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Short Communication

Speech-on-speech masking and psychotic symptoms in schizophrenia

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ABSTRACT

People with schizophrenia have impairments of target-speech recognition (TSR) in noisy environments with multiple people talking. This study investigated whether the TSR impairment in schizophrenia is associated with their impaired auditory working memory or certain psychotic symptoms. Thirty participants with schizophrenia (mean age = 35.2 ± 12.7 years) and 30 demographics-matched healthy controls (mean age = 32.9 ± 10.9 years) were tested for their TSR against a two-talker-speech masker. Auditory working memory and memory capacity were evaluated using the Paced Auditory Serial Addition Test (PASAT) and Digit Span Test. Psychotic symptoms were evaluated using the Positive and Negative Syndrome Scale (PANSS). The results showed that participants with schizophrenia had higher TSR threshold (i.e., poorer TSR performance) and poorer PASAT scores than their healthy controls. Moreover, positive correlations (with age, sex, educational years, ill-duration, and dosage of antipsychotics controlled as covariates) were revealed between the TSR threshold and the PANSS-positive syndrome (especially delusion), and between the TSR threshold and the PANSS-negative syndrome (especially lack of spontaneity in speech and passive-apathetic-social withdraw). However, neither the PASAT nor the forward digit span exhibited significant correlations with the TSR. This study provides evidence that the TSR impairment (i.e., augmented vulnerability to informational speech masking), which reflects disorganization of speech information processing (inability in either inhibiting unrelated speech signals or capturing the wanted speech signals), is specifically associated with the severity of delusion, poverty of speech, and hypobulia, suggesting the potential value of the TSR impairment used for predicting certain core symptoms of schizophrenia.

People with schizophrenia exhibit impairments of target-speech recognition (TSR) in noisy environments with multiple people talking (Wu et al., 2012, 2017a, b; Zheng et al., 2016), indicating the deficits in perceptual segregation between target-speech and masking-speech signals. So far, whether this impairment is associated with certain psychotic symptoms has not been reported in the literature.

One hypothesis is that the impairment of TSR against informational speech masking in people with schizophrenia may be related to their deficits in auditory working memory and/or in capacity and rate of information processing (Townsend et al., 2001), affecting their performance in tasks that demand divided attention and/or dual processing (Fuller and Jahanshahi, 1999; Wylie et al., 2010). Another hypothesis is that this TSR impairment, which reflects disorganization of speech information processing (inability in either inhibiting unrelated speech signals or capturing the wanted speech signals), may be correlated to thought or speech-processing related symptoms.

In this study, 30 patients with schizophrenia (mean age = 35.2 ± 12.7 years) and 30 demographics-matched healthy controls (mean age = 32.9 ± 10.9 years) were recruited for examining these hypotheses (Table S1 in Online Supplementary Data presents the main characteristics of these two participant groups). The procedures were approved by the Independent Ethics Committee (IEC) of the Beijing Anding Hospital.

Materials (on-line Supplementary material) of this study were similar to those used in our previous studies (Wu et al., 2012, 2017a). Participants were tested for their TSR against a two-talker-speech masker. Auditory working memory and memory capacity were evaluated using the Paced Auditory Serial Addition Test (PASAT) (Correia, 2011; Surhone et al., 2010) and Digit Span Test. Psychotic symptoms were evaluated using the Positive and Negative Syndrome Scale (PANSS). Scores for the five dimensions of PANSS (Mass et al., 2000) were calculated. Partial correlation analyses (with age, sex, educational

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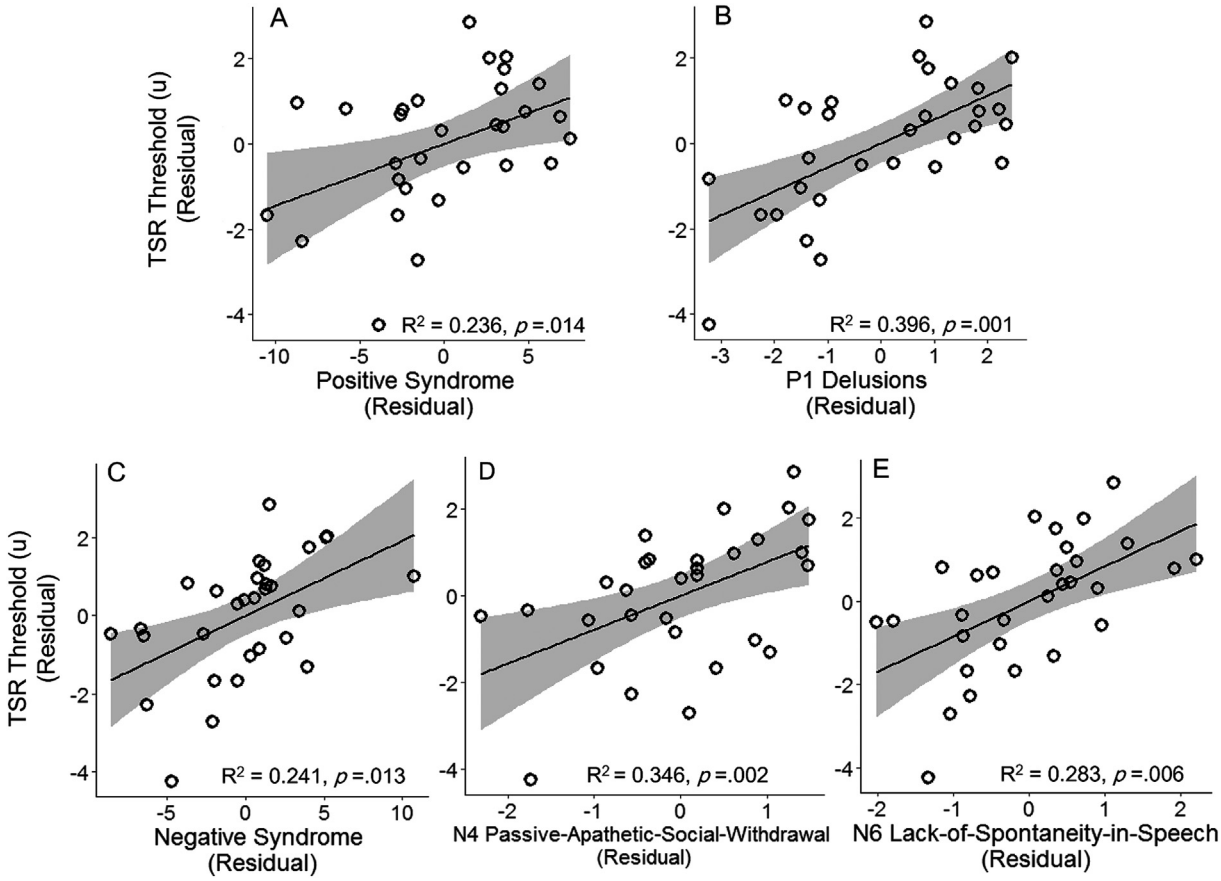

