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The Effect of Auditory Masking on Error-Related Negativity (ERN): A Pilot Study

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Abstract

- The **error-related negativity (ERN)** is an event-related potential (ERP) elicited by erroneous responses during cognitive tasks; it is a biomarker of error-processing (1).
- According to the error-detection theory, the ERN relies on **informational processing** of stimuli to estimate the existence of an incorrect response (2). As such, **reducing the information** provided by stimuli **may affect** the ability to **detect errors** which should modulate the ERN.
- In daily life, various circumstances can contribute to the **limited information of auditory stimuli, such as** impoverished **speech in noisy environments** (3).
- Considering the impact of informational processing on ERN, it seems promising to investigate noise-induced changes on ERN.

Objective

- To evaluate the effect of auditory noise on error-related negativity (ERN).

Method

- Participants and stimuli: n=5, age=18-35 years old, with no history of neurological, ontological and psychological disorders. Stimuli included 120 da and 120 ga, duration=300 milliseconds, in quiet, white noise and babble noise (SNR* = 0 and 5dB), binaurally, intensity = 80dBSPL.

- Electroencephalography (EEG) recording and analysis: The 32 electrodes have been used for EEG recording, FCz as ground, referenced to nose. Fz and Cz was evaluated to trace ERN. ERN was detected around 100 milliseconds after the onset of response, in incorrect trials. Repeated Measures ANOVA, was used for evaluating the effect of noise types and SNR levels (within subject factors).

