SPEECH AUDITORY BRAINSTEM RESPONSES AND WORDS-IN-NOISE RECOGNITION SCORES: IS THERE A LINK?

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1 Introduction

Normally developing children obtain lower scores on speech recognition in noise tasks compared to adolescents and adults.[1] However, many children with school-based learning problems have more difficulties recognizing speech in the presence of background noise compared to peers of similar age.[2] Although there are effective interventions to cope for these listening problems, early identification of speech recognition problems in noise has been an ongoing challenge. Because of immature attention, language and hearing skills, it is not possible to accurately measure speech recognition in noise abilities before the age of six years old.

Some authors have suggested that measuring the electrophysiological response of the brainstem following the presentation of speech stimuli (cABR) may provide an indirect measure of proficiency in listening to speech in noise.[3] cABRs show a high degree of transparency to the stimulus waveform and have a high test-retest reliability.[3]As such, cABRs are being considered for evaluating speech recognition in noise ability in young children as they do not require patient response. In the meantime however, available data showing correlation between behavioral scores on speech recognition in noise tasks and electrophysiological measures are scarce[4].

The aim of the present study was to investigate possible relationship between variables of cABR and the performance measured at a word-in-noise recognition task on adults. This is part of a larger study aiming at developing a screening tool for listening difficulties in noise for young children.

2 Method

This study had been previously approved by the Ethic board of the institution and was conducted at the *Laboratoire de recherche en audition* of the University of Ottawa (Ottawa, Ontario).

2.1 Participants

Forty-three normal hearing adults from 18 to 30 years old participated in this study. They had no history of hearing problems or language development difficulties. They all had attended francophone schools, up to high school. All participants had a hearing screening at 20 dB HL from 250 to 8000 Hz prior to experimental measures.

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2.2 Procedure

Experimental measures included monosyllabic word recognition tasks presented at 60 dB HL, with and without ipsilateral competing white noise in the right ear with insert earphones. Electrophysiological measures with a pre-recorded 40 ms syllable /da/ presented at 60 dB HL, with and without competing ipsilateral competing white noise in the right ear with insert earphones were following. The electrophysiological responses were collected using a vertical electrode montage (active Cz, forehead ground, ipsilateral mastoid bone reference) using Ag–AgCl electrodes.

3 Results

The sample was divided in three groups as following:

- Group 1 (n=14) was exposed to SNR of + 5 dB for the word recognition task in noise and the cABR measured with noise;
- Group 2 (n=15) was exposed to SNR of + 0 dB;
- Group 3 (n=14) was exposed to SNR of -5 dB.

3.1 Word-in-noise recognition scores

As shown in Table1, close to perfect average score was obtained by each group at the word recognition task (35 items) without competing noise (quiet condition). There was no statistical difference in the mean scores between the groups in quiet condition ($F_{(2,42)=}.753$, p =.48).

Table 1. Mean correct word recognition score for each group with standard deviation.

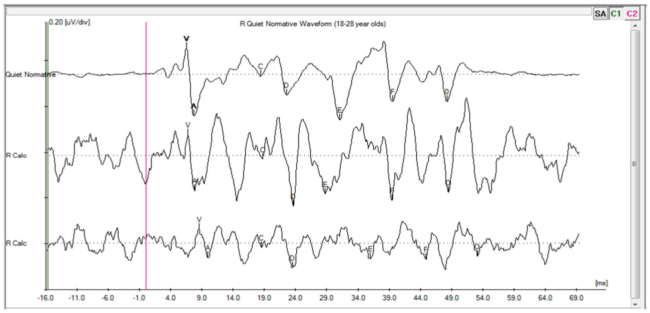
	Quiet condition	Noise condition
Group 1	93.47% (±4.811)	91.02% (±3.56)
Group 2	94.48% (±4.64)	84.29% (±5.18)
Group 3	95.71% (±5.10)	76.73% (±9.87)

The average score was lower when words were presented with an ipsilateral white noise (noise condition). As expected, the Group 3 who was exposed to a higher noise level (i.e.: SNR of +5 dB) had the lowest average correct score. There was a statistically significant in the correct recognition scores for the three groups ($F_{(2,42)}$ =15.82, p =.00). Post hoc comparisons using the Tukey HSD test indicated that the mean score for Group 1 was significantly different from Group 2, as well as Group 3. The Group 2 did also differ significantly from Group 3.