Fig. 1. Relationship between target-speech recognition and psychotic symptoms. Partial regression plots for the relationships between target-speech recognition (TSR) and psychotic symptoms in participants with schizophrenia. The poorer (positive residual of the y scale) the TSR (higher u value) was, the more severe (positive residuals of the x scale) the positive syndrome (panel A) and the negative syndrome (panel C) were. The delusion (P1 of PANSS) (panel B) contributed to the correlation between the positive syndrome and the TRS; the passive-apathetic-social withdraw (N4 of PANSS) (panel D) and the lack of spontaneity in speech (N6 of PANSS) (panel E) contributed to the correlation between the negative syndrome and the TSR against informational masking.

years, ill-duration, and dosage of antipsychotics controlled as covariates) were conducted to investigate relationships among TSR, PASAT, digit span, and psychotic symptoms.

The behavioral results showed that the TSR threshold was significantly higher in participants with schizophrenia (−1.23 ± 2.10 dB) than that in healthy controls (−3.7 ± 1.4 dB) ($t = 5.26$, $p < 0.001$; Cohen's $d = 1.36$, 95% CI ranged between 0.78 and 1.93). Participants with schizophrenia also exhibited lower PASAT score (correct response/total response × 100%) than healthy controls (i.e., 84.07 ± 18.29 for patient participants, and 93.14 ± 5.89 for healthy controls) ($t = 2.59$, $p = 0.012$; Cohen's $d = 0.67$, 95% CI ranged between 0.14 and 1.2). There was no significant difference in forward digit span between participants (11.27 ± 10.34) and controls (9.16 ± 1.15).

Thus, participants with schizophrenia were more vulnerable to speech masking and showed slower auditory information processing and poorer working memory than their healthy controls.

For participants with schizophrenia, a positive partial correlation was also revealed between the TSR threshold (μ value) and the PANSS-positive syndrome ($r = 0.486$, $p = 0.014$, FDR-corrected $p = 0.035$) (Fig. 1A and Table S2). Further inspection on each item of the PANSS positive syndromes showed that the P1 (delusion) score contributed to the positive correlation ($r = 0.629$, $p = 0.001$, FDR-corrected $p = 0.013$) between the positive syndrome and the μ value (Fig. 1B and Table S3). Also, a significant positive correlation was found between the TSR threshold and the PANSS-negative syndrome ($r = 0.491$, $p = 0.013$, FDR-corrected $p = 0.035$) (Fig. 1C and Table S2). More specifically, the N4 score of PANSS (passive-apathetic-social withdraw) and the N6 score of PANSS (lack of spontaneity in speech) contributed to the correlation between negative syndrome and the μ value (Fig. 1D, E and Table S3). Thus, in participants with schizophrenia, poor TSR against informational speech masking is associated with both delusion severity and negative symptoms especially the decline in spontaneous speech and act of will.

Moreover, no significant correlations were found between the TSR and PASAT, or between the TSR and forward digit span (Table S2). Thus, in people with schizophrenia, the TSR impairment may not be induced by impaired working memory, but more likely be associated with thought disorder or poverty of speech. This association may be due to the impaired inhibitory mechanisms (Gottesman and Gould, 2003), which reflect the incapability of adequately filtering information from multiple sources at the perceptual level in participants with schizophrenia (Braff et al., 1999; Gottesman and Gould, 2003), leading to disorganized or limited informational processing and ultimately psychotic symptoms (Gottesman and Gould, 2003; Grillon et al., 1990).

This study, for the first time, provides evidence that in people with schizophrenia the TSR impairment (augmented vulnerability to informational speech masking) is associated with the severity of delusion, poverty of speech, and hypobulia, suggesting that the TSR impairment is useful for predicting certein core symptoms of schizophrenia. Future studies will examine whether the TSR impairment is useful for early detection of schizophrenia.

Declaration of interests

All authors declare that there is no any actual or potential conflict of

interest including any financial, personal or other relationships with other people or organizations.

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Contributors

Each of the authors, Chao Wu, Chuanyue Wang, and Liang Li designed the study and wrote the protocol. Experiments were conducted Chao Wu. Chao Wu wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scog.2018.02.005.

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