

## **Ergonomics– rok 2019, ročník 62**

### **Číslo 11**



**Juergen Sauer, Sven Schmutz, Andreas Sonderegger & Nadine Messerli. *Social stress and performance in human-machine interaction: a neglected research field.* Pages: 1377-1391.**

Given the increasing capabilities of highly automated systems, the article argues for a need to address the issue of social stress in human-machine interaction. It suggests a classification system of subordinate concepts found in the research literature under the heading of social stress. A review of the literature revealed a paucity of studies examining the effects of social stressors on performance. In particular, the review showed a shortage of experimental lab-based work, needed to establish clear cause-effect relationships. The article examined the suitability of different social stressors for lab-based research, not only when humans are the source of stress but also in so-called hybrid teams where social stress is caused by machine agents. The review shows that a closer link is needed between the separate literature on social stress and automation. Finally, three mechanisms are proposed that may predict how social stress may affect performance: 'blank-out'-mechanism, 'rumination'-mechanism, and 'increased-motivation'-mechanism. **Practitioner summary:** Theories of ergonomics and human factors may benefit from better integration of research and theoretical work in the domain of social stress. This is due to the increasing capabilities of machines to induce social stress.

- **Keywords:** Social stress, performance, laboratory research, automation, human-machine interaction

**Gisele C. Gotardi, Gabriel K. Kuga, Rafael O. Simão, Matheus B. Brito, Gabriel P. Paschoalino, Gustavo A. Silva, Fabio A. Barbieri, Paula F. Polastri, Paulo Schor, Martina Navarro & Sergio T. Rodrigues. *Combining experiences of race gaming and natural driving affects gaze location strategy in simulated context.* Pages: 1392-1399.**

The aims of the study were to investigate the effects of race gaming experience in playing racing video games on gaze behaviour and performance of drivers and the effects of natural driving experience on gaze behaviour and performance of gamers. Thirty

participants, divided into drivers-gamers, drivers-non-gamers and non-drivers-gamers, were asked to drive in a race circuit as fast as possible while their eye movements were recorded. Drivers-gamers spent more time looking at the lane than non-drivers-gamers. Furthermore, drivers-gamers performed greater number of fixations towards the speedometer and showed faster performance in the racing task than the drivers-non-gamers. Combining natural driving and race gaming experiences changed the gaze location strategy of drivers. **Practitioner summary:** Racing video games practitioners have high propensity to exhibit attitudes and intentions of risky driving behaviour. Combining natural driving and race gaming experiences affects gaze behaviour strategy of drivers.

- **Keywords:** Racing video games, ergonomics, visual search, virtual environment

**Iolanda Fiorillo, Silvana Piro, Shabila Anjani, Maxim Smulders, Yu Song, Alessandro Naddeo & Peter Vink. *Future vehicles: the effect of seat configuration on posture and quality of conversation.* Pages: 1400-1414.**

The percentage of passengers that prefer travelling in groups is increasing. In most vehicles, passengers sit side by side and need to turn their body to be engaged in the conversation with their fellow travellers. However, rotating the body could lead to discomfort which influences conversation quality. The aim of this research is to study the effect of seat configuration on the (dis)comfort experience, conversation quality and posture. Experiments in which participants were asked to talk to each other while sitting at the same distance (1 m) were conducted in four seating arrangements (with seat-belts on), where the angle between the forward directions of two seats were positioned at 0° (side by side), 22.5°, 90° and 120° (almost opposite each other), respectively. Optical tracking has been deployed and the collected data were processed with MatLab® to acquire postural angles over time. Questionnaires were also used to evaluate the perceived (dis)comfort and the quality of the conversation. Experiment results indicate that the 120° configuration scored the best in the overall comfort and the quality of conversation, but only slightly better than the 90° configuration. **Practitioner summary:** Seating side by side is not optimal to have a comfortable conversation with your seatmate. To improve comfort and quality of conversation in future vehicles, we tested four seating arrangements analysing the effect of seat layout on (dis)comfort experience. Statistical analysis of objective and subjective data shows the optimal configuration for a comfortable conversation.

