

# **Ergonomics– rok 2020, ročník 63**

## **Číslo 1**



**Kate O’Keeffe, Simon Hodder & Alex Lloyd. *A comparison of methods used for inducing mental fatigue in performance research: individualised, dual-task and short duration cognitive tests are most effective.* Pages: 1-12.**

Despite research indicating the negative impact that mental fatigue has on physical and cognitive performance, whether this is a result of mental fatigue or a state of under-arousal remains unclear. The current research aimed to explore the effectiveness of the methods being used to induce mental fatigue. Twelve participants attended six sessions in which two cognitive tests, the AX-continuous performance test (AX-CPT) and the TloadDback test, were compared for their effectiveness in inducing mental fatigue. Both tests were set at a standard processing speed (1.2 ms) for two conditions, and a further condition involved the individualisation of the TloadDback test. Participants presented significantly higher physiological and psychological arousal ( $p < 0.05$ ) in the individualised dual-task test compared to the AX-CPT. The individualised TloadDback test is a more effective method of inducing mental fatigue compared to the AX-CPT, as it sustains physiological arousal whilst inducing measurable reductions in mental resources. **Practitioner summary:** Mental fatigue negatively impacts physical and cognitive performance. It is unclear whether the current methods being used to induce mental fatigue are effective. This study compared different methods and confirmed that short, individualised and dual-task tests are most effective for inducing mental fatigue whilst maintaining arousal.

- **Keywords:** Mental fatigue, arousal, galvanic skin conductance, heart rate variability, cognitive loading

**Christin Gerhardt, Maria Undine Kottwitz, Tarsia Jana Lüdin, Dominique Gabriel & Achim Elfering. *Work and sleep quality in railway employees: an actigraphy study.* Pages: 13-30.**

This actigraphy study tests whether daily work stressors (time pressure, social stressors), work resources (control, social support) and mental detachment from work predict sleep quality, when controlling for demands and control after work. Fifty-two railway employees participated during five consecutive workdays by completing diary

questionnaires and wearing an actigraphy device. The results confirmed that social stressors from supervisors predicted more frequent sleep fragmentation and lower sleep efficiency the following night. Higher levels of daily time control at work predicted shorter sleep-onset latency and better self-reported sleep quality. Leisure time control as a covariate turned out to be a private resource, followed by fewer awakenings the following night. Detachment after work related negatively to social stressors and time pressure at work but was unrelated to indicators of sleep quality; detachment after work neither mediated nor moderated the relationship between social stressors from supervisors and sleep quality. Work redesign to increase time control and reduce social stressors is recommended to preserve daily recovery in railway employees. **Practitioner summary:** Sleep is important to renew health- and safety-related resources in railway employees. This diary and actigraphy study shows that higher daily work stressors were antecedents of lower sleep quality the following night, while more time control was followed by better sleep quality. Work redesign could promote health and safety by improving sleep quality.

- **Keywords:** Sleep, actigraphy, occupational health, time pressure, social stressors at work

**Daniel J. Yee, Mark W. Wiggins & Ben J. Searle. *Higher social cue utilisation improves communication, reduces perceived workload, and improves performance amongst ad hoc dyads in simulated rail control.* Pages: 31-47.**

The objective was to examine whether ad hoc dyads with different collective social cue utilisation would record differences in performance and perceptions of workload during a simulated rail control task that incorporated distinct levels of demand. The frequency of two types of communicative statements was also examined as mediating factors: closing the loop and informative responding. A quasi-experimental design was employed using 40 dyadic teams. The results indicated that ad hoc teams whose members comprised higher social cue utilisation recorded relatively faster response times and perceived lower levels of workload, and engaged in a greater frequency of communicative statements that involved 'closing the loop' and 'informative responses'. Social cue utilisation also exerted an indirect effect on perceived workload through informative responding. The outcomes have theoretical implications for models of ad hoc team performance, and practical implications for the selection and training of teams that operate on an ad hoc basis. **Practitioner summary:** This study indicates that, in the context of simulation tasks requiring teamwork, higher social cue utilisation amongst ad hoc team members is associated with communication, workload perception, and overall performance.