Results

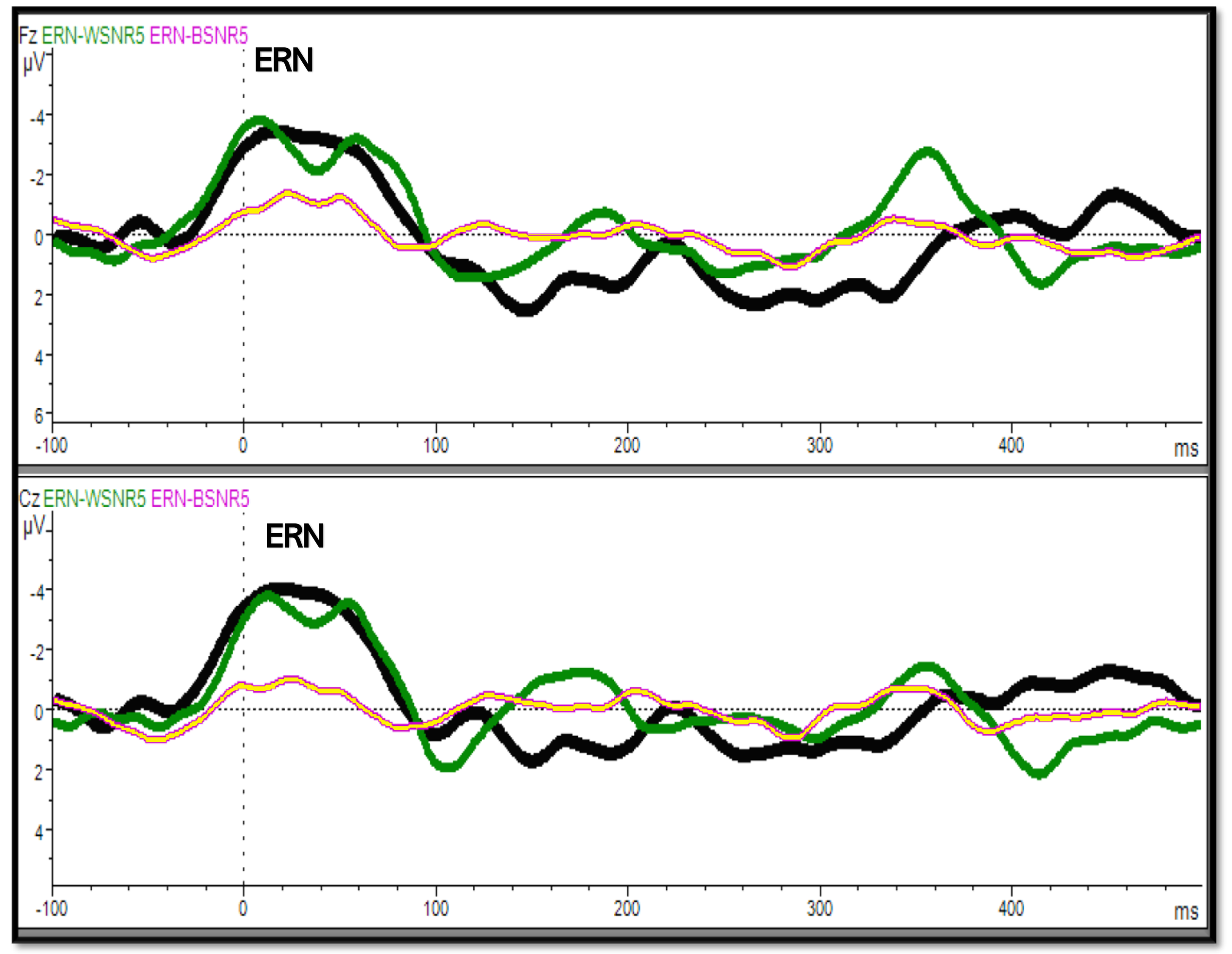

Figure 1. Grand average of ERN in quiet, white noise, and babble noise, SNR = 5dB. The ERN was smaller in babble noise compared to quiet and white noise ($F(2, 8) = 32.06$, $p = 0.001$). There was not significant difference in the amplitude of ERN between white noise and quiet conditions ($F(1, 4) = 4.69$, $p = 0.09$), Cohen's d= -0.604.

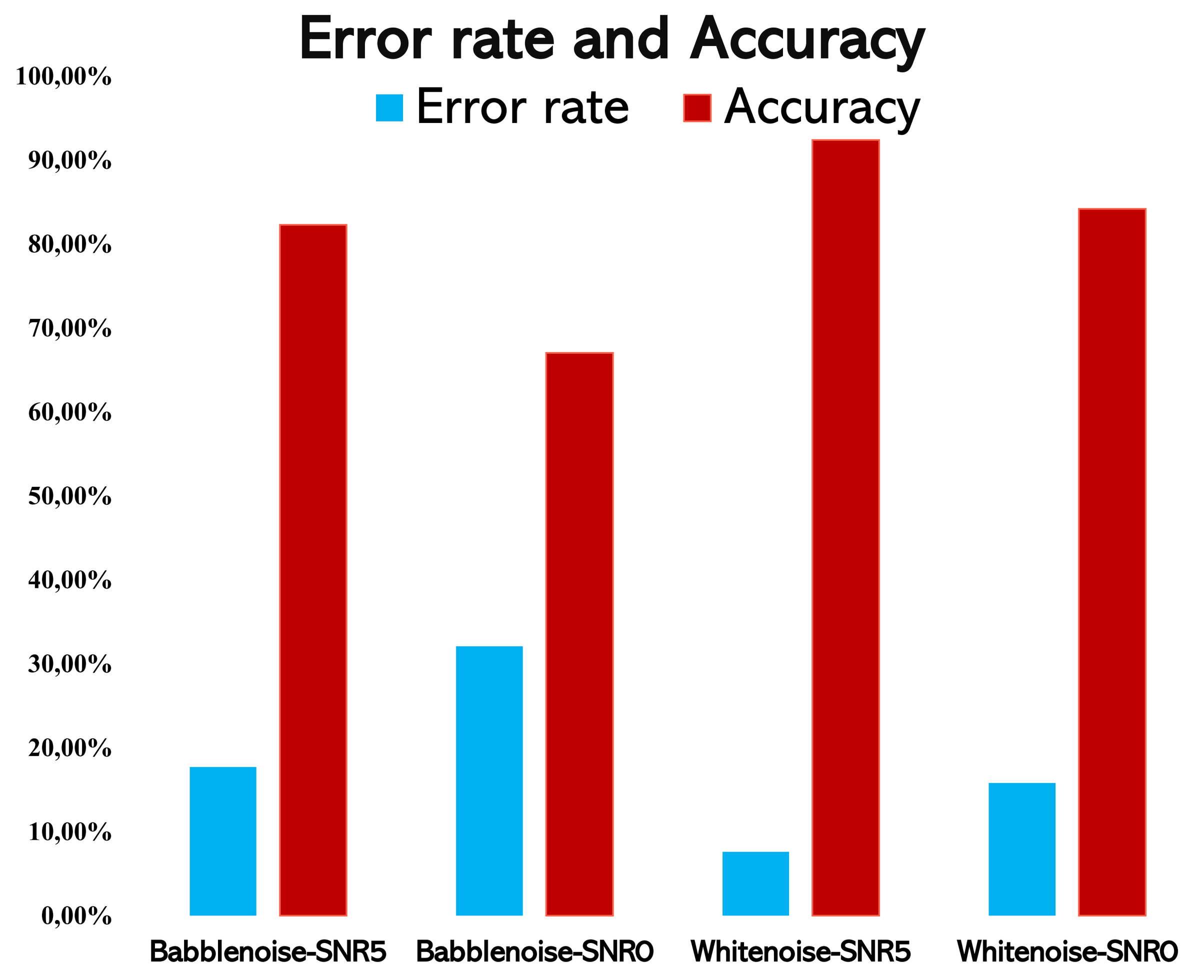

Figure 2. The average of accuracy (AC) and error rates (ER) in different listening conditions. At SNR = 5dB ($F(2, 8)= 77.26$, $p < 0.001$) and SNR = 0dB ($F(2, 8) = 54.77$, $p < 0.001$), there were higher AC and lower ER in white noise than babble noise.