- **Keywords:** Comfort, seating arrangement, conversation quality, seat layout, vehicle design

**Ryan David Greene, Mona Frey, Samareh Attarsharghi, John Charles Snow, Matthew Barrett & Diana De Carvalho. *Transient perceived back pain induced by prolonged sitting in a backless office chair: are biomechanical factors involved?* Pages: 1415-1425.**

It is not currently known if biomechanical factors contribute to low back pain (LBP) during prolonged sitting. Thus, this study recruited 90 participants (61 with no history of LBP, and 29 with) to sit for 1 hour where back electromyography, spine posture, and perceived pain ratings (PPR) were collected. Participants were classified as Pain Developers (PD) or Non-Pain Developers (NPD) based on their maximum PPR. PDs had significantly higher PPR ( $p = 0.000$ ) and lower number of spine fidgets ( $p = 0.004$ ) than NPDs. There was a significant interaction between clinical health history and pain group ( $p = 0.037$ ) for PPR. Besides fidget frequency, there were no biomechanical differences between pain groups. Therefore, sitting-induced back pain does not appear to be due to posture or muscle activity; however, it may be related to micro-movement strategies. Future work should explore fidgeting further and whether healthy PDs are at risk for clinical LBP in the

future. **Practitioner summary:** We have replicated the differential transient sitting-induced pain response observed in previous studies. Pain developers do not sit differently than non-pain developers, although they do appear to move less. More research is warranted to better understand these groups and the relationship between pain developers and future cases of back pain.

- **Keywords:** Sitting, spine biomechanics, back pain, office chair, perceived pain

**Tyson A. C. Beach, David M. Frost, Jackie D. Zehr, Samuel J. Howarth, Stuart M. McGill & Jack P. Callaghan. *Spine loading during laboratory-simulated fireground operations – inter-individual variation and method of load quantification.* Pages: 1426-1438.**

Spine loading data are needed to design low-back health-preserving ergonomic interventions for firefighters. Study objectives were to quantify spine loads during simulated fireground operations using simple (polynomial) and advanced (EMG-assisted musculoskeletal model) methods and to describe the variation in spine loads between performers (N = 20). Spine compression forces differed by as much as 5.5 times bodyweight between individuals performing identical tasks. Anteroposterior and mediolateral shear forces varied by as much 3.2 and 2.1 times bodyweight between individuals performing the same tasks, respectively. Large variations in spine load magnitudes were documented regardless of whether simple or advanced quantification methods were used. Results suggest that low-back loading demands on the fireground would vary widely depending on the physical characteristics of individual firefighters, movement strategies employed, and tasks performed. Thus, personalised ergonomic interventions are warranted to regulate spine loading and load tolerance in firefighters.

**Practitioner summary:** Even when performing the same work, the associated spine loading demands will vary widely across people due to differences in their body sizes, shapes, and movement strategies. Therefore, personalised interventions are needed to regulate spine loading and load tolerance in workers (e.g. obesity prevention, physical capacity-building exercise, and movement [re]training).

- **Keywords:** Injury prevention, firefighters, motor behaviour, biomechanics, low-back disorders

**Mark A. Faghy & Peter I. Brown. *Functional training of the inspiratory muscles improves load carriage performance.* Pages: 1439-1449.**

Inspiratory Muscle Training (IMT) whilst adopting body positions that mimic exercise (functional IMT; IMT<sub>F</sub>) improves running performance above traditional IMT methods in unloaded exercise. We investigated the effect of IMT<sub>F</sub> during load carriage tasks. Seventeen males completed 60 min walking at 6.5 km·h<sup>-1</sup> followed by a 2.4 km load carriage time-trial (LC<sub>TT</sub>) whilst wearing a 25 kg backpack. Trials were completed at baseline; post 4 weeks IMT (consisting of 30 breaths twice daily at 50% of maximum inspiratory pressure) and again following either 4 weeks IMT<sub>F</sub> (comprising four inspiratory loaded core exercises) or maintenance IMT (IMT<sub>CON</sub>). Baseline LC<sub>TT</sub> was 15.93 ± 2.30 min and was reduced to 14.73 ± 2.40 min (mean reduction 1.19 ± 0.83 min, *p* < 0.01) after IMT. Following phase two, LC<sub>TT</sub> increased in IMT<sub>F</sub> only (13.59 ± 2.33 min, *p* < 0.05) and was unchanged in post-IMT<sub>CON</sub>. Performance was increased following IMT<sub>F</sub>, providing an additional ergogenic effect beyond IMT alone. **Practitioner Summary:** We confirmed the ergogenic benefit of Inspiratory Muscle Training (IMT) upon load carriage performance. Furthermore, we demonstrate that functional IMT methods provide a greater performance benefit during exercise with thoracic loads.

