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ERP Indicators of Objective and Subjective Disturbances Caused by Noise Impulses

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Our purpose was to evaluate certain electro-cortical events and their psychophysical relationships to levels and characteristics of noise of the kind generated by machine tools. These are intense brief noises, which we refer to as noise impulses. In the working environment they tend to give rise to stress, to subjective feelings of hindrance, disturbances of attention and increases in accidents.

Ten pink noise pulses were selected after subjective tests, as giving clear differences

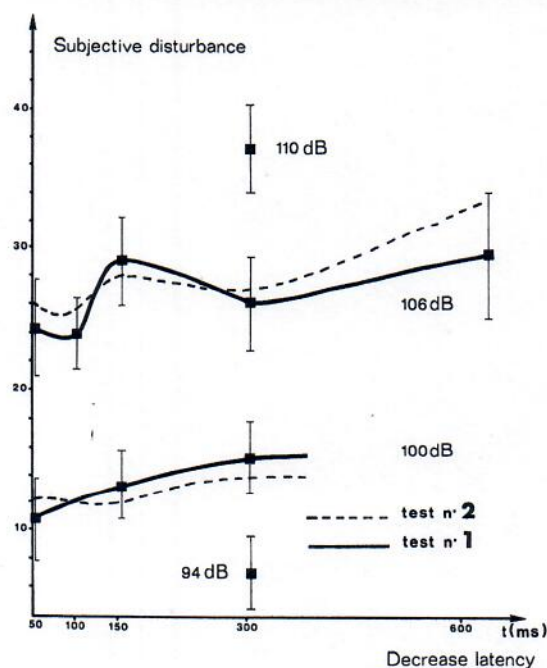


Fig. 1. Levels of subjective disturbance (on a scale of 0–50 arbitrary units) plotted for 10 forms of pink noise, rated by intensity and duration. The 10 noises in test 1 were extracted from a total of 25 pink noise bursts originally tested.

in the level of subjective disturbance (Paty et al. 1986). Initially (test 1) 25 paired noises, varying in intensity and duration, were scored by 35 subjects as being subjectively more (+2) or less (0) disturbing. These scores were used to compile a disturbance scale ranging from 0 to 50 (arbitrary units). The 10 noises selected for use as the warning stimulus in a CNV-RT paradigm were 94 dB, 300 msec; 100 dB, 50, 150, 300 msec; 106 dB, 50, 100, 150, 300, 600 msec; 110 dB, 300 msec. These 10 were further evaluated (test 2) in 12 subjects, normalisation of the scales being at the 94 dB, 300 msec and 110 dB, 300 msec points. Fig. 1 illustrates the curves obtained, which were similar to one another.

The imperative stimulus (S2), which followed S1 after an inter-stimulus interval of 2 sec, was the less disturbing noise. Trials occurred at pseudorandom intervals ranging from 10 to 20 sec. Recording was from electrodes located at F3, F4, Cz, P3 and P4, each referred to linked ears. Averages were computed and amplitude and latency measures made of N100, P200, N250 and P300 following both S1 and S2. Measures were also made of CNV amplitude, of alpha spectral power density before S1, immediately after S1 and after S2, and of RT.

Trends in RT and electro-cortical changes elicited by noise impulses were compared with subjective disturbance curves, using a two-way analysis of variance (ANOVA) to

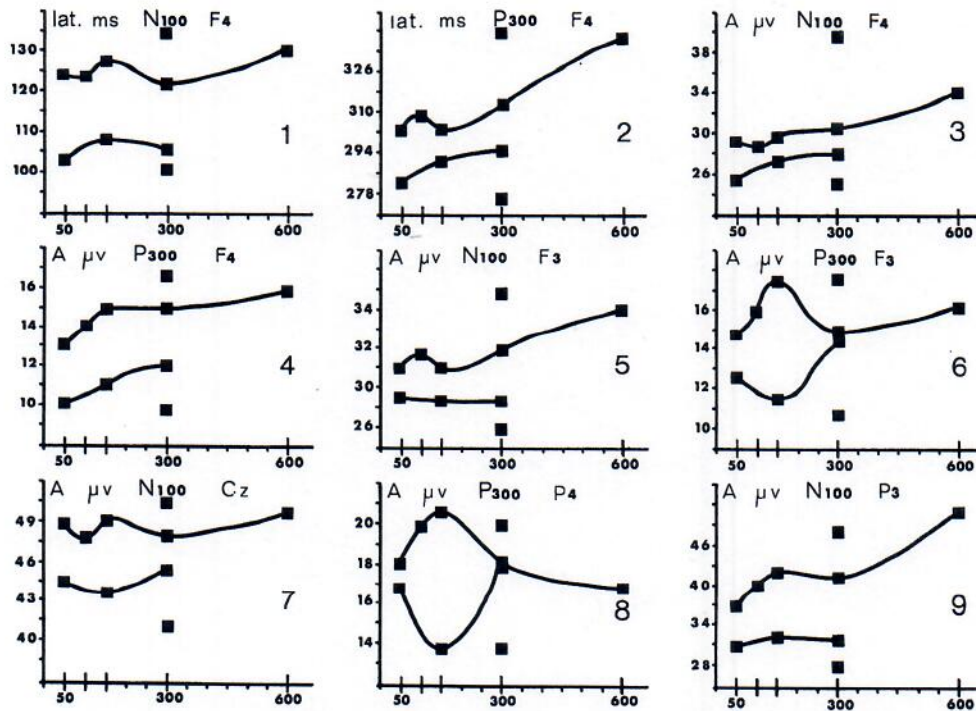


Fig. 2. Graphs of ERP amplitude and latency measures to the 10 forms of white noise. The 9 ERP measures illustrated are those showing a main effect for noise on the 2-way ANOVA and a Spearman rho coefficient of 1.0 when correlated with subjective disturbance level.

evaluate noise and subject effects and a Spearman non-parametric correlation was carried out to compare the subjective and objective tests.

Four CNV parameters showed a high correlation with subjective disturbance, but no significant main noise-effect on the ANOVA; these were at electrode F3: mean (negative) amplitude from 1450 to 1950 msec after S1; at electrode F4: mean (negative) amplitude from 750 to 1250 msec after S1; P3 amplitude to S2 and mean (positive) amplitude from 750 to 1250 msec after S2. Nine other (ERP) parameters, all related to S1, showed a significant main effect for noise on the ANOVA ($P < 0.05$) and a very high correlation with subjective disturbance (Spearman $\rho = 1.0$). They were N100 amplitude at electrodes F3, F4, Cz and P4; P300 amplitude at electrodes F3, F4 and P4 and N100 and P300 latency at electrode F4 (see Fig. 2).

On the basis of this evidence it seems to be possible to differentiate several electrocortical parameters which are related to physical characteristics of the sound stimuli and others which are related to the subjective consequences of the stimuli. The subjective feeling of disturbance appears to be associated primarily with ERP changes in frontal areas.

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