score of CMV-PANSS in participants with schizophrenia.

Brain region	MNI coordinate	Speech recognition			P1-delusion			G9-Unusual-thought-content		
		r	p	p ^{corr}	r	p	p ^{corr}	r	p	p ^{corr}
L mOFG	[5,44, 6]	-0.453*	0.016	0.039	-0.472*	0.011	0.032	0.400	0.035	0.089
L P Fusiform	[26, 45, 12]	-0.411*	0.030	0.042	-0.484*	0.009	0.032	0.391	0.039	0.089
L Cerebellum	[36, 50, 27]	-0.454*	0.015	0.039	-0.468*	0.012	0.032	0.397	0.036	0.089
L Cerebellum	[27, 47, 2]	-0.488*	0.008	0.039	-0.550*	0.002	0.032	0.536	0.003	0.054
L Insular	[32,26, 5]	-0.479*	0.010	0.039	-0.485*	0.009	0.032	0.428	0.023	0.089
L MCC	[2,29,33]	-0.433*	0.021	0.039	-0.425*	0.024	0.032	0.355	0.064	0.089
L MTG	[60, 29, 3]	-0.429*	0.023	0.039	-0.437*	0.020	0.032	0.382	0.045	0.089
L OR	[39, 18,12]	-0.406*	0.032	0.042	-0.396*	0.037	0.039	0.319	0.098	0.098
L OR	[48, 7,3]	-0.403*	0.033	0.042	-0.432*	0.022	0.032	0.360	0.060	0.089
L STG	[42, 7, 12]	0.377	0.048	0.051	-0.457*	0.015	0.032	0.367	0.055	0.089
L STG	[57, 3, 14]	0.361	0.059	0.059	-0.487*	0.009	0.032	0.346	0.072	0.089
R mOFG	[1,36, 14]	-0.431*	0.022	0.039	-0.428*	0.023	0.032	0.381	0.045	0.089
R Insular	[33,23, 8]	0.380	0.046	0.051	-0.417*	0.027	0.032	0.325	0.091	0.096
R Insular	(, 20, 34)	-0.399*	0.036	0.043	-0.441*	0.019	0.032	0.343	0.074	0.089
R Insular	(, 7, 39)	-0.459*	0.014	0.039	-0.431*	0.022	0.032	0.352	0.066	0.089
R MTG	[54, 32, 2]	-0.426*	0.024	0.039	-0.417*	0.027	0.032	0.388	0.041	0.089
R MTG	[65, 24, 6]	-0.428*	0.023	0.039	-0.406*	0.032	0.036	0.362	0.058	0.089
R STG	[59, 15, 8]	-0.468*	0.012	0.039	0.336	0.080	0.080	0.334	0.083	0.093

mOFG, medial orbital frontal gyrus; MCC, mid-cingulate cortex; MTG, middle temporal gyrus; OR, orbital operculum; STG, superior temporal gyrus; L, left; R, right; P, posterior. The p-value was obtained controlling for age, sex, education years, illness duration, medication dosage of antipsychotics and total score of CMV-PANSS. The p^{corr} was corrected by the Benjamini-Hochberg standard false discovery rate (FDR) method. The bold emphases indicate significant correlations corrected by the FDR method (p < 0.05).

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Speech Recognition Against Informational Masking Is Negatively Correlated With Delusion Severity and Unusual Thought Content

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