

REDUCING RECORDING TIME OF BRAINSTEM AUDITORY EVOKED RESPONSES BY THE USE OF RANDOMIZED STIMULATION

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1 - INTRODUCTION

Many protocols for newborn and infant hearing screening incorporate the acquisition of Brainstem Auditory Evoked Responses (BAER). This evoked potential represents the neural activity associated with the brainstem in response to a sound stimulus. The biological response waveform is characterized by a series of positive waves that occur during the first 10 ms after stimulus presentation. Since wave V is the most robust wave, it is usually used as an indicator of hearing loss. The conventional acquisition technique elicit the biological response by presenting to the patient a pulse train with a fixed inter-stimulus interval (ISI) and averaging then the sweeps corresponding to each stimulus. Usually, more than 1500 sweeps must be averaged to obtain a reliable biological response. The exploration time is therefore an important limitation in the recording of these potentials. This preliminary study presents a novel technique to reduce the recording time.

2 - RANDOMIZED STIMULATION

In contrast to the conventional technique, in which stimuli are presented synchronously with a period greater than the averaging window (usually 10 ms) (figure 1.A), the Randomized Stimulation technique consists of the average of auditory responses corresponding to a burst of stimuli whose period varies randomly within two values according to a predefined probability distribution. Figure 1.B shows an example of Randomized Stimulation sequence in which the ISI varies uniformly random between 3 and 8 ms. In this example, ISI is smaller than the averaging window, leading to overlapping responses. A histogram for an ISI₃₋₈ sequence is presented in figure 1.C.

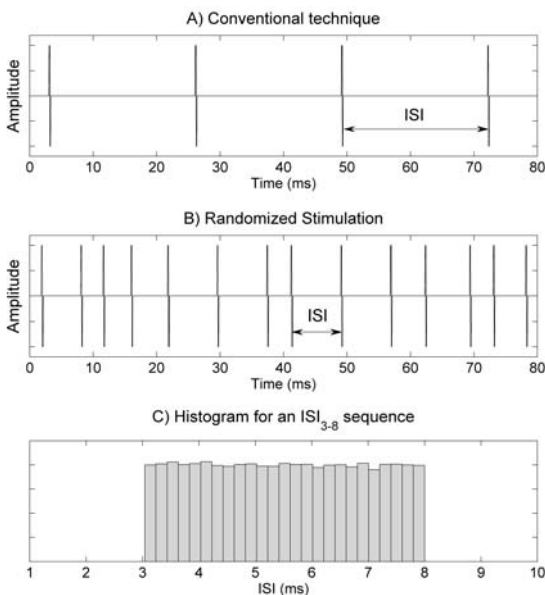


Figure 1. (A) Stimulation sequence in the conventional technique. Stimuli are presented synchronously with a period greater than the averaging window. (B) ISI₃₋₈ Randomized Stimulation sequence. Inter-stimulus interval (ISI) is smaller than the averaging window, leading to overlapping responses. (C) Histogram for an ISI₃₋₈ Randomized Stimulation sequence. ISI varies uniformly random within the range 3 - 8 ms.

3 - ASSESSMENT

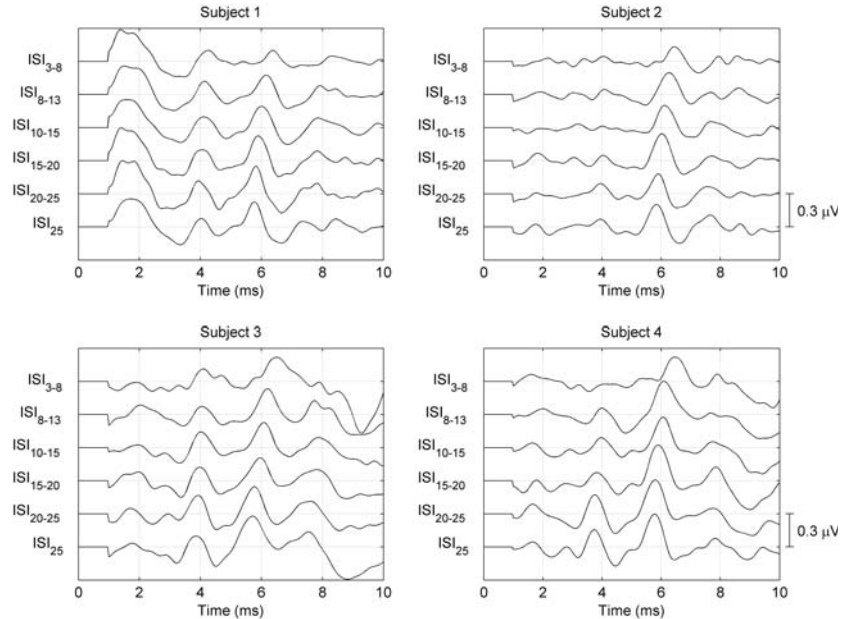


Fig. 2. BAER signals from 4 normally hearing subjects recorded by averaging 4,000 sweeps at different stimulation rates using the Randomized Stimulation technique. Wave V can be identified in each recorded signal.

The BAER from four normally hearing subjects were acquired using the Randomized Stimulation technique at different stimulation rates in order to test the feasibility of the proposed methodology (figure 2). These recordings were obtained by averaging 4,000 sweeps. Figure 2 shows that wave V can be recognized in the four subjects at every stimulation rate. This figure also shows that the effects of adaptation on the evoked potentials increase with stimulation rate (amplitudes decrease and latencies increase, especially in more central waves), which confirms the recording of BAER. The time necessary to obtain BAER at different stimulation rates is analyzed in table 1. The results of this study show that the use of the Randomized Stimulation technique at high stimulation rates yields to an important reduction of the recording time.

ISI	Sweeps	Recording time	Time reduction
ISI ₂₅	4046	101,15 s	-
ISI ₂₀₋₂₅	4174	93,92 s	7,14 %
ISI ₁₅₋₂₀	4188	73,29 s	27,54 %
ISI ₁₀₋₁₅	4152	51,90 s	48,69 %
ISI ₈₋₁₃	3984	41,83 s	58,64 %
ISI ₃₋₈	3992	21,96 s	78,29 %

Table 1. Analysis of the time required to obtain BAER by averaging 4,000 sweeps at different stimulation rates using the Randomized Stimulation technique. The recording time is compared with the conventional technique at ISI = 25 ms.

4 - CONCLUSIONS

- ✓ The Randomized Stimulation technique can be used to record BAER at high stimulation rates.
- ✓ The recording time required to obtain brainstem auditory evoked potentials can be considerably reduced using the Randomized Stimulation technique.
- ✓ A fast detection of the wave V facilitates the implementation of newborn and infant hearing screening protocols.