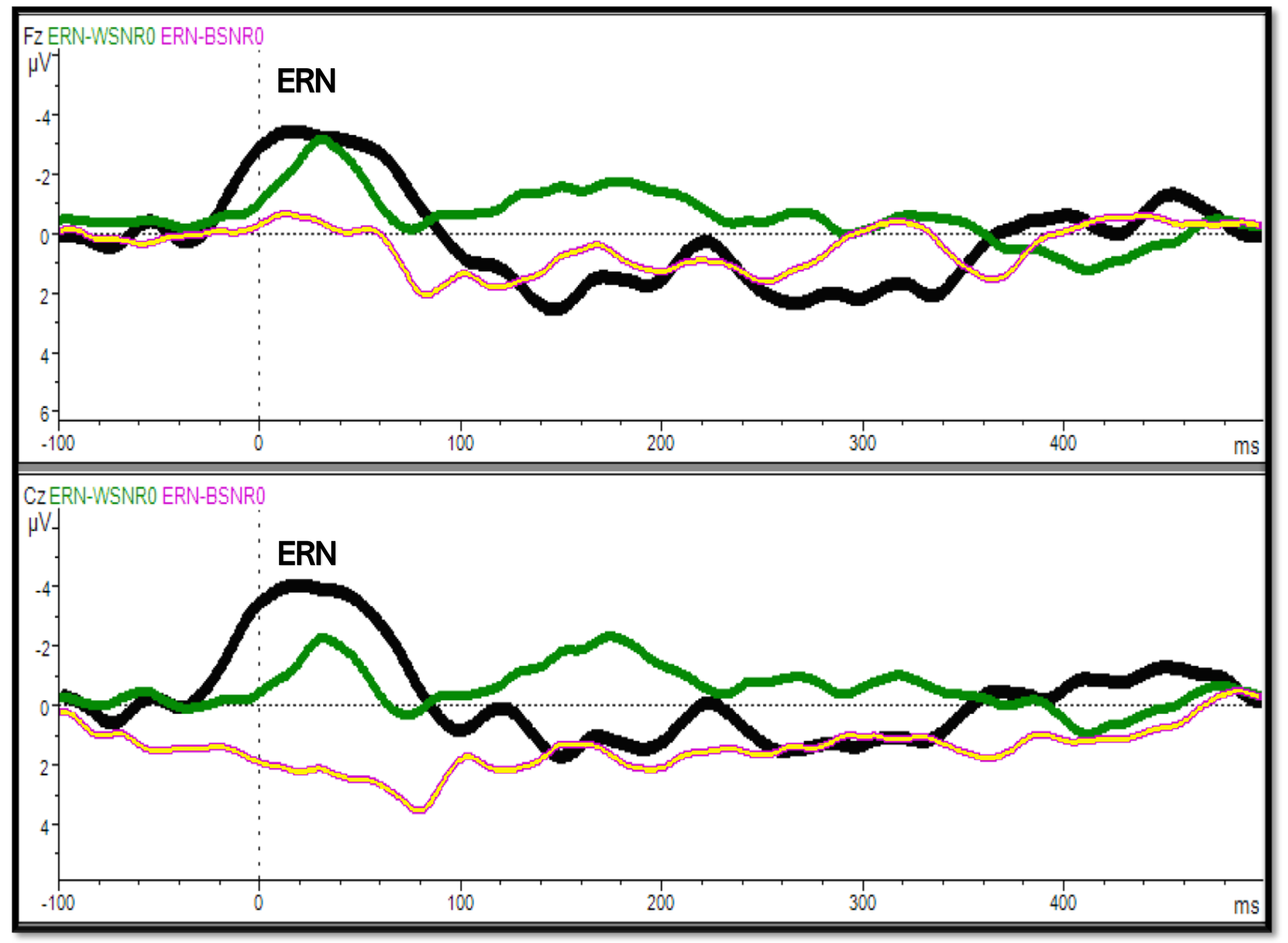

Figure 3. Grand average of ERN in quiet, white noise and babble noise, SNR = 0dB. The ERN was smaller in white noise and difficult to identify in babble noise. There was significant in amplitude of ERN between quiet, white noise and babble noise conditions ($F(2, 8) = 30.41$, $p < 0.001$). Cohen's d=-0.604.

Discussion and Conclusion

- ✓ Babble noise is a more effective masker compared to white noise, as **it** is an informational **mask** that influences attention as well as degrading the acoustical features of the target stimulus. White noise as acoustical mask only masks physical features of the sounds (4).
- ✓ **Babble noise may lead to reduced allocation of attention to the target stimuli, which was manifested by a smaller ERN, than the ERN traced in white noise condition.**
- ✓ Given that babble noise is a common background noise that people may be exposed to within society, this study emphasize the importance of investigating the effect of noise on error-processing. Also, these novel results may highlight the **contribution of error-processing in understanding speech in noise**. However, considering the small sample size, more research with larger sample size is warranted to confirm the current findings.

Reference

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- * SNR = Signal-to-noise ratio.

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