RELATIONSHIP BETWEEN ANNOYANCE AND BRAIN ACTIVITIES

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Introduction To obtain a basic knowledge of the temporal aspect of the human brain and the environment, studies have been carried out using magnetoencephalography (MEG) [1, 2]. MEG is a noninvasive technique for investigating neuronal activity in the living human brain. In MEG studies, the weak magnetic fields produced by electric currents flowing in neurons are measured with multichannel SQUID (superconducting quantum interference device) gradiometers with which many interesting properties of the working human brain can be studied [3]. To investigate human brain responses that correspond to annoyance for bandpass noise, MEG measurements and analysis by autocorrelation function (ACF) were carried.

Methods The scale values of annoyance were obtained by the paired-comparison. Six subjects participated in the experiment. Each trial consisted of pure tone (1000 Hz) and bandpass noise. The center frequency of the bandpass noise was 1000 Hz and the bandwidth was varied at five levels (0, 40, 80, 160, and 320 Hz) using a 2000 dB/octave sharp filter. All stimuli were fixed at the same sound pressure level. The duration of the stimulus was 2.0 s. The stimulus was presented binaurally via silicon tubes and earpieces. The subjects were requested to judge which stimulus they perceived to be more annoying. The scale values of annoyance obtained from the six subjects are shown in Fig. 1. Different symbols indicate scale values obtained with different subjects. In MEG measurements, combinations of a reference stimulus (pure tone) and test stimuli (bandpass noise) were presented alternately 30 times at a constant 2 s interstimulus interval. The magnetic responses induced by the stimuli were recorded and analyzed by the ACF. The ACF provides the same information as the power spectral density of a signal. We calculated the effective duration of the normalized ACF, τ_e, defined by the time taken for the ACF envelope to reduce to ten percent of its original value, representing repetitive features within the signal itself. Eighteen channels in each hemisphere were selected for the ACF analyses.

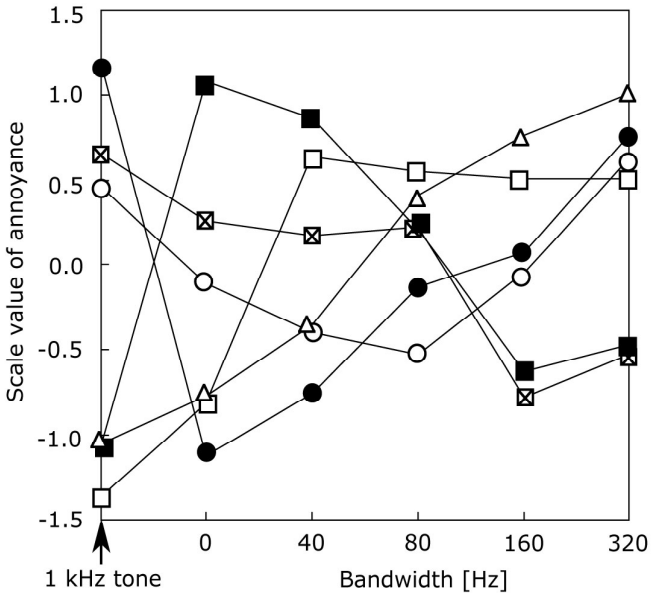

Fig. 1 Scale values of annoyance as a function of the bandwidth.

Results The results from the channel that signify the highest correlations between the scale values of annoyance and averaged τ_e values in 36 channels were discussed here. Relationship between the difference of scale values [SV(bandpass noise) to SV(pure tone)] and the ratio of τ_e values at bandpass noise to τ_e values at pure tone is shown in Fig. 2. Different symbols indicate different subjects. The ratio of τ_e in alpha-waves range (8-13 Hz) decreased with increasing the difference of scale value of annoyance. It indicates that the value of τ_e becomes shorter during presentations of annoying stimulus.

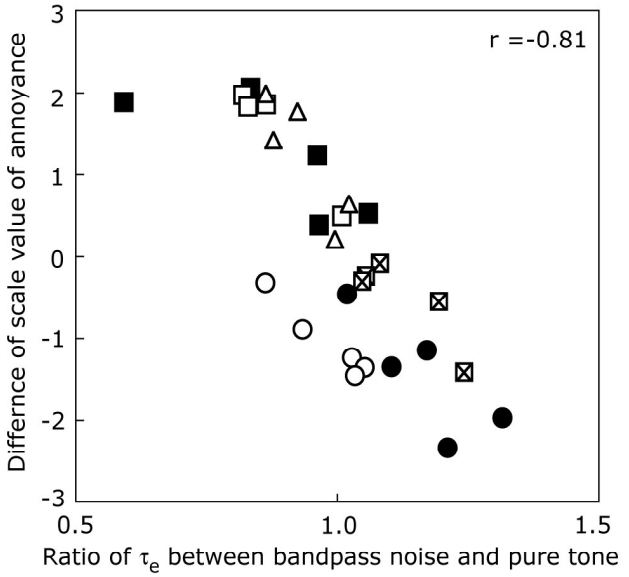

Fig. 2 Relationship between the difference of scale values of annoyance and the effective duration of the ACF, τ_e.

Discussion Our previous studies show that the τ_e in alpha-waves range becomes longer under preferred sound fields [1]. It indicates that the brain is repeating a similar rhythm under the preferred conditions. Then the shorter values of τ_e that appear for alpha waves indicate that the brain is unstable under annoying conditions.

Keywords: annoyance, magnetoencephalography (MEG), autocorrelation function (ACF)

References

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