

EYE BLINK RATE AS A PRACTICAL PREDICTOR FOR VIGILANCE S. R. Quartz*, M. Stensmo, S. Makeig[†] and T. J. Sejnowski Howard Hughes Medical Institute, The Salk Institute, 10010 North Torrey Pines Road, La Jolla, CA 92137, U.S.A. [†]Naval Health Research Center, P.O. Box 85122, San Diego, CA 92186, U.S.A.

Performance on signal detection tasks depends on a subject's state of alertness. We are developing methods to automatically assess the state of alertness of human subjects using electrooculogram (EOG) signals. Eye movements were monitored on human subjects in 28-minute sessions during which they responded to randomly-occurring targets (rate 10/min) consisting of barely audible noise-bursts. The responses were used to compute a local error rate (percent of recognized targets during the past minute). Ten subjects performed two or more experiments on different days. The vertical EOG (VEOG) signal was analyzed to extract eye closure and opening events, which were also translated into per minute rates. In an initial study only eye closure events were used. This simple measure of alertness nonetheless showed good correlation over the entire sessions to local error rate (max. -0.85). Further analysis of the VEOG showed that error rate was also correlated with amplitude and blink rate (where a blink is defined as an eye closure followed by an opening within 1 second). We trained a nonlinear neural network predictor on the first experiment session, and tested it by prediction of the local error rate from blink events on the second session, for six subjects with meaningful blink rate/performance correlations in both sessions. We were able to predict the local error rate of the subjects with an average accuracy of 0.176 ± 0.03 s.d. root-mean-square error. This was not significantly different from the accuracy of estimates based on spectral data from two channels of the electroencephalogram (EEG), 0.156 ± 0.05 s.d. Psychophysical experiments from other laboratories support our findings. However, our study is, so far as we know, the first in which eye blink data were used to predict as well as analyze error rates. A measure based on eye blinks, and also perhaps eye movements, could be used in a practical device to monitor the alertness of, e.g., sonar operators, truck drivers or air-traffic controllers.