Ergonomics– rok 2020, ročník 63

Číslo 7

Chongyang Wang, Liangchang Shen & Wenguo Weng. *Experimental study on individual risk in crowds based on exerted force and human perceptions*. **Pages: 789-803.**

Initial results suggest that decision support systems (DSSs) can trigger 'directed forgetting' in business settings if users trust in the DSS. In the present study, we further examined this trust effect on DSS-cued forgetting and related positive effects on users' cognitive resources, performance, and well-being. Moreover, we investigated how trust translates into behavioural intentions to use a DSS, and into actual usage of the DSS. Finally, we examined if risk-related framing of decision outcomes (loss vs. gain framing) moderates trust effects on directed forgetting and behavioural intentions. In line with our expectations, results of an experiment with $N = 200$ participants confirmed that trust significantly enhances directed forgetting, performance, and well-being. Behavioural intentions fully mediated the trust effect on DSS use. Framing of decision outcomes showed no moderation but a main effect on directed forgetting, with loss framing reducing the directed forgetting effect. **Practitioner summary:** This experimental study demonstrates the importance of trust in information systems to leverage positive effects of these systems on users' cognitive resources, performance, and well-being in a simulated complex business setting.

- ▪ **Keywords:** Directed forgetting, decision making, trust in technology, information quality, system quality

Erika Nelson-Wong, Kaitlin Gallagher, Elizabeth Johnson, Clare Antonioli, Abigail Ferguson, Staci Harris, Holly Johnson & James Blake Miller. *Increasing standing tolerance in office workers with standing-induced back pain*. **Pages: 804-817.**

Sit-stand desks are popular however many people have standing-induced low back pain (LBP). People with LBP have fewer standing weight shifts compared with back-healthy people. Participants were classified as standing-tolerant or intolerant. Participants were provided sit-stand desks for 12 weeks. Participants were assigned to intervention (graded standing exposure and exercise) or control (no instruction) conditions. Participants reported weekly sitting time and average/worst LBP. Standing weight shifts and LBP were

re-assessed post-intervention. All groups decreased sitting time (range: 30–50%) over 12 weeks. Sitting time and average LBP were correlated in all standing-intolerant individuals, worst LBP and sitting time were correlated for intervention group only. All standing-intolerant individuals increased standing weight shifts and decreased LBP after 12-weeks. Standing-intolerant individuals benefitted from 12-weeks of sit-stand desk use regardless of intervention. Motivated individuals with standing-induced LBP may increase standing tolerance with sit-stand desk use. Additional benefits may exist when structured guidance is provided. **Practitioner summary:** Many people are standing-intolerant due to low back pain (LBP). This lab and field-based study showed some benefits from structured approaches to gradually progress standing time when transitioning to standing work. Using a sit-stand desk for 12 weeks resulted in decreased LBP and sitting time in standing-intolerant people.

- **Keywords:** Standing work, low back pain, sedentary work, standing desks, standing intolerance

Kirsten Huysamen, Valerie Power & Leonard O'Sullivan. *Kinematic and kinetic functional requirements for industrial exoskeletons for lifting tasks and overhead lifting*. Pages: 818-830.

The aim of this study was to sample human kinematics and kinetics during simulated tasks to aid the design of industrial exoskeletons. Twelve participants performed two dynamic tasks; a simulated lifting task and an overhead lifting task. Based on the current data, to completely assist a worker with lifting loads up to 15 kg, hip actuators would need to supply up to 111 Nm of extensor torque at speeds up to 139°/s of extension velocity and 26°/s of flexion velocity. The actuators should allow the hip to extend to 11° and flex to 95°, and supply a power of 212 W. To completely assist workers lifting a 3 kg load overhead, actuators assisting shoulder flexion would need to supply up to 20 Nm of flexor torque at speeds up to 21°/s of extension velocity and 116°/s of flexion velocity. The actuators should also allow 67° of shoulder flexion and supply a power of 27 W. **Practitioner summary:** There is increasing interest in developing exoskeletons for industrial applications. This study details relevant kinetic and kinematic exposures for common production tasks, which can be used to inform functional requirements of industrial exoskeletons.

