

# Cortical Evoked Response Audiometry Thresholds and Neuroleptic, Sedative, Hypnotic Drugs

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**Abstract:** Cortical evoked response audiometry is adequate for approximating hearing threshold levels with frequency specificity when the psychoacoustic responses lack reliability and reproducibility (compensation claim). It is well-known that control of wakefulness is essential for the reliability of slow vertex responses (SVR). Therefore, sedative, hypnotic, and neuroleptic drugs are supposed to have possible adverse effects on the detection of SVR. In contrast, brainstem evoked responses (BER) have proved not to be significantly affected by therapeutic doses of these compounds. The purpose of our study was to assess the reliability of SVR-threshold definition in subjects taking neuroleptic, sedative, and hypnotic drugs. Fifteen subjects examined for occupational hearing loss at the Fund for Occupational Diseases in Brussels and regularly taking one or several of these drugs were compared with 27 comparable controls. In each subject the auditory thresholds were defined with both techniques: SVR (1, 2, and 3 kHz) and BER (clicks). A highly significant difference is observed between the two groups: In the group receiving drugs, the SVR threshold for 3 kHz is 12.1 dB (average) higher than the BER threshold, whereas in the group without drugs, the SVR threshold for 3 kHz is 7.77 dB (average) lower than the BER threshold. In the drug group, large interindividual differences are observed. It may be concluded that the use of neuroleptics, sedatives, and hypnotics renders the auditory threshold definition with SVR completely unreliable. In using SVR for medicolegal threshold definition, controlling the 3-kHz threshold with BER always is necessary.

**Keywords:** cortical response audiometry; evoked potentials; forensic medicine; hypnotics; legal medicine; neuroleptics; sedatives; slow vertex responses

Suspicious audiometric findings are fairly common in medicolegal patients, as soon as the prospect of material gain may promote either deliberate exaggeration of hearing loss or perhaps unconscious elevation of response criteria [1]. In Belgium, a financial compensation can be allocated by the Fund for Occupational Diseases (FMP/FBZ) to a worker who has been professionally exposed to damage risk (intense noise) and demonstrates some degree of occupational disablement resulting from noise-induced hearing im-

pairment. The latter is calculated by averaging the hearing loss (dB HL) at 1, 2, and 3 kHz on the best ear, with a weighting by the loss at the poorer ear.

In previous studies [2,3] focused on brainstem, mid-latency, and cortical evoked response audiometry, we have shown that, when dealing with compensation claimants for professional noise-induced hearing loss, electrical response audiometry (ERA) techniques can provide a reliable hearing threshold level approximation. Furthermore, especially with cortical evoked response audiometry (CERA) or slow vertex responses (SVR), it is possible to define frequency-specific electrophysiological thresholds at 1, 2, and 3 kHz. As shown by comparison with cooperating subjects, the electrophysiological thresholds are correlated strongly

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with the psychoacoustic (perceptual) thresholds (shift of approximately 10 dB).

In current practice, apparently some subjects considered for objective definition of auditory thresholds by CERA daily take one of several neuroleptic, sedative, or hypnotic drugs. Wakefulness is well-known as an important condition for the reliability of SVR, especially when investigating thresholds [4–7]. As these drugs depress a wide range of cellular functions [8], they could be suspected to be able to perturb the CERA, even if the wakefulness is controlled during the investigation.

The need for some clinical data about this topic continues, because of its importance in medicolegal context. Moreover, it is not possible, in this context, to ask affected subjects to interrupt the intake of drugs for some period. If some effect is shown, a possibility of control should be sought.

## MATERIAL AND METHODS

### Subjects

We investigated 42 male subjects who had noise-induced hearing loss and submitted claims for compensation. Mean age was  $55.2 \pm 11.7$  years (maximum, 79; minimum, 34). No subject had middle-ear pathology or conduction hearing loss. All subjects were questioned carefully about the use of drugs; 15 subjects mentioned that they daily used neuroleptic or sedative or hypnotic drugs. They were compared with the 27 subjects who did not absorb such categories of drugs.

### Methods

In each subject, besides an exhaustive conventional liminar, supralimiar, and impedance audiometry, the CERA threshold was defined at 1, 2, and 3 kHz at each

ear. The criterion for CERA threshold was the lowest stimulus value (dB HL: steps of 10 dB) evoking an undoubted averaged response (i.e., the expected pattern unequivocally recognized on a superimposition of four displayed averaged ERA traces resulting from identical stimulations). So, in each ear and for each frequency, at least  $2 \times 4$  superimposed tracings of SVR were available for enlargement and analysis. Finally, the investigation was completed with a threshold definition using brainstem evoked response audiometry (BERA) [2,4].

### Material

Conventional and electrophysiological audiometric procedures (pure-tone audiometry, 125–8,000 Hz; air and bone conduction; test-retest; speech audiometry c.q. with and without hearing aids; impedance audiometry) were performed in a soundproof booth with a Madsen Orbiter 922 audiometer, a Madsen ZO 72 impedance audiometer, and an Interacoustics Békésy-audiometer.

