Simulated critical incidents: anaesthetists' experience, workload and visual attention

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Introduction

In a pilot study, eye tracking-based assessment of anaesthetists' visual attention and workload was investigated during simulated critical inci- dents1, 2. Pupil size reflected workload fluctuations within simulator sessions but did not allow workload comparisons between sessions or individuals1. Some evidence was found that work experience influences visual attention2. In the same trial, the unexperienced anaesthetists (group A) tended to rate workload higher than the experienced (group B) on Borg's Rating of Perceived Exertion Scale3. Because of different work- load ratings between unexperienced and experienced subjects, we hypothesized that the relative changes of the physiological workload indicators pupil diameter and heart rate from the beginning of the sce- nario to the peak of the critical incident were lower in the more experienced subjects. Moreover, the impact of the relative increase of the physiological workload indicators on visual attention was calculated.

Methods

Fifteen anaesthetists wore a mobile head-mounted eye tracker (Eye- SeeCam) during induction of anaesthesia with and without critical incident (anaphylaxis) in a full-scale simulator. The eye tracker consisted of cameras for measuring binocular eye positions and a gaze-driven camera. It recorded anaesthetists pupil diameter, heart rate and distribution of visual attention. The spatial resolution of this system is below 0.1 , and total accuracy is in the order of 0.5 . For the critical incidents, the relative increase of mean pupil size and heart rate between the beginning of the scenario and during severe ana- phylaxis was calculated. Post hoc video analysis revealed information about the anaesthetists distribution of visual attention between manual tasks, monitoring tasks and other. T-tests and multivariate tests were used for statistical analysis.

Results

Pupil size of twelve subjects (4 of group A, 8 of group B) and heart rate of ten subjects (3 group A, 7 group B) was analysed. Mean pupil diameter increase was 8.1 % (±2.2) in group A and 15.8 % (± 3.7) in group B (p = 0.191). Mean heart rate increase was 10.1 % (±3.1)) in

Table1

	Regression coefficient B for relative increase of	
	Pupil diameter	Heart rate
Manual tasks	0.48 ± 1.06 ($p = 0.668$)	0.77 ± 0.81 ($p = 0.385$)
Monitoring tasks	-0.50 ± 0.98 ($p = 0.632$)	-0.34 ± 0.81 ($p = 0.687$)
Other	0.02 ± 0.39 ($p = 0.963$)	-0.43 ± 0.26 ($p = 0.155$)

group A and 10.5 % (±3.1) in group B (p = 0.956). The impact of physiological workload indicators on visual attention was analysed for 7 subjects (3 of group A, 4 of group B). An increase of both pupil diameter and heart rate altered the temporal distribution of visual attention in the same way but none of these effects were significant (Table 1).

Discussion

The increase of pupil diameter tended to be more pronounced in the experienced subjects whereas no difference in heart rate increase could be detected. This was in contradiction to our assumption that increase of workload indicators is higher in unexperienced subjects. Interestingly, an increase of the workload indicators pupil diameter or heart rate coincided with an increase of the time dedicated to manual tasks and a decrease of the time dedicated to monitoring tasks. However, the sample size was very low and none of the effects was statistically sig- nificant. Nevertheless, the eye tracking-based combined assessment of anaesthetists' workload and visual attention in standardized simulator settings is a tool for the objective investigation of human factors in anaesthesia and can be used to investigate the effect of different anaesthesia machines and monitoring systems on workload and visual attention. Though, larger sample sizes are needed.

References

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