- **Keywords:** Individual differences, decision making, social cue utilisation, ad hoc teams, teamwork

**Daniel Sturman, Mark W. Wiggins, Jaime C. Auton & William S. Helton. *Cue utilisation predicts control room operators' performance in a sustained visual search task.* Pages: 48-60.**

This research was designed to determine whether qualified practitioners' cue utilisation is predictive of their performance during a sustained visual search task in an operational context. Australian Distribution Network Service Provider (DNSP) operators were recruited for two experiments, and were classified with either higher or lower cue utilisation based on an assessment of cue utilisation within the context of power distribution. Operators' performance was assessed using a domain-related sustained visual search task. In both experiments, power distribution operators with higher cue utilisation demonstrated shorter mean response latencies during the sustained visual search task, compared to operators with lower cue utilisation. Further, no differences in accuracy based on cue utilisation were observed during the sustained visual search task.

The results are consistent with the proposition that power operators with higher cue utilisation have a greater capacity to sustain visual search during domain-related tasks, compared to operators with lower cue utilisation. **Practitioner summary:** Power distribution system operators' cue utilisation was used to predict performance during a domain-related sustained visual search task. Power distribution operators with higher cue utilisation demonstrated shorter mean response latencies during the sustained visual search task, but no differences in accuracy, compared to operators with lower cue utilisation.

- **Keywords:** Cue utilisation, power distribution, sustained visual search, cognitive load

**David Rudi, Peter Kiefer & Martin Raubal. *The instructor assistant system (iASSYST) - utilizing eye tracking for commercial aviation training purposes. Pages: 61-79.***

This work investigates the potential of providing commercial aviation flight instructors with an eye tracking enhanced observation system to support the training process. During training, instructors must deal with many parallel tasks, such as operating the flight simulator, acting as air traffic controllers, observing the pilots and taking notes. This can cause instructors to miss relevant information that is crucial for debriefing the pilots. To support instructors, the instructor ASSistant SYSTem (iASSYST) was developed. It includes video, audio, simulator and eye tracking recordings. iASSYST was evaluated in a study involving 7 instructors. The results show that with iASSYST, instructors were able to support their observations of errors, find new errors, determine that some previously identified errors were not errors, and to reclassify the types of errors that they had originally identified. Instructors agreed that eye tracking can help identifying causes of pilot error. **Practitioner summary:** This paper introduces an instructor assistant system, which is evaluated in a user study involving 7 airline flight instructors. The system can be used by airline flight instructors to complement their observations, as a basis for discussions with pilots during debriefing, and by airline pilots to improve their flight performance.

- **Keywords:** Aviation, training, eye tracking, user study

**Greta Ontrup, Miriam Vogel, Oliver T. Wolf, Peter K. Zahn, Annette Kluge & Vera Hagemann. *Does simulation-based training in medical education need additional stressors? An experimental study. Pages: 80-90.***

The increased curricular integration of simulation-based training (SBT) in medical education is accompanied by researchers' calls to examine the effectiveness of SBT. We address conflicting results regarding effects of an added stressor on learning outcomes. In an experimental setting, one group of medical students (N = 20) performed cardiopulmonary resuscitation on a patient simulator. For a second group (N = 21) the scenario differed in that they encountered a defect defibrillator. We found participants of both groups to show increased biological stress-levels, independent of group allocation. Paradoxically, participants who encountered the equipment failure subjectively reported less stress. We discuss the implications of the comparable high stress levels in both groups with regards to future studies. We further discuss the result regarding subjective stress levels within the framework of attribution theory. **Practitioner summary:** The results of our experimental study underline the need for evidence-based choices of additional stressors for the design of simulation scenarios. We describe the choice of stimuli and setting in detail to maximise practical value for the construction of simulation-based medical trainings.

- **Keywords:** Simulation-based training, high-fidelity simulator, stress responses, performance, learning

**Tomoko Sugawara, Hiroyuki Sakai & Yutaka Hirata. *Vestibulo-ocular reflex characteristics during unidirectional translational whole-body vibration without head restriction*. Pages: 91-100.**

The vestibulo-ocular reflex (VOR) plays a crucial role in ocular stability. However, VOR characteristics under realistic whole-body vibration conditions, particularly without head restriction, remain unclear. The aim of this study was to characterise the VOR over a wide range of whole-body vibration frequencies (0.7–10 Hz), such as occur when driving a car. Eye and head movements were measured in response to unidirectional translational whole-body vibration that resembled actual vehicle vibrations. The VOR was then modelled by regressing eye velocity data on multiple head movement components. Results showed that the VOR was explained by angular velocity, linear acceleration, and linear jerk components of the head movements. Because the VOR in response to head linear-jerk components disrupted ocular stability in the current experimental setup, our results suggest that degraded vision in whole-body vibratory environments might be partially attributable to jerky head movements. **Practitioner summary:** The vestibulo-ocular reflex (VOR) during unidirectional translational whole-body vibration without head restriction was modelled using multiple head movement components, with the aim of characterising the VOR. Results showed that the VOR was explained by angular velocity, linear acceleration, and linear jerk components of head movements.