For ERA, a Medelec Audiostar SM 273 88.1 ERA system was used with Madsen ERA electrodes. Subjects were placed in a relaxed, supine position, with the head resting on pillows. Minimizing neck movements is important to avoid muscle artifacts. Wakefulness was controlled permanently.

For SVR, a positive electrode was placed at the mastoid. Stimuli consisted of tone bursts (rise time, 25 msec; plateau time, 40 msec; fall, 25 msec) repeated at a rate of 1 Hz. The high and low filters were 1 and 30 Hz, respectively. Analysis time was 500 msec, and the number of sweeps was  $4 \times 256$  in separate tracings.

For BERA, a positive electrode was placed at the vertex. Clicks of 0.1-msec and at a repetition rate of 10 Hz were used. The high and low filters were 200 and

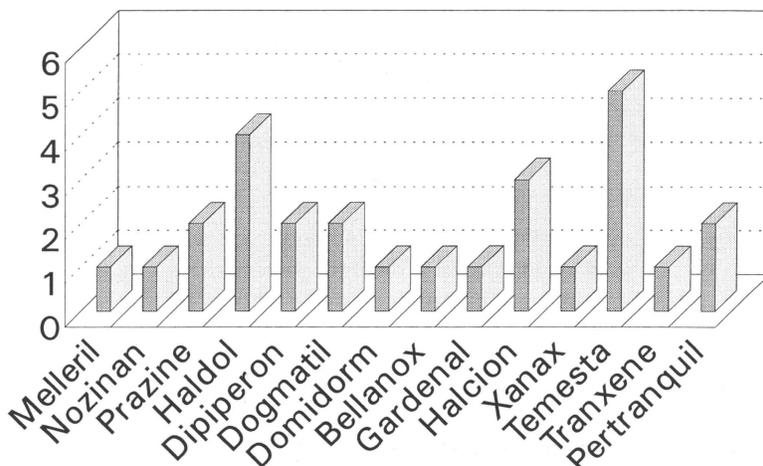
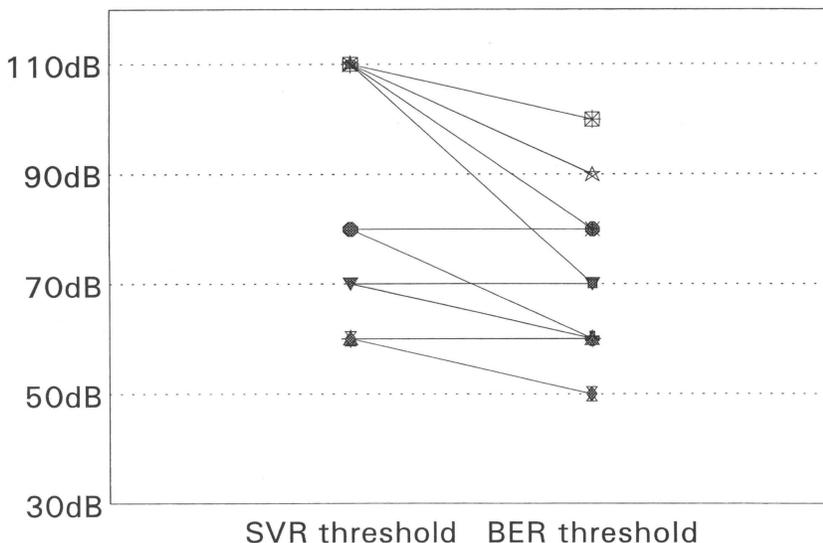


Figure 1. Drugs (neuroleptics, sedatives, hypnotics) involved in this study and the number of subjects using each (n = 15).



**Figure 2.** Differences between the slow vertex reflex (SVR) threshold (3 kHz) and the brainstem evoked response (BER) threshold in the group with drug intake (n = 15).

3 kHz, respectively. Analysis time was 10 msec, and the number of sweeps was 2,048 or 4,096.

**RESULTS**

No statistically significant difference ( $p = .05$ ) was seen between the two groups for the parameter age; mean values were 59.1 years for the group with drug intake and 53.8 years for the group without drug intake. The mean BERA threshold values are 76 dB in the first group and 83 dB in the second ( $p > .05$ , a nonsignificant difference).

