Evaluation of the magnitude and phase of sweep-visual evoked potentials.

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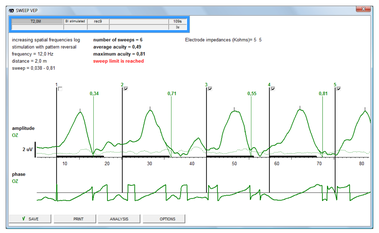
Introduction

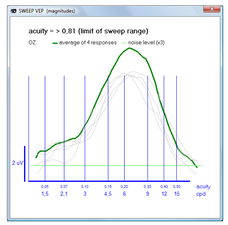
Sweep visual evoked potentials (SVEP) is a promising technique for the assessment of visual acuity in non-cooperative patients. However several studies have shown the presence in a significant number of subjects of a reduction of the response amplitude ("notch") at intermediate spatial frequencies (Tyler & al, 1978, Joost & Bach, 1990). The presence of such a "notch" is surprising as it occurs in a range of spatial frequencies where contrast sensitivity is far from threshold. Several interpretations have been given based on a destructive summation of signals from different generators: cancellation of responses from higher and upper hemifields (Regan, 1977), cancellation of responses from the parvo and magnocellular systems (Strasburger & al, 1986). The purpose of the present study was to evaluate if the reduction of amplitude observed during sweep VEPs was related to a change in phase of the response.

Methods

SVEP records from 16 subjects presenting a notch were analyzed. The sweeps were performed with a checkerboard pattern reversing at a frequency of 12 Hz. The spatial frequency was progressively changed during the sweep from 0.6 CPD to 9 CPD with a logarithmic progression. The duration of the sweep was 12 seconds and a Digital Fourier Transform (DFT) was performed over a sliding time window. A vector average was calculated over the different sweeps recorded from each subject and the resulting magnitude and phase were plotted for the 2nd (12Hz) harmonic.

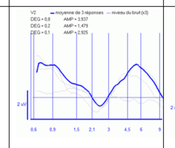
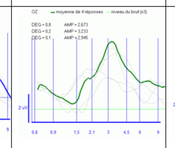
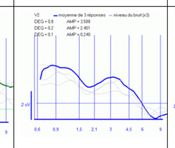
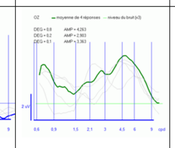
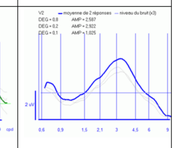
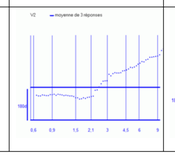
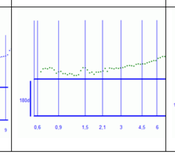
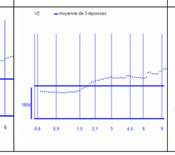
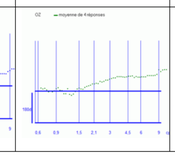
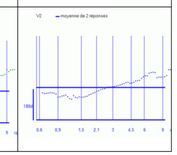


Magnitude and phase plot versus time showing 5 sweep responses

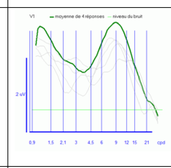
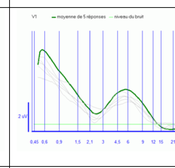
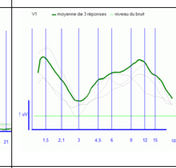
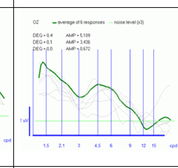
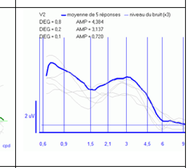
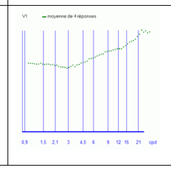
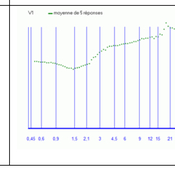
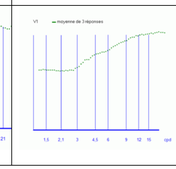
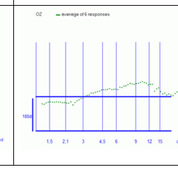
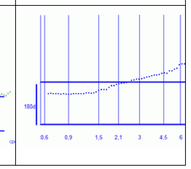


Vector average case without "notch"

Results

Subject	Bot.	Bla.	Bro.	Stev.	Urv
Age	7	11	28	8	15
Magnitude plot					
Phase plot					

An amplitude notch was found between 1.5 and 3 CPD. It was systematically correlated with the beginning of the phase shift with spatial frequency, the phase being typically constant for spatial frequency below the notch and increasing at a constant rate above that frequency.

Subject	Aurélie	Hélène	Sébastien	Katiane	Aufray
Age	22	22	30	24	46
Magnitude plot					
Phase plot					

Simulation

**A numerical simulation pas performed with SCILAB software to evaluate the effect of phase changes on the magnitude of the response. The input was a sinusoidal signal with a constant amplitude.
An increase of the phase of the input at a constant rate does not affect the magnitude calculated by the DFT as it is equivalent to a shift of frequency (provided that the phase shift is not too fast compared to the frequency resolution). However, when the phase start changing, a reduction of magnitude quite similar to the one found in the results from patients is found.**

Conclusions

This result gives a new possible interpretation for the notch found in SVEP responses of some subjects. Destructive interference between different sources may not be the only cause of amplitude reduction at intermediate spatial frequencies. This reminds us that we need to be careful about the use of DFT analysis when signals are not linear. It also suggests that new algorithms taking into account phase changes may be more appropriate to analyze SVEP responses.

References

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Author disclosure block

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