- **Keywords:** Exoskeleton, assistive robotics, kinematic and kinetic, industrial tasks

Liuxing Tsao, Maury A. Nussbaum, Sunwook Kim & Liang Ma. *Modelling performance during repetitive precision tasks using wearable sensors: a data-driven approach*. Pages: 831-849.

In modern manufacturing systems, especially assembly lines, human input is a critical resource to provide dexterity and flexibility. However, the repetitive precision tasks common in assembly lines can have adverse effects on workers and overall system performance. We present a data-driven approach to evaluating task performance using wearable sensor data (kinematics, electromyography and heart rate). Eighteen participants (gender-balanced) completed repeated cycles of maze tracking and assembly/disassembly. Various combinations of input data types and classification algorithms were used to model task performance. The use of the linear discriminant analysis (LDA) algorithm and kinematic data provided the most promising classification performance. The highest model accuracy was found using the LDA algorithm and all data types, with respective levels of 62.4, 88.6, 85.8 and 94.1% for predicting maze errors, maze speed, assembly/disassembly errors and assembly/disassembly speed. The presented approach provides the possibility for real-time, on-line and comprehensive monitoring of system performance in assembly-lines or similar industries. **Practitioner summary:** This paper proposed models the repetitive precision task performance using data collected from wearable sensors. The use of the LDA algorithm and kinematic data

provided the most promising classification performance. The presented approach provides the possibility for real-time, on-line and comprehensive monitoring of system performance in assembly lines or similar industries.

- **Keywords:** Performance modelling, wearable technologies, repetitive precision task, classification

Brooke R. Brisbine, Julie R. Steele, Elissa J. Phillips & Deirdre E. McGhee. *Breast and torso characteristics of female contact football players: implications for the design of sports bras and breast protection*. Pages: 850-863.

This study aimed to provide normative data characterising the breast size, breast position and torso size of female contact football players. 117 AFL, Rugby League, Rugby Union and Rugby 7s players attended a single testing session where a three-dimensional scan was taken of their naked breasts and torso. Dimensions relevant to the design of sports bras and breast protective equipment were then calculated from the scans. Several breast and torso characteristics of female contact football athletes differed to measurements reported for females in the general population and amongst the contact football codes. Designers and manufacturers of sports bras or breast protective equipment should consider the specific breast and torso dimensions of female contact football players to maximise the fit, comfort and efficacy of these garments. **Practitioner summary:** Using three-dimensional scanning, this study characterised the breast and torso size and shape of 117 female contact football players. These normative data should be used to improve the fit and comfort of sports bras and breast protective equipment for female contact football players.

- **Keywords:** Anthropometry, athletes, breast/anatomy and histology, equipment design, imaging three-dimensional/methods, protective equipment

Ben D. Sawyer, Benjamin Wolfe, Jonathan Dobres, Nadine Chahine, Bruce Mehler & Bryan Reimer. *Glanceable, legible typography over complex backgrounds*. Pages: 864-883.

Modern digital interfaces display typeface in ways new to the 500 year old art of typography, driving a shift in reading from primarily long-form to increasingly short-form. In safety-critical settings, such at-a-glance reading competes with the need to understand the environment. To keep both type and the environment legible, a variety of 'middle layer' approaches are employed. But what is the best approach to presenting type over complex backgrounds so as to preserve legibility? This work tests and ranks middle layers in three studies. In the first study, Gaussian blur and semi-transparent 'scrim' middle layer techniques best maximise legibility. In the second, an optimal combination of the two is identified. In the third, letter-localised middle layers are tested, with results favouring drop-shadows. These results, discussed in mixed reality (MR) including overlays, virtual reality (VR), and augmented reality (AR), considers a future in which glanceable reading amidst complex backgrounds is common. **Practitioner summary:** Typography over complex backgrounds, meant to be read and understood at a glance, was once niche but today is a growing design challenge for graphical user interface HCI. We provide a technique, evidence-based strategies, and illuminating results for maximising legibility of glanceable typography over complex backgrounds.

