Short Communication

Speech-on-speech masking and psychotic symptoms in schizophrenia

Chao Wu, Chuanyue Wang, Liang Li

Faculty of Psychology, Beijing Normal University, Beijing 100875, China
Beijing Anding Hospital, Capital Medical University, Beijing 100088, China
School of Psychological and Cognitive Sciences, Beijing Key Laboratory of Behavior and Mental Health, Key Laboratory on Machine Perception (Ministry of Education), Peking University, Beijing 100080, China
Beijing Institute for Brain Disorder, Capital Medical University, Beijing 100088, China

ARTICLE INFO

Keywords:
Schizophrenia
Speech recognition
Informational masking
Delusion, poverty of speech

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.

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. 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) 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 years, illness-duration, and dosage of antipsychotics controlled as covariates) were performed between the TSR and the PANSS-positive syndrome (especially delusion), and between the TSR 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.

* Corresponding author at: School of Psychological and Cognitive Sciences, Peking University, 52 Haidian Road, Beijing 100080, China.
E-mail address: liangli@pku.edu.cn (L. Li).

https://doi.org/10.1016/j.scog.2018.02.005
Received 13 February 2018; Received in revised form 20 February 2018; Accepted 22 February 2018
2215-0013/ © 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/BY-NC-ND/4.0/).
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 syndrome 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 certain 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.

Role of funding source

This work was supported by the National Natural Science Foundation of China (81601168, 31771252), the China Postdoctoral Science Foundation Special Program (2016T90050), and the Beijing Municipal Science & Tech Commission (Z161100002616017). They had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

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.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (81601168, 31771252), the China Postdoctoral Science Foundation Special Program (2016T90050), and the Beijing Municipal Science & Tech Commission (Z161100002616017).

Appendix A. Supplementary data

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

References

Braff, D.L., Sverdlov, N.R., Geyer, M.A., 1999. Symptom correlates of prepulse inhibition deficits in male schizophrenic patients. Am. J. Psychiatry 156 (4), 596–602.
Correia, S., 2011. Paced auditory serial attention test. In: Kretzer, J.S., DeLuca, J., Caplan, B. (Eds.), Encyclopedia of Clinical Neuropsychology. Springer, New York, NY.
Fuller, R., Jahanshahi, M., 1999. Concurrent performance of motor tasks and processing capacity in patients with schizophrenia. J. Neurol. Neurosurg. Psychiatry 66, 668–671.
Gottesman, L.I., Gould, T.D., 2003. The endophenotype concept in psychiatry: etymology and strategic intentions. Am. J. Psychiatry 160 (4), 636–645.
Grillon, C., Courchesne, E., Ameli, R., Geyer, M.A., Braff, D.L., 1990. Increased distractibility in schizophrenic patients. Electrophysiological and behavioral evidence. Arch. Gen. Psychiatry 47, 171–179.
Mass, R., Schoenig, T., Hirschfeld, K., Wall, E., Haasen, C., 2000. Psychopathological syndromes of schizophrenia: evaluation of the dimensional structure of the positive and negative syndrome scale. Schizophr. Bull. 26 (1), 167–177.
Surbone, L.M., Tennoe, M.T., Henssonow, S.F., 2010. Paced Auditory Serial Addition Test. Townsend, L.A., Malla, A.K., Norman, R.M., 2001. Cognitive functioning in stabilized first-episode psychosis patients. Psychiatry Res. 104 (2), 119–131.
Wu, C., Cao, S., Zhou, F., Wang, C., Wu, X., Li, L., 2012. Masking of speech in people with first-episode schizophrenia and people with chronic schizophrenia. Schizophr. Res. 134 (1), 33–41.
Wu, C., Zheng, Y., Li, J., Wu, H., She, S., Liu, S., Ning, Y., Li, L., 2017a. Brain substrates underlying auditory speech priming in healthy listeners and listeners with schizophrenia. Psychol. Med. 47 (5), 837–852.
Wu, C., Zheng, Y., Li, J., Zhang, B., Li, R., Wu, H., She, S., Liu, S., Peng, H., Ning, Y., Li, L., 2017b. Activation and functional connectivity of the left inferior temporal gyrus during visual speech priming in healthy listeners and listeners with schizophrenia. Front. Neurosci. 11, 107.
Wylie, G.R., Clark, E.A., Butler, P.D., Javitt, D.C., 2010. Schizophrenia patients show task switching deficits consistent with N-methyl-D-aspartate system dysfunction but not global executive deficits: implications for pathophysiology of executive dysfunction in schizophrenia. Schizophr. Bull. 36 (3), 585–594.
Zheng, Y., Wu, C., Li, J., Wu, H., She, S., Liu, S., Mao, L., Ning, Y., Li, L., 2016. Brain substrates of perceived spatial separation between speech sources under simulated reverberant listening conditions in schizophrenia. Psychol. Med. 46 (3), 477–491.