momentum increases their incidence, as we have proposed.

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# Identification of averaged auditory evoked potentials in man

SAYERS *et al.*[1,2], in their work on the Fourier analysis of averaged auditory evoked potentials (AEP) have suggested that suppositions for arithmetic averaging are violated, since there are no differences between the mean powers in the pre- and post-stimulus averaged potentials. Their results contradict the fact that the amplitudes of AEP seem much more pronounced in comparison with averaged spontaneous EEG activity.

Fourier analyses of averaged potentials (Fig. 1) show that the forms of both amplitude and phase spectra in the post-stimulus period, where the AEP can be seen, differ significantly from those in the pre-stimulus period, where no response occurs. The maximum in the amplitude spectra of post-stimulus averaged signals (the region of the AEP) with lower sound intensities diminishes and shifts to lower frequencies. In the pre-stimulus regions the amplitude and phase spectra always have irregular forms and lower amplitudes. Therefore, both the amplitude and the phase spectra are of importance in the objective detection of AEPs by Fourier analysis.

Further, the mean power ($P_{\bar{x}}$) of the post-stimulus averaged signal is higher than in a corresponding length of the pre-stimulus period (Table 1). This behaviour can be observed down to the hearing threshold in cases of low spontaneous EEG activity.

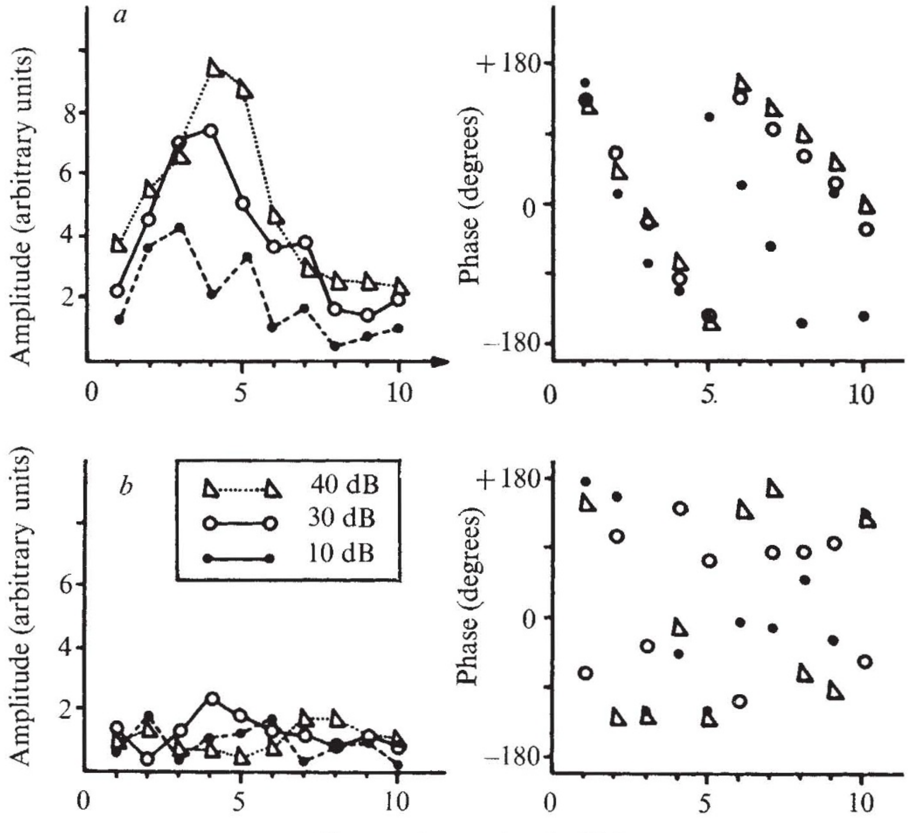


**Fig. 1** Normal hearing female adult, binaural stimulation with 1-kHz tone bursts of 300-ms duration and 8-ms rise–fall time; interstimulus interval 3.2 s, $n = 50$ averaging cycles. Parameter: sensation level; frequency interval between harmonics 0.98 Hz; connecting lines illustrate typical behaviour. *a*, Amplitude and phase spectra of averaged responses (post-stimulus periods, 0–1,023 ms after onset of stimulation). *b*, Amplitude and phase spectra of averaged spontaneous activity (pre-stimulus periods, 1,800–777 ms before stimulation). △, 40 dB; ○, 30 dB; ●, 10 dB.

To show that single AEPs consist of an additive contribution to the spontaneous EEG we evaluated the averaged power spectrum (by means of the sum of power spectra of the single EEG responses) for both pre- and post-stimulus periods. The mean power ($\bar{P}_{x_i}$) of pre- or post-stimulus electroencephalic activity can be calculated using this averaged power spectrum. The observed increase of $\bar{P}_{x_i}$ in the post-stimulus period (Table 1) is in agreement with the assumption of an additive superposition of the single AEPs to the spontaneous EEG (see ref. 3).

Averaging the squared single EEG responses, $x_i^2(t)$, gives the same result.

**Table 1** Mean power of averaged potentials ($P_{\bar{x}}$) and mean power ($\bar{P}_{x_i}$) of electroencephalic activity*

| 1 kHz dB | $P_{\bar{x}}$ 0–511† (ms) | $P_{\bar{x}}$ 512–1,023‡ (ms) | $\bar{P}_{x_i}$ 0–511† (ms) | $\bar{P}_{x_i}$ 512–1,023‡ (ms) |
|---|---|---|---|---|
| 10 | 101 | 22 | 70 | 50 |
| 30 | 398 | 18 | 77 | 55 |
| 40 | 600 | 17 | 88 | 58 |

*Arbitrary units, different for $P_{\bar{x}}$ and $\bar{P}_{x_i}$.
†Post-stimulus periods.
‡Pre-stimulus periods.
In interindividual comparisons the enhancement of $\bar{P}_{x_i}$ in the post-stimulus regions has been found down to 10 dB but statistically significant for dB values ≥30 dB (5% level of significance, *t*-test of compounded samples only.)

The evaluated mean square values

$$\overline{x^2(t)} = (1/n)\sum_{i=1}^{n} x_i^2(t)$$

are proportional to the mean power of the EEG. Because of an additive contribution of single responses to the spontaneous EEG an increase of the mean power in the region of the AEP is detectable down to 20 dB.

Using the mean square values $\overline{x^2(t)}$ it is possible to calculate the standard deviation $s(t)$ of the AEPs. In this way the statistical significance of registrated AEPs can be evaluated without using the Fourier method[2] with its more complex problems of utilisation.

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