3.2 Speech evoked ABR

An example of a cABR waveform is presented in Figure 1. For the purpose of this paper, only the average amplitude and latency of wave V and A was computed as they are more commonly recognized by clinicians.

Figure 1. Example of a cABR waveform. Middle: cABR waveform in quiet condition. Lower: cABR waveform in noise condition.



The mean latency values of wave V and A are presented in Table 2. As expected, there was a significant (*p*< .00) increase of wave V latency from the quiet to the noise condition, as well as for wave A latency. There was no effect of SNR on the latency value of wave V or wave A. The difference in the mean latency of wave V ($F_{(2,42)}$ =0.24, *p* =.79) and wave A ($F_{(2,42)}$ =0.09, *p* =.92) between the groups did not reach statistical significance.

Table 2. Mean latency (in ms) of wave V and A with and without noise (standard deviation).

	Wave V No noise	With noise	Wave A No noise	With noise
Group 1	6.77 (±0.32)	9.87 (±2.47)	8.22 (±0.78)	12.23 (±2.84)
Group 2	6.53 (±0.54)	9.26 (±2.51)	7.70 (±0.38)	12.04 (±3.02)
Group 3	6.37 (±0.33)	9.83 (±2.79)	7.58 (±0.64)	11.79 (±2.96)

The mean amplitude values of wave V and A are presented in Table 3. As expected, there was decrease of the wave V amplitude from the quiet to the noise condition, as well as for wave A. That decrease of amplitude between quiet and noise condition only reached statistical significance for wave A amplitude in Group 1 and 3.

There was no significant effect of SNR on the amplitude value of wave V or wave A. The difference in the mean amplitude of wave V ($F_{(2,42)}$ = 1.24, p =.30) between the groups did not reach statistical significance, nor of wave A ($F_{(2,42)}$ = 1.80, *p* =.18). As opposed to behavioral measures in noise, no linear trend can be identified with the latency or the amplitude of wave V and A with decreasing SNR.

3.3 Word recognition scores in noise and speech evoked ABR

Correlations between speech recognition scores in noise and cABR variables (latency of wave V and B measured with and without competitive noise, as well as amplitude of wave V and B measured with and without noise) were computed for each group. Only the correlation between the word recognition score and the amplitude of wave V reached the statistical significance (*p*=.03).

Table 3. Group average amplitude value (in mV) of wave V and A with and without white noise (standard deviation).

	Wave V No noise	With noise	Wave A No noise	With noise
Group 1	.10 (±.05)	.08 (±.03)	-.18 (±.07)	-.08 (±.04)
Group 2	.15 (±.06)	.10 (±.06)	-.20 (±.05)	-.14 (±.16)
Group 3	.10 (±.06)	.08 (±.04)	-.21 (±.08)	-.08 (±.05)

4. Discussion and Conclusion

Similarly to studies investigating effects of white noise on cABR,[5] there was an increase of latency of wave V and A from quiet to noise condition, as well as reduction of their amplitude. However, there was no effect of SNR on the latency of wave V or A, neither on the amplitude. For example, the mean latency of wave V measured in noise condition was not significantly different between the groups. The presence of background noise appears to affect the processing of the stimulus at the subcortical level, but there is no linear trend that can be observed with the increase of the noise level, as can be observed with word recognition tasks in noise. The absence of SNR effect may be due to the fact that the three groups were not exposed to the three SNRs.

Only one correlation between speech recognition score in noise with one cABR variable at only one SNR condition, which is not sufficient at this point to suggest any link between cABR and hearing in noise. Analyses of other cABR components, such as transition wave (C), Frequency Following Responses (D, E, F) and the offset wave (O) could bring some insights about the possibility to use cABR as a clinical tool to identify speech in noise problems.

Acknowledgments

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