



Letter to the Editors

Disappearance of the unmasking effect of temporally pre-presented lipreading cues on speech recognition in people with chronic schizophrenia

Dear Editors,

To recognize target speech in noisy environments with multiple people talking, listeners try to use various perceptual/cognitive cues to facilitate perceptual segregation between target and masker signals. These cues include both working-memory-based knowledge about part of the target-sentence content (i.e., temporally pre-presented content prime, Freyman et al., 2004; Yang et al., 2007) and viewing a speaker's movements of the speech articulators (i.e., simultaneous visual lipreading) (Summerfield, 1979; Helfer and Freyman, 2005). Moreover, based on a combined effect of working memory and audiovisual integration, the temporally pre-presented lipreading cue also improves recognition of speech-masked speech (Wu et al., 2013).

Although people with schizophrenia have impairments in speech perception under masking conditions (Wu et al., 2012), they still retain the ability to unmask speech signals using either temporally pre-presented content primes (Wu et al., 2012) or simultaneously presented lipreading cues (Ross et al., 2007). Since both working memory impairments (Haenschel and Linden, 2011) and audiovisual integration reduction (de Gelder et al., 2003; Williams et al., 2010) are amongst the most consistent perception/cognitive deficits in people with schizophrenia, this study examined whether the unmasking effect of the pre-presented lipreading cues (Wu et al., 2013) is vulnerable to schizophrenia.

Sixteen patients with chronic schizophrenia and 16 demographics-matched healthy controls participated in this study (Table 1 in *Online Supplementary Data* presents the main characteristics of the two participant groups). Materials and procedures of this study were similar to those used in our previous studies (Wu et al., 2013).

The top and middle panels of Fig. 1 show group-mean percent-correct recognition of target speech keywords for the health-control participants and patient participants, respectively, as a function of signal-to-masker ratio (SMR) along with the group-mean best-fitting psychometric functions under the no-priming condition (open triangles and dash curve), false-priming condition (open squares and dash curve), and true-priming condition (filled circles and solid curve).

The speech-recognition performance was significantly poorer in the patient group than the healthy control group at low SMRs (−8 and −4 dB, $p < 0.004$, separate one-way ANOVAs, for all priming conditions). Thus, patients were more vulnerable to speech masking than their healthy controls (Wu et al., 2012).

The speech-recognition performance was also poorer in patients with auditory verbal hallucinations (AVHs) ($n = 8$) than patients without AVHs ($n = 8$). For example, a two-way ANOVA showed that under the no-priming condition (bottom panel of Fig. 1), the main effect of patient type was significant ($p < 0.001$) but the interaction between patient type and SMR was not ($p = 0.119$). Patients with AVHs confused their internally generated speech for external speech, leading to

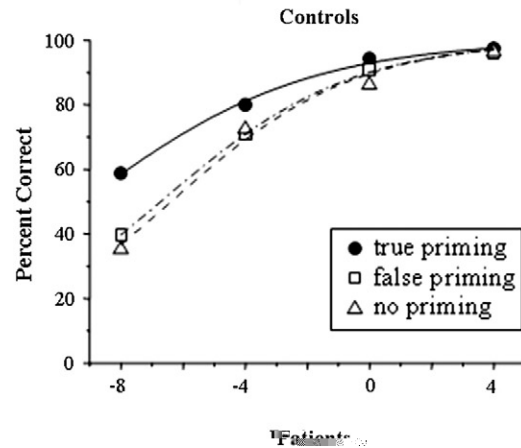


Fig. 1. Group-mean percent-correct recognition of the target keywords for the health-control participants (top panel) and patient participants (middle panel) as a function of signal-to-masker ratio (SMR) along with the group-mean best-fitting psychometric functions under the no-priming condition (open triangles and dash curve), false-priming condition (open squares and dash curve), and true-priming condition (filled circles and solid curve). Bottom panel: Comparisons in mean percent-correct recognition of target keywords as a function of the SMR under the no-priming condition between patient participants with auditory verbal hallucination (filled circles and solid curve) and patient participants without hallucination (open circles and dash curve).

interference with the processing of externally presented target speech under speech masking conditions (also see Hubl et al., 2007; Hugdahl, 2012).

