Objective measures of human temporal resolution with ABR – A preliminary study

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Introduction

Auditory temporal resolution is an important aspect of suprathreshold hearing, especially for speech comprehension and it is typically defined as the ability to detect temporal changes in a signal. The assessment of temporal resolution is typically conducted using behavioral gap detection methods, and the Gaps in Noise (GIN) test is one of the most commonly used methods (Musiek 2020). Although some objective methods of assessing temporal resolution have been proposed, such as adapting GIN to ABR (Werner, Folsom et al. 2001), these methods have not been compared in the same subjects. The present study aims to compare a number of possible protocols to develop a reliable objective method based on the ABR to measure temporal resolution thresholds. This involves paradigms that can be combined with sensitive statistical detection methods for the ABRs to improve sensitivity.

Experimental Design

ABR Stimulation

The ABR method applied five different paradigms:

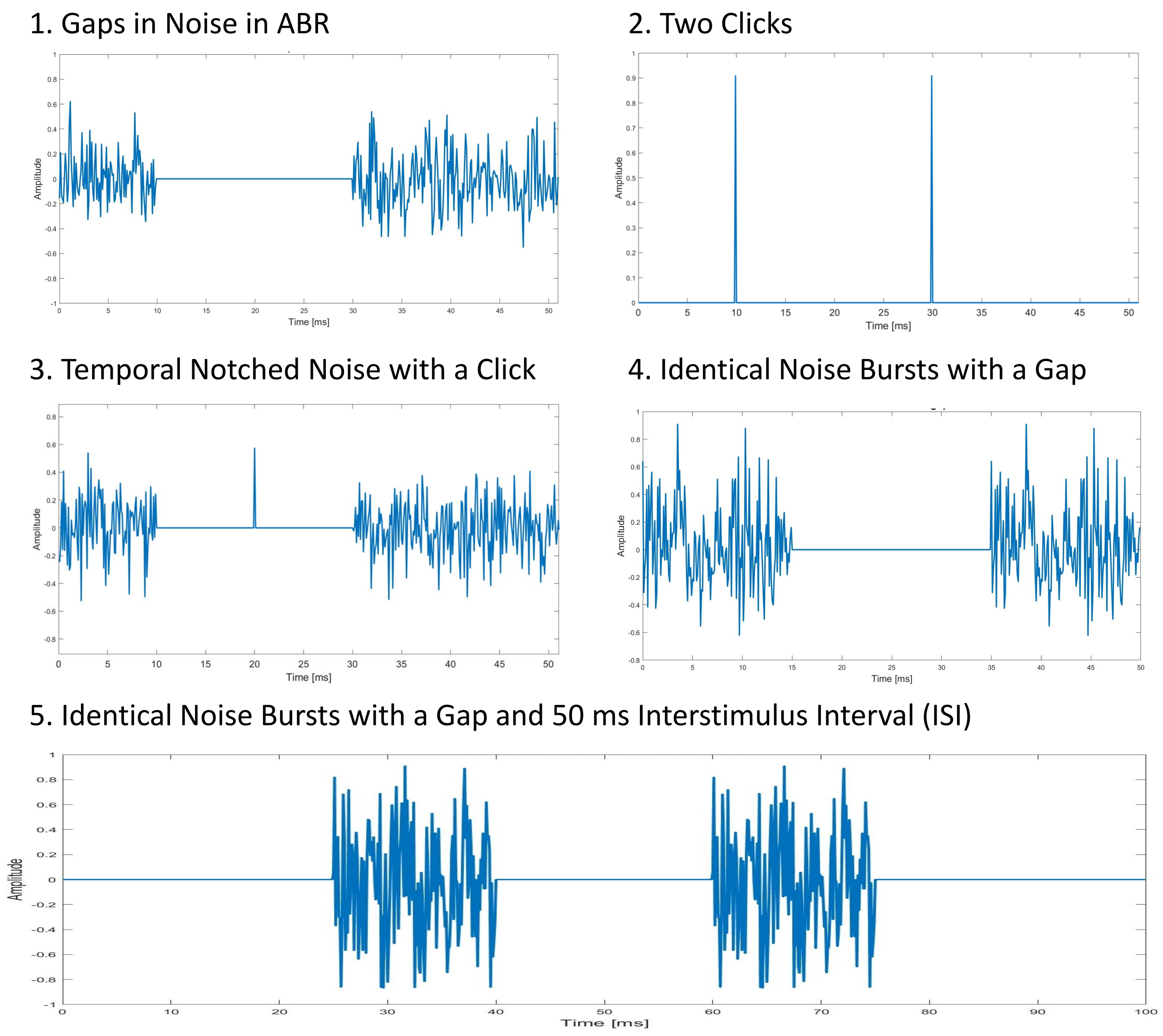

Figure 1. *A schematic illustration of the five ABR paradigms.*

In each paradigm, a gap in various durations (from 4ms to 30 ms) is added between either noises or clicks. Click stimulus was presented at 70 dB HL, and stimuli containing noise were presented at 70 dBA. 6000 epochs were recorded for each stimulus on 7 subjects aged between 20 to 33 with normal hearing.

Response Analysis

Three different detection methods were used to analyse the ABR presence: fsp, Hotelling's T^2 (HT2), HT2 on bootstrap (BS).

Results

There seemed to be a visual response in the conditions with the widest gap durations for each paradigm. However, the fsp values in the gaps in noise and identical noise paradigms were below 1 and were not statistically significant.

