View onto alertness - objective assessment of central nervous activation level by pupillography

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This contribution gives an overview about the measurement of alertness by means of the pupillographic sleepiness test (PST). Those measurements are typically done in complete darkness. In an alert subject the pupils remain dilated in darkness and change less than 0.3 mm in their diameter. In case of sleepiness pupils begin slowly to constrict and to redilate, thus forming so called sleepiness waves. This phenomenon has been observed in the sixties by Lowenstein and Loewenfeld and was named fatigue waves. Today we know that not fatigue but sleepiness is the background of those pupillary changes in darkness.

In several papers our group (8, 10) and others (2) could show that the amount of those sleepiness waves correlated well with other measures of sleepiness, e.g. the time of sleep deprivation. The Pupil Unrest Index (PUI) has been introduced to quantify pupillographic sleepiness, best understood as the distance covered by a point on the pupillary margin during the 11 minutes lasting recording. The more waves and the higher their amplitudes, the higher is the amount of the PUI (4). Much work has been done to standardize the PST and to collect normal values in a large collective of adult normals. More recently, the feasibility of the PST in school pupils was proven.

It could be shown that patients with disorders like sleep apnea or narcolepsy have higher PUI than normals and that the treatment of sleep apnea reduces PUI (9). In studies on road houses at German highways pathologic sleepiness could be shown in a large amount of drivers, especially severe in professional truck drivers (7). Pharmacologic studies have been done (1), industrial medicine studies were done in physicians after night duty and in miners during extended shift duration (11).

The physiological background is a direct connection and control of the pupillary diameter by the alertness-promoting Locus Coerėleus. Recordings within the locus coeruleus in the primate model showed electrical activity that was well correlated with the changes in pupillary diameter (5,6).

The PST is an excellent method to assess alertness objectively in different settings: Sleep medicine and research, psychiatry (e.g. differentiation between depression and hypersomnia or sleep deficit), neurology, clinical pharmacology (sedative and alerting drug effects), industrial medicine and psychology. An important prerequisite is measurement in complete darkness, standardized conditions (quiet environment, no caffeine, no nicotine before the test) and a clear and standardized instruction. Given this, PST is a powerful and well evaluated test.

References