- **Keywords:** Ocular stability, whole-body vibration, vestibulo-ocular reflex, vision

**Jeff Matthew Barrett, Colin McKinnon & Jack P. Callaghan. *Cervical spine joint loading with neck flexion*. Pages: 101-108.**

Cervical spine flexion is a common posture for those using computers, tablets, and smartphones; the latter being dubbed 'text-neck' in recent years. Coincidentally, flexion has been flagged as a significant mechanical risk factor for the development of chronic neck pain. Unfortunately, few modelling endeavours have attempted to quantify the intervertebral joint loads throughout the cervical spine in flexion, while still accounting for muscular activation. Eight healthy male subjects undertook five trials beginning in a neutral posture, flexed to 45 degrees, and returned to a neutral posture. 3 D head-trunk angles and surface electromyography from 10 neck muscles (5 bilaterally) were used as inputs into an inverse dynamic cervical spine model based on a 50th percentile male to compute the compression and anteroposterior (AP) shear forces for this flexion task. In general, compression increases cranially to caudally throughout the cervical spine, but levels off at the C5-C6 level. Conversely, in a neutral posture, there is a constant 18 N of anterior shear at each joint level. Compression increased twofold throughout the cervical spine with flexion, whereas anterior shear increased fourfold in the upper cervical spine and dramatically decreased caudally. The dramatic change in joint kinetics provides some mechanical evidence for the role of posture and interplay with muscle activity in the development of chronic neck pain. Results from this study can reinforce the need for appropriate workstation and monitor configurations and support the increased loading hypothesised to occur in 'text neck' postures. **Practitioner summary:** The purpose of this investigation was to quantify the compression and shear forces in the neck in 45 degrees of flexion compared to neutral. Flexion increased compression throughout the cervical spine 1.6-fold compared to a neutral posture. In the upper cervical spine, AP-shear increased four-fold compared to neutral.

- **Keywords:** Flexion, text neck, compression, shear, neck

**Michael J. Tipton, Cristian Abelairas-Gómez, Adrian Mayhew & Gemma S. Milligan. *The thermal demands of flood rescue and impacts on task performance*. Pages: 109-118.**

The aim of this study was to determine the thermal demand of simulated Flood Rescue tasks and impacts on performance. Ten participants undertook two simulations: 'Cold' (4 °C) -participants stood in knee height moving water (4.8 km·h<sup>-1</sup>), with simulated wind and rain for 60 min. 'Warm' (20 °C) - participants performed 6x7 min walking in knee height moving water (3.2 km·h<sup>-1</sup>), pulling 10 kg. Grip strength, manual dexterity, and jump height were measured pre and post. The cold resulted in cooling of the great toe and finger (9.98 [0.84]°C and 10.38 [8.21–12.1] °C, respectively). Jump height, manual dexterity and grip strength fell by 20%, 22% and ~13%, respectively. In the 'Warm': heart rates were 157 (19)b·min<sup>-1</sup>, oxygen consumption 30.62 (7.83) mL.kg<sup>-1</sup>·min<sup>-1</sup>, and sweat loss 1.06 (0.31) L. There were no differences in the physical tests. Flood Rescue represents significant, but different, challenges. Remaining static in the cold resulted in peripheral neuromuscular cooling, whilst exercising in the warm resulted in a significant thermal challenge. **Practitioner Summary:** Little is known about the physical requirements, thermal profiles and optimum personal protective equipment for flood rescue. Flood rescue represents significant challenges. In the cold, emergency responders may be incapacitated by peripheral cooling. In the heat, they may be incapacitated by heat-related exhaustion. Consideration should be given to these risks.

- **Keywords:** Fitness, flowing water, personal protective equipment, technician