- **Keywords:** Perception, vision and lighting, environmental ergonomics, information displays, human-machine systems, mixed reality virtual environments human-computer interaction

Shaoyao Zhang, Yu Tian, Chunhui Wang & Kunlin Wei. *Target selection by gaze pointing and manual confirmation: performance improved by locking the gaze cursor*. Pages: 884-895.

Eye movement-based human-computer interactions are emerging in diverse scenarios. When selecting targets on a user interface, the method of combining fast gaze pointing with reliable manual action is becoming increasingly popular. However, this method suffers from noise in gaze pointing caused by eye jitters and users' habitual early move-away of gaze before manual actions. Here we propose a novel solution to mitigate these problems by locking the gaze cursor at the target for imminent manual selection. We compared this gaze-lock cursor with a conventional gaze cursor in a typing task with varying key sizes and key gaps. Results show that typing performance was significantly better with larger key size and gap. More importantly, the gaze-lock cursor significantly increased speed and decreased errors when compared to a conventional gaze cursor. Our findings demonstrate that the gaze-lock cursor is a promising tool for gaze interactions involving frequent target selections. **Practitioner summary:** Target selection by gaze pointing and manual confirmation suffers from eye jitters and users' habitual early move-away of gaze before manual actions. The performance of this method can be improved by applying the gaze-lock cursor we proposed, increasing target size or increasing the target gap.

- **Keywords:** Eye tracking, human-computer interaction, gaze cursor, eye jitters

Yi Ding, Yaqin Cao, Vincent G. Duffy, Yi Wang & Xuefeng Zhang. *Measurement and identification of mental workload during simulated computer tasks with multimodal methods and machine learning*. Pages: 896-908.

This study attempted to multimodally measure mental workload and validate indicators for estimating mental workload. A simulated computer work composed of mental arithmetic tasks with different levels of difficulty was designed and used in the experiment to measure physiological signals (heart rate, heart rate variability, electromyography, electrodermal activity, and respiration), subjective ratings of mental workload (the NASA Task Load Index), and task performance. The indices from electrodermal activity and respiration had a significant increment as task difficulty increased. There were no significant differences between the average heart rate and the low-frequency/high-frequency ratio among tasks. The classification of mental workload using combined indices as inputs showed that classification models combining physiological signals and task performance can reach satisfying accuracy at 96.4% and an accuracy of 78.3% when only using physiological indices as inputs. The present study also showed that ECG and EDA signals have good discriminating power for mental workload detection. **Practitioner summary:** The methods used in this study could be applied to office workers, and the findings provide preliminary support and theoretical exploration for follow-up early mental workload detection systems, whose implementation in the real world could beneficially impact worker health and company efficiency.

- **Keywords:** Mental workload, multi-modal measures, psychophysiology, machine learning, workload classification

Sarah M. Meeßen, Meinald T. Thielsch, Dennis M. Riehle & Guido Hertel. *Trust is essential: positive effects of information systems on users' memory require trust in the system*. Pages: 909-926.

Initial results suggest that decision support systems (DSSs) can trigger 'directed forgetting' in business settings if users trust in the DSS. In the present study, we further

examined this trust effect on DSS-cued forgetting and related positive effects on users' cognitive resources, performance, and well-being. Moreover, we investigated how trust translates into behavioural intentions to use a DSS, and into actual usage of the DSS. Finally, we examined if risk-related framing of decision outcomes (loss vs. gain framing) moderates trust effects on directed forgetting and behavioural intentions. In line with our expectations, results of an experiment with $N = 200$ participants confirmed that trust significantly enhances directed forgetting, performance, and well-being. Behavioural intentions fully mediated the trust effect on DSS use. Framing of decision outcomes showed no moderation but a main effect on directed forgetting, with loss framing reducing the directed forgetting effect. **Practitioner summary:** This experimental study demonstrates the importance of trust in information systems to leverage positive effects of these systems on users' cognitive resources, performance, and well-being in a simulated complex business setting.