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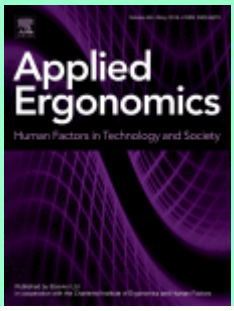


**Nathan Edward Sanders, Ziyang Xie, Karen B. Chen. *A comparison of the psychological effects of robot motion in physical and virtual environments*. 104039.**

A mixed-methods approach was used to assess the fidelity of virtual environments as ergonomic assessment tools for human-robot interaction. Participants performed a visual search task in the physical environment while a nearby collaborative robot repeatedly extended its arm toward them. This scenario was reconstructed in two virtual environments with different levels of graphical detail. Measures of presence, task performance, workload, and anxiety were taken to determine the effect of robot motion in all three environments. Task performance decreased in response to robot motion in the physical environment, while workload and anxiety increased. This simple effect of motion was consistent across environments for measures of task performance and anxiety. However, people performed faster overall in virtual reality, and the effect of motion on workload was greatly reduced in virtual reality. Results in the virtual environments suggest that people were distracted by the sound of the robot, and that presence was affected by manipulations of immersion and coherence.

- **Keywords:** Human-robot interaction; Virtual reality; Workload

**Micaela Porta, Simona Porceddu, Bruno Leban, Giulia Casu, Giovanni M. Mura, Marcello Campagna, Massimiliano Pau. *Characterization of upper limb use in health care workers during regular shifts: A quantitative approach based on wrist-worn accelerometers*. 104046.**

Despite the high prevalence of upper limb (UL) work-related musculoskeletal disorders (WRMSD) among health care workers (HCWs), little is known about their relationship with exposure to biomechanical risk factors. This study aimed to assess UL activity features under actual working conditions using two wrist-worn accelerometers. Accelerometric data were processed to obtain duration, intensity, and asymmetry of UL use in 32 HCWs during the execution of commonly performed tasks (e.g., patient hygiene, transfer, and meal distribution) within a regular shift. The results show that such tasks are characterized by significantly different patterns of UL use, in particular, higher intensities and larger asymmetries were observed respectively for patient hygiene and meal distribution. The proposed approach appears, thus, suitable to discriminate tasks characterized by different UL motion patterns. Future studies could benefit from the integration of such measures with self-reported workers' perception to elucidate the relationship between dynamic UL movements and WRMSD.

- **Keywords:** Upper limb