

A Neural Network Based Analysis of the Electroencephalogram in Sleep Stage 2 Concerning the Elicitability of Evoked K-Complexes

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Aims

K complexes (KC) are beside spindles the most prominent signs of sleep in stage 2. Until now their significance is not fully understood and deviations from their normative features observed in polysomnography have still gained no clinical importance. KC seem to be elements of an arousal reaction mobilizing simultaneously also sleep protective processes. Therefore, we asked if the elicibility of evoked KC is depending on the cortical state which should be reflected by EEG characteristics in pre-stimulus-intervals (PSI). A precursory investigation of 16 subjects showed no differences of EEG power spectral densities in PSI. The aim of this work was to verify these results using more subjects and by an improved Neural Network methodology.

Methods

24 adults (13 women, 11 men; mean age: 25.3 years, SD 7.2, range 18-47) spent a single night in the laboratory. Pairs of tone clicks with an inter-stimulus-interval of 3 sec were presented every 20 to 30 sec randomly. Inside visually scored stage 2 four elicibility responses (00, 10, 01, 11) were classified regarding occurrence (1) or non-occurrence (0) of KC on first and second stimuli respectively. EEG of PSI was analyzed utilizing four different methods of spectral estimation and two different wavelet filter banks. Obtained parameters were put into a discriminant analysis utilizing five different types of Artificial Neural Networks.

Results

All in all 7,412 responses were analyzed. Elicibilities of KC responses vary largely: (59±18) % for 00, (9±3) % for 01, (23±10) % for 10 and (9±9) % for 11. Elicibility of KC on the second stimulus [(17±11) %] is lower than on the first [(32±17) %]. All different methods utilized for EEG analysis in PSI resulted same: there are no differences in spectral and wavelet parameters of the EEG in PSI when KC are occurring or not.

Conclusions

Elicibility of KC on the second stimulus is halved compared to the first stimulus; it is lower, when a KC is evoked by the first stimulus. But generally, elicibility is independent of EEG running before the stimulus. Cortical states reflected by characteristically EEG alterations are not verifiable. Decisions on eliciting KC seem to be generated in subcortical, probably thalamic, structures. Drastic reductions or the absence of spontaneous KC might give hints on malfunctions of subcortical structures. Further neurological - polysomnographic investigations might serve for supporting contributions.