

ABSTRACT

Eye tracking is a research method for tracking movement of the eyes. The method is widely used in qualitative studies which serve to determine areas of special interest to study subjects (e.g. marketing studies). Attempts at employing eye tracking to assess mental labour load reveal a number of inconsistencies and suggest that eye movement parameters depend on multiple factors which may affect measurements and interpretation, thereby hindering unambiguous assessment of workload related to mental labour in individual subjects.

The aim of the doctoral treatise was to investigate the thesis that eye movement parameters may be used to assess workload related to mental labour in individual subjects. To achieve this aim, the following experimental and real-life studies were used:

- repeatability of eye tracking parameters in individual study subjects;
- variations in the values of eye movement parameters depending on individual factors (gender, age and temperament);
- influence of work environment factors (information carrier size, time pressure and colour of light) on changes in the values of eye movement parameters;
- influence of eight-hour work (on the position of dispatcher, traffic controller and office worker) on changes in the values of eye movement parameters.

Values of eye movement parameters were set for the signal recorded using the SMI eye-tracking system (250 Hz) while the study subject was taking a Visual Perceptual Activity Test (VPAT), which simulated mental labour requiring perceptiveness, fast work pace and concentration. To assess the influence of work on the values of eye movement parameters, VPAT and eye tracking took place before and after the factor which occurs during simulated mental labour operated or before and after work on real-life positions. Research also involved assessment of the temperament factors (briskness, perseverance, sensory sensitivity, emotional reactivity, endurance and activity) in the subjects on the basis of the "Formal Characteristics of Behaviour – Temperament Questionnaire". To simulate work and assess its effectiveness, SUDOKU tables and the SuperOko programme were used.

Analysis of repeatability of eye tracking records has shown that subsequent records are repeatable, which means that eye movement parameter values observed while VPAT is being done may constitute the basis for assessment of mental labour load.

The studies and eye tracking records analyses show that the values of some of the eye movement parameters analysed vary, depending on the characteristics of individual subjects. These parameters include: fixation duration total (FDT), fixation dispersion maximum and minimum (FRX, FRM), saccade amplitude maximum and minimum (SAX, SAM) and saccade velocity maximum and minimum (SVX, SVM).

Mental labour with the use of different information carriers (10" tablet and 22" monitor) affects the values of the following eye movement parameters: blink duration average (BDA), fixation count and frequency (FC, FF), fixation duration average (FDA), fixation dispersion total (FRT), scanpath length (SPL), saccade count and frequency (SC, SF), saccade duration average (SDA), saccade amplitude total (SAT), saccade velocity total and average (SVT, SVA) and saccade latency average (SLA). This effect is more evident in the case of the stationary 22" monitor than for the 10" tablet.

Performing tasks at an imposed increasing work pace (time pressure) affects the characteristics of eye movement in study subjects in terms of the following parameters: blink frequency, fixation duration average and saccade frequency (BF, FDA and SF).

Results of studying the colour of light's impact during work allow to ascertain that they may result in changes in the values of the following parameters: blink count (BC), blink duration total, average and maximum (BDT, BDA, BDX), fixation count and frequency (FC, FF), fixation dispersion average (FRA), fixation dispersion total (FRT), saccade frequency (SF) and scanpath length (SPL). The direction of changes in values of these parameters varied, depending on the colour of the light.

Eight-hour mental labour (on the position of dispatcher, traffic controller and office worker), which is affected by a number of work environment factors operating simultaneously, results in: increased blink frequency (BF), increased blink duration total (BDT), decreased fixation count and frequency (FC, FF), extended scanpath length (SPL), increased saccade duration average and minimum (SDA, SDM) as well as decreased saccade velocity total and average (SVT and SVA).

On the basis of the studies conducted, the following categories of eye movement parameters have been defined: those dependent on characteristics of an individual only, those dependent on the work performed and characteristics of an individual, and those dependent on mental labour load only (and independent of characteristics of an individual). This enabled identification of eye movement parameters which may be used for assessment of mental labour load.

The studies have demonstrated that mental labour may be assessed using the following eye movement parameters: blink count and frequency (BC, BF), blink duration total, average and maximum (BDT, BDA, BDX), fixation count and frequency (FC, FF), fixation duration average and maximum (FDA, FDX), fixation dispersion average and total (FRA, FRT), scanpath length (SPL), saccade count and frequency (SC, SF), saccade duration average, maximum and minimum (SDA, SDX, SDM), saccade amplitude total (SAT), saccade velocity total and average (SVT, SVA) and saccade latency average (SLA). Of the aforementioned parameters, only those independent of characteristics of individuals may be used for intersubject (intergroup) comparison, i.e. BDT, BDX, FDX, SC, SF, SDA, SDX, SDM, SVT and SLA. Due to lower repeatability of the results, special caution should be exercised in drawing conclusions about the parameters related to blinking as well as maximum saccade and fixation values.

The results of the studies, the analysis thereof and the conclusions drawn support the hypothesis that eye movement parameters may serve to assess an employee's workload related to mental labour while selected eye movement parameters may constitute workload indices.