

## **Ergonomics– rok 2020, ročník 63**

### **Číslo 4**



**Ben D. Sawyer, Jonathan Dobres, Nadine Chahine & Bryan Reimer. [\*The great typography bake-off: comparing legibility at-a-glance\*](#). Pages: 391-398.**

Typography plays an increasingly important role in today's dynamic digital interfaces. Graphic designers and interface engineers have more typographic options than ever before. Sorting through this maze of design choices can be a daunting task. Here we present the results of an experiment comparing differences in glance-based legibility between eight popular sans-serif typefaces. The results show typography to be more than a matter of taste, especially in safety critical contexts such as in-vehicle interfaces. Our work provides both a method and rationale for using glanceable typefaces, as well as actionable information to guide design decisions for optimised usability in the fast-paced mobile world in which information is increasingly consumed in a few short glances. **Practitioner summary:** There is presently no accepted scientific method for comparing font legibility under time-pressure, in 'glanceable' interfaces such as automotive displays and smartphone notifications. A 'bake-off' method is demonstrated with eight popular sans-serif typefaces. The results produce actionable information to guide design decisions when information must be consumed at-a-glance.

- **Keywords:** Reading, attention, usability, font, glanceability

**Álvaro Bustamante-Sánchez & Vicente Javier Clemente-Suárez. *Psychophysiological response in night and instrument helicopter flights*. Pages: 399-406.**

Instrument and night flights are sources of mishaps: they produce stressful contexts to aircrews in which operability can be affected. This study aimed to analyse the effect of night and instrument flights in cortical arousal, autonomic modulation, muscle strength, and stress perception. 23 people were analysed (8 helicopter pilots, 4 helicopter mechanics – Spanish Air Forces – and 11 controls) before and after instrument and night flight exposition. Lactate and perceived exertion rose after flights. Anxiety was higher in instrument than in night flights. Pilots had a higher sense of anxiety before a flight compared to mechanics, although mechanics experienced a higher raise of heart rate during flight, with lower heart rate variability. Breath capacity was affected in pilots.

Cortical arousal was more affected in unexperienced than in experienced aircrew during flights. These data suggest differences in their previous training. **Practitioner summary:** Night and instrument helicopter flights produced a different psychophysiological response of aircrew. These results could help to design specific training for aircrew that usually face instrument and night manoeuvres. Specific training based on high-intensity interval training integrated with reverse periodisation could improve their preparation.

- **Keywords:** Pilot, psychophysiology, aircrew, stress, arousal

**Hammad Hussain Awan, Ali Pirdavani, Muhammad Adnan, Ansar-ul-Haque Yasar, Geert Wets & Tom Brijs. *Standard freeway merge designs support safer driver behaviour compared to taper designs: a driving simulator study.* Pages: 407-420.**

Road geometric design standards provide various possibilities for merging freeways with a decreasing number of lanes. In this study, an alternative design (i.e. taper design) is investigated and compared with the standard design under three different heavy vehicle compositions to understand driving performance in relation to the flow of traffic. Taper design is not always the first choice in the road geometric design guidelines and the designer has to provide arguments for selecting this design. Taper design and its comparison with other alternatives are also not well explored in literature. In this study, a driving simulator was used to examine and compare the performance of these two designs under different heavy vehicle compositions. Qualitative results showed that the perceived safety was better for the standard design compared to the taper design. Mean speed, acceleration, standard deviation of acceleration/deceleration, and cumulative lane changes were chosen as behavioural parameters to compare these two designs using MANOVA and repeated measures ANOVA. Results revealed that drivers' discomfort in performing merging manoeuvres was greatest in case of a taper design and when the percentage of heavy vehicles was moderate (15%). Overall, the standard design was found to be more favourable. **Practitioner summary:** Driving behaviour at merging freeways with a decreasing number of lanes is underexplored. We analysed safety in driving behaviour considering heavy vehicles for taper and standard designs provided in Dutch guidelines using a driving simulator. The standard design was found to be safer and the presence of moderate heavy vehicles caused more disturbances in driving behaviour.

- **Keywords:** Merging of freeways, taper design, heavy vehicles, vehicle compositions, driving behaviour, driving simulator

**Richard Pak, Jessica J. Crumley-Branyon, Ewart J. de Visser & Ericka Rovira. *Factors that affect younger and older adults' causal attributions of robot behaviour.* Pages: 421-439.**

Stereotypes are cognitive shortcuts that facilitate efficient social judgments about others. Just as causal attributions affect perceptions of people, they may similarly affect perceptions of technology, particularly anthropomorphic technology such as robots. In a scenario-based study, younger and older adults judged the performance and capability of an anthropomorphised robot that appeared young or old. In some cases, the robot successfully performed a task while at other times it failed. Results showed that older adult participants were more susceptible to aging stereotypes as indicated by trust. In addition, both younger and older adult participants succumbed to aging stereotypes when measuring perceived capability of the robots. Finally, a summary of causal reasoning results showed that our participants may have applied aging stereotypes to older-appearing robots: they were most likely to give credit to a properly functioning robot when it appeared *young* and performed a *cognitive* task. Our results tentatively

suggest that human theories of social cognition do not wholly translate to technology-based contexts and that future work may elaborate on these findings. **Practitioner summary:** Perception and expectations of the capabilities of robots may influence whether users accept and use them, especially older users. The current results suggest that care must be taken in the design of these robots as users may stereotype them.