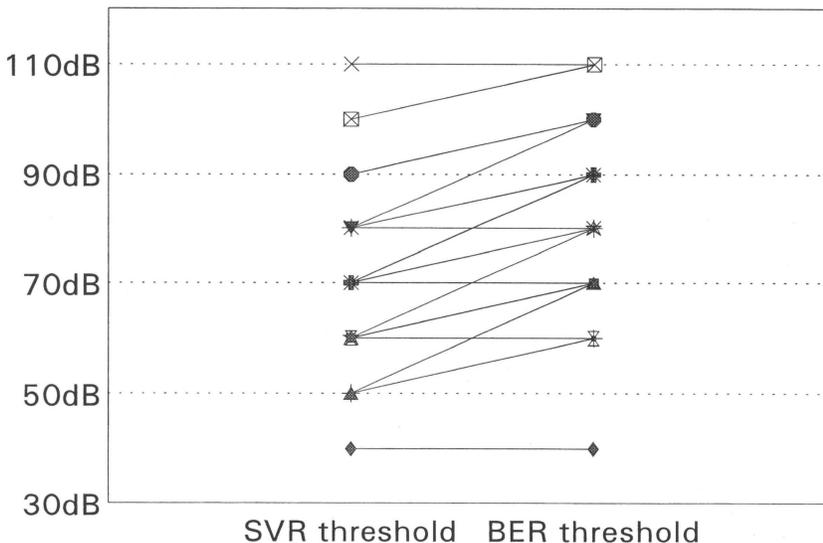
Figure 1 shows the concerned drugs and the number of subjects using each one. Figures 2 and 3 show the differences between the SVR threshold (3 kHz) and

the BER threshold in the two groups. Figure 4 shows the distribution of the threshold differences (BER, SVR, 3 kHz) in the two groups.

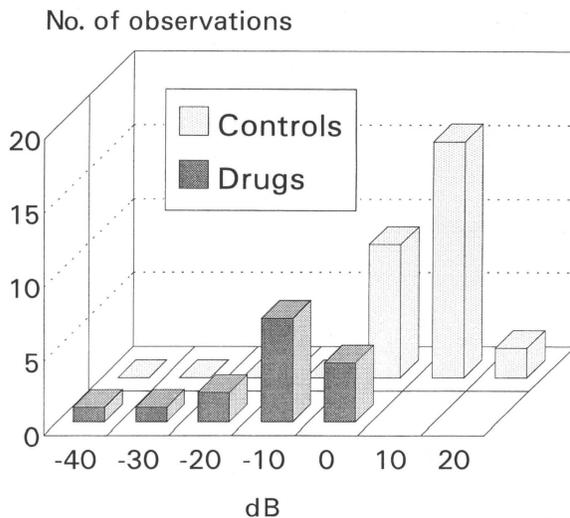
In case of drug intake, the average BER threshold is 12 dB lower than the SVR threshold on 3 kHz. In subjects without drugs, the average BER threshold is 7.8 dB higher than the SVR threshold on 3 kHz. The difference between both groups is highly significant ( $p < .0001$ ).

**DISCUSSION**

BER generally are considered a very stable and reliable signal: Drug intake levels below toxic limits have been found to have little or no effect on the response [4,5].



**Figure 3.** Differences between the slow vertex reflex (SVR) threshold (3 kHz) and the brainstem evoked response (BER) threshold in the control group (n = 27).



**Figure 4.** Distribution of the threshold differences (brainstem evoked response, slow vertex reflex, 3 kHz) in the two groups (one taking drugs, the other not).

The limit for medicolegal use (when psychoacoustic thresholds seem insufficiently reliable) is that one can only estimate hearing sensitivity in the frequency range of 3,000 Hz.

The sources of the SVR are believed to be the primary and secondary cortical projection areas in the temporal and parietal lobes of the cortex. Owing to neural branching as the auditory pathway is ascended, small numbers of peripheral active cells can elicit activity in very large numbers of more central units. The effective elementary potential sources are almost certainly synaptic and dendritic electric fields, which have a time course of many milliseconds [6]. Not surprisingly, awareness, attention, or state of consciousness may cause variability in the late components [4,7]. Drugs inducing sedation or sleep or, in a more general way, a central depressant action, thus may be expected to influence the SVR, especially near to the threshold of auditory sensation.

Our findings point out the presence of an average shift of approximately 20 dB for the SVR threshold when affected patients daily take one or more neuroleptic, sedative, or hypnotic drugs, with a further wide variation from one subject to the other. Effects of specific drugs cannot be identified in this study, owing to the limited number of subjects and to combined intake.

A limit remains, of course: the reliability of affected patients' anamnesis. Possibly, some subjects take such drugs without mentioning that fact. A control by blood analysis is, in this context, impossible. This means that SVR thresholds become unreliable as soon as patients take neuroleptic, sedative, or hypnotic drugs. The SVR

threshold value on 3,000 Hz must be checked systematically with a BERA investigation in one ear.

In case of drug intake, the modified technique of BERA, as proposed by Frattali et al. [9], and permitting a more accurate determination of hearing threshold at 1,000 and 2,000 Hz, possibly will permit the avoidance of the influence of neuroleptics, sedatives, and hypnotics.

## CONCLUSIONS

SVR threshold definition for medicolegal purposes (when patients are unwilling to respond accurately during behavioral audiometric testing) becomes unreliable as soon as affected patients take neuroleptic, sedative, or hypnotic drugs. The SVR threshold value on 3,000 Hz must be checked systematically with a BERA investigation in one ear.

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