- **Keywords:** Inspiratory muscle training, functional training, exercise performance, load carriage

**Anna M. West, James Tarrier, Simon Hodder & George Havenith. *Sweat distribution and perceived wetness across the human foot: the effect of shoes and exercise intensity*. Pages: 1450-1461.**

This study investigates foot sweat distribution with and without shoes and the relationship between foot sweat distribution and perceived wetness to enhance guidance for footwear design. Fourteen females performed low-intensity running with nude feet and low- and high-intensity running with shoes (55%VO<sub>2max</sub> and 75%VO<sub>2max</sub>, respectively) on separate occasions. Right foot sweat rates were measured at 14 regions using absorbent material applied during the last 5 min of each work intensity. Perceptual responses were recorded for the body, foot and four foot regions. Foot sweat production was 22% greater nude ( $p < .001$ ) and with shoes did not increase with exercise intensity ( $p = .14$ ). Highest sweat rates were observed at the medial ankle and dorsal regions; lowest sweat rates at the toes. Perceptions of wetness and foot discomfort did not correspond with regions of high sweat production or low skin temperature but rather seemed dominated by tactile interactions caused by foot movement within the shoe. **Practitioner summary:** This study provides a detailed view of foot sweat distribution for female runners with and without shoes, providing important guidance for sock and footwear design. Importantly, perceptions of wetness and foot discomfort did not correspond with areas of high sweat production. Instead tactile interactions between the foot, sock/shoe play an important role.

- **Keywords:** Sweat mapping, regional sweating, feet, exercise, footwear, comfort

**Sara Königs, Susanne Mayr & Axel Buchner. *A common type of commercially available LED light source allows for colour discrimination performance at a level comparable to halogen lighting*. Pages: 1462-1473.**

As light sources based on light emitting diodes (LED) are increasingly used to replace classic tungsten-based light sources in household lighting applications, possible impairments of colour perception under those light sources due to a different spectral power distribution become a major concern. The Colour Rendering Index (CRI) which is the only measure available to the end user is controversial and does not represent a comprehensive measure of colour perception. Aspects of colour perception disregarded by the CRI such as colour discrimination have to be taken into account as well. Therefore, we evaluated colour discrimination performance under a commercially available phosphor-converted LED light source from a popular brand (OSRAM) in comparison to a classic tungsten-based halogen light source. Colour discrimination performance was not affected by the type of light source, indicating that the phosphor-converted LED light source enables colour discrimination performance comparable to that of halogen lighting despite being associated with a lower CRI. **Practitioner summary:** Considering the increasing use of energy efficient light sources, we compared colour discrimination under a common type of phosphor-converted LED and under traditional halogen lighting. Colour discrimination performance was comparable in both lighting conditions, indicating that the phosphor-converted LED can replace halogen lighting without sacrificing colour discrimination for energy efficiency.

- **Keywords:** Phosphor-converted LED, halogen lamp, colour discrimination, illuminance level

**Huiju Park, Jie Pei, Mengyun Shi, Qinwen Xu & Jintu Fan. *Designing wearable computing devices for improved comfort and user acceptance*. Pages: 1474-1484.**

This study identified acceptable range of physical attributes (form factors, weight, volume and contact area) of wearable computing devices (WCD) on different body areas in relation to human factors, through human performance tests with 41 participants. Findings of this study discovered that there is a different level of threshold to discomfort on each part of the body; forearm has the smallest estimated mean of acceptable maximum weight of WCD followed by shirt pocket and collar area. On the other hand, front waist and back waist, when placed on one side, showed significantly higher estimated means of acceptable maximum weight of WCD than any other areas. Similar data trend was found in acceptable maximum volume and contact area of WCD. Body movement and posture influence the users' comfort, as the weight of WCD can cause unhealthy posture over time, and increased energy expenditure, which may cause orthopaedic problems and discomfort. **Practitioner summary:** This study discovered that in carrying wearable computing devices (WCD), there is a different level of threshold to discomfort on each part of the body, as evidenced by significantly different acceptable maximum weight, volume and contact area of WCD on different body part.

- **Keywords:** Comfort, wearable computing, ergonomics, human factors

**Glenn Holmes, Amanda Clacy & Paul M. Salmon. *Sports-related concussion management as a control problem: using STAMP to examine concussion management in community rugby*. Pages: 1485-1494.**

The effective management of sports-related concussion is an on-going problem in amateur sport due to a number of systemic issues. These factors have often been studied in isolation with minimal consideration for the interactions between them, or the overall system in which they occur. The aim of this research was to model the actors, controls, and feedback mechanisms influencing the management of concussion in community rugby union using the Systems-Theoretic Accident Model and Processes (STAMP) method. Findings show that there are currently many inadequate controls, that are directly and indirectly impacting effective concussion management. The practical implications of these findings are discussed (e.g. improved guideline education, mandatory medical presence, rule amendments). Additionally, the model provides a sound framework similar team sports can use to inform research into injury management and prevention (e.g. rugby league, hockey, AFL). **Practitioner Summary:** Research shows that concussion management in regional sport is inconsistent due to contextual limitations. Systems-Theoretic Accident Model and Processes was applied to identify the systemic factors currently influencing concussion management practices in community sport. Findings show inadequate controls precipitate concussion management gaps. Practical implications of the findings are discussed.

- **Keywords:** Concussion, sports-related concussion, SRC, systems theory