- **Keywords:** Aging, stereotype, anthropomorphism, causal reasoning, human-robot interaction

**L. Reinerman, J. Mercado, J. L. Szalma & P. A. Hancock. *Understanding individualistic response patterns when assessing expert operators on nuclear power plant control tasks.* Pages: 440-460**

We evaluated the performance of three highly practiced participants on three task types that comprised a simulated nuclear power plant control operation. Multiple subjective, physiological, and objective performance measures were collected on these three highly-practiced individuals. Results indicated ceiling effects in terms of performance accuracy, yet each individual adopted a unique response strategy across the respective sub-tasks. Their maximised accuracy was achieved at the expense of longer response times across differing sub-tasks. The measures which proved diagnostic and predictive of performance capacity were explored. The current conclusion presents us with an invidious problem in that performance and workload associations, insensitivities, and dissociations may be unique to each individual operator, and may well depend also upon the overall task in context. Such findings push our science away from seeking nomothetic assertions and toward individuated concerns. In consequence, the age of the idiographic may well be upon us. **Practitioner summary:** The importance and relevance of nuclear power control is self-evident. Concerns here have centred around the safety of the technology and its operators. Our work informs practitioners in this industry, and in Ergonomics in general, of the response of highly trained individuals in these safety-critical, operational domains. We show that even experts engage in personal and individual strategies, an observation critical to the assessment of this specific workplace, and potentially all others.

- **Keywords:** Objective performance measurement, subjective response, physiological reactions, nuclear power plant control

**Amir Mehdizadeh, Alexander Vinel, Qiong Hu, Mark C. Schall Jr., Sean Gallagher & Richard F. Sesek. *Job rotation and work-related musculoskeletal disorders: a fatigue-failure perspective.* Pages: 461-476.**

Job rotation is an organisational strategy that can be used, in part, to reduce occupational exposure to physical risk factors associated with work-related musculoskeletal disorders (MSDs). Recent studies, however, suggest that job rotation schedules may increase the overall risk of injury to workers included in the rotation scheme. We describe a novel optimisation framework evaluating the effectiveness of a job rotation scheme using the fatigue failure model of MSD development and a case study with real injury data. Results suggest that the effect of job rotation is highly-dependent on the composition of the job pool, and inclusion of jobs with higher risk results in a drastic decrease in the effectiveness of rotation for reducing overall worker risk. The study highlights that in cases when high-risk jobs are present, job redesign of those high risk tasks should be the primary focus of intervention efforts rather than job rotation. **Practitioner summary:** Job rotation is often used in industry as a method to 'balance' physical demands experienced by workers to reduce musculoskeletal disorder (MSD) risk. This article examines the efficacy of reducing MSDs through job rotation

using numerical simulation of job rotation strategies and utilising the fatigue failure model of MSD development.

- **Keywords:** Job rotation, musculoskeletal disorders, fatigue-failure theory, optimisation

**Carl Mikael Lind, Mikael Forsman & Linda Maria Rose. [Development and evaluation of RAMP II - a practitioner's tool for assessing musculoskeletal disorder risk factors in industrial manual handling.](#) Pages: 477-504.**

RAMP II is an observation-based tool developed for assessing a wide range of musculoskeletal disorder risk factors related to industrial manual handling. RAMP II, which is part of the RAMP tool, is based on research studies and expert judgments. The assessment relies mainly on direct or video observations of the work being assessed, but additionally on measured push/pull forces and weights of handled objects, and on perceived workload and discomfort. Over 80 practitioners participated in the development of the tool. According to the evaluations, 73% of the assessment items evaluated had acceptable reliability, and the majority of the potential end-users reported that RAMP II is usable for assessing risks and as a decision base. It is concluded that this study provides support that RAMP II is usable for risk assessment of musculoskeletal disorder risk factors in industrial manual handling. **Practitioner summary:** RAMP II is an observation-based assessment tool for screening and assessing major musculoskeletal exposures in industrial manual handling jobs. Over 80 practitioners participated in the development of the tool. This study provides support that RAMP II is usable for risk assessment of musculoskeletal disorder risk factors in industrial manual handling.

- **Keywords:** The RAMP tool, risk assessment, screening, observation, musculoskeletal disorders

**Eric B. Weston, Alexander M. Aurand, Jonathan S. Dufour, Gregory G. Knapik & William S. Marras. *One versus two-handed lifting and lowering: lumbar spine loads and recommended one-handed limits protecting the lower back.* Pages: 505-521.**

The objectives of this study were to quantify loads imposed upon the lumbar spine while lifting/lowering with one versus two hands and to create guidelines for one-handed lifting/lowering that are protective of the lower back. Thirty subjects (15 male, 15 female) performed one- and two-handed exertions in a laboratory, lifting from/lowering to 18 lift origins/destinations using medicine balls of varying masses. An electromyography-assisted model predicted peak spinal loads, which were related to tissue tolerance limits to create recommended weight limits. Compared to two-handed exertions, one-handed exertions resulted in decreased spinal compression and A/P shear loading ( $p < 0.001$ ) but increased lateral shear ( $p < 0.001$ ). Effects were likely driven by altered moment exposures attributable to altered torso kinematics. Differences between spinal loads for one- versus two-handed exertions were influenced by asymmetry ( $p < 0.001$ ) and amplified at lower lift origin/destination heights, lower object masses and larger horizontal distances between the body and the load ( $p < 0.001$ ). **Practitioner summary:** A biomechanical model was utilised to compare spinal loading for one versus two-handed lifting/lowering. Spinal loads in compression and A/P shear were reduced for one-handed relative to two-handed exertions. As current lifting guidelines cannot appropriately be applied to one-handed scenarios, one-handed weight limits protecting the lower back are presented herein.

- **Keywords:** Low back, spine, maximum acceptable weight, occupational guidelines