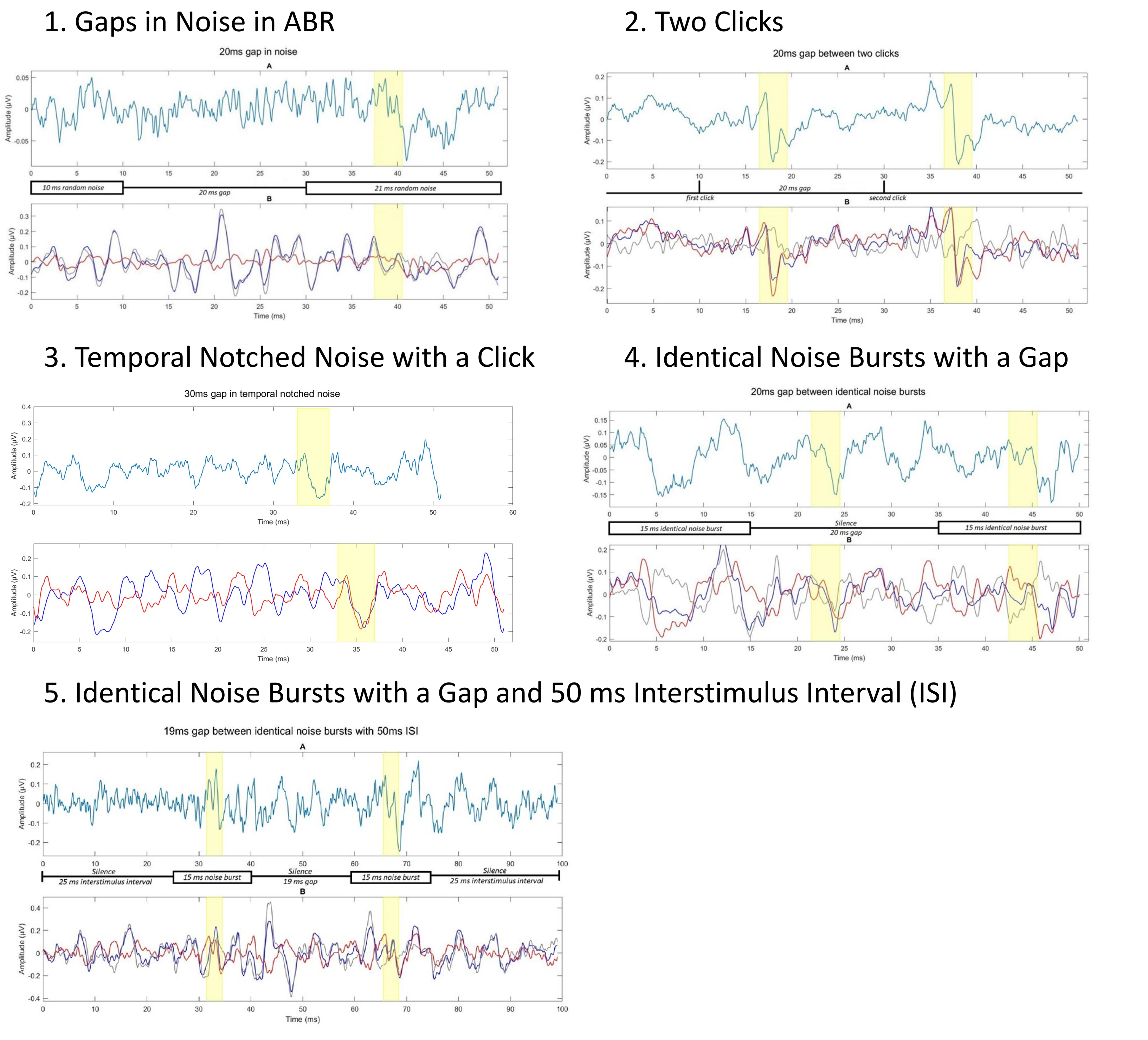

Figure 2. *The ABRs to five paradigms with a symbolic view of the stimulus underneath. The top plots demonstrate the mean of 6000 epochs recording. The bottom plots: The blue line demonstrates the mean of the first half of the total recording, the red line illustrates the mean of the second half of the total recording, and the grey line shows the difference between the two halves of the recording. The yellow rectangles highlight the latencies expected to be seen in wave V.*

In the Two Clicks paradigm, most of the participants had a measurable ABR response for conditions with gap durations of 4 ms and above in the analysis including the objective detection methods. The fsp values were above 10. Similarly, in the Temporal Notched Noise with a click paradigm, most of the participants had significant responses for gap durations of 8 ms and above. The number of subjects with a measurable response reduced as the duration of the gap approached to the threshold levels.

In the other three types of paradigms, there were not any significant ABRs for all the gap durations in the analysis with the objective detection methods.

Conclusion

- The Two Clicks paradigm and the Temporal Notched Noise with a Click paradigm showed more measurable ABRs than the others in ABR based on reported behavioral thresholds (~4 ms)(Musiek, Shinn et al. 2005).
- Although clear responses were obtained for the 20 ms gap for each stimuli type in ABR, it is difficult to interpret the waves as they approach the threshold levels.
- Our results do not agree with the previous studies that have reported GIN in ABR provides reliable responses for temporal resolution, however, they were done with a smaller cohort and visual detection (Poth, Boettcher et al. 2001, Werner, Folsom et al. 2001).
- Current studies on the Two Clicks paradigm are generally animal studies (Mulsow, Coffinger et al. 2018, Lee, Lee et al. 2020). Our results show that this method is a potential method that can also be used to assess human temporal resolution.

Contact

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