More importantly, for the healthy control group, presenting the true-priming lipreading cue improved the recognition of target speech at the SMR of -8 dB ($p < 0.001$, separate one-way ANOVA). However, neither the true-priming lipreading cue nor the false-priming lipreading cue affected speech recognition in the patient group: A 3 (prime type) by 4 (SMR) two-way ANOVA confirmed that the main effect of priming type was not significant ($p = 0.857$) and the interaction between priming type and SMR was not significant ($p = 0.987$).

This study, for the first time, provides evidence showing that the unmasking effect of the temporally pre-presented lipreading cues completely disappears in patients with chronic schizophrenia, suggesting a summed effect of the working-memory deficits and the audiovisual integration deficits. Future studies will examine whether the method established by this study is useful for improving the accuracy of diagnosing schizophrenia.

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Contributors

Each of the authors, Chao Wu, Huahui Li, Qing Tian, Xihong Wu, Chuangyue Wang, and Liang Li designed this study and contributed to the experimental protocol. The experiment program was written by Huahui Li. Experiments were conducted by Chao Wu and Qing Tian. Chao Wu mainly contributed to data analyses wrote the first draft of the manuscript. All authors contributed to and approved the final manuscript.

Disclosures

Each of the authors has no conflict of interests to disclose.

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References

- de Gelder, B., Vroomen, J., Annen, L., Masthof, E., Hodiament, P., 2003. Audio-visual integration in schizophrenia. *Schizophr. Res.* 59, 211–218.
- Freyman, R.L., Balakrishnan, U., Helfer, K.S., 2004. Effect of number of masking talkers and auditory priming on informational masking in speech recognition. *J. Acoust. Soc. Am.* 115, 2246–2256.
- Haenschel, C., Linden, D., 2011. Exploring intermediate phenotypes with EEG: Working memory dysfunction in schizophrenia. *Behav. Brain. Res.* 216, 481–495.
- Helfer, K.S., Freyman, R.L., 2005. The role of visual speech cues in reducing energetic and informational masking. *J. Acoust. Soc.* 117, 842–849.
- Hubl, D., Koenig, T., Strik, W.K., Garcia, L.M., Dierks, T., 2007. Competition for neuronal resources: how hallucinations make themselves heard. *Br. J. Psychiatry* 190, 57–62.

- Hugdahl, K., Løberg, E.M., Falkenberg, L.E., Johnsen, E., Kompus, K., Kroken, R.A., et al., 2012. Auditory verbal hallucinations in schizophrenia as aberrant lateralized speech perception: evidence from dichotic listening. *Schizophr. Res.* 140, 59–64.
- Ross, L.A., Saint-Amour, D., Leavitt, V.M., Molholm, S., Javitt, D.C., Foxe, J.J., 2007. Impaired multisensory processing in schizophrenia: Deficits in the visual enhancement of speech comprehension under noisy environmental conditions. *Schizophr. Res.* 97, 173–183.
- Summerfield, A.Q., 1979. Use of visual information for phonetic processing. *Phonetica* 36, 314–331.
- Williams, L.E., Light, G.A., Braff, D.L., Ramachandran, V.S., 2010. Reduced multisensory integration in patients with schizophrenia on a target detection task. *Neuropsychologia* 48, 3128–3136.
- Wu, C., Cao, S.-Y., Zhou, F.C., Wang, C.Y., Wu, X.H., Li, L., 2012. Masking of speech in people with first-episode schizophrenia and people with chronic schizophrenia. *Schizophr. Res.* 134, 33–41.
- Wu, C., Cao, S.-Y., Zhou, F.C., Wu, X.H., Li, L., 2013. Temporally pre-presented lipreading cues release speech from informational masking. *J. Acoust. Soc. Am.* 133, EL281–EL285.
- Yang, Z.G., Chen, J., Wu, X.H., Wu, Y.H., Schneider, B.A., Li, L., 2007. The effect of voice cuing on releasing Chinese speech from informational masking. *Speech Comm.* 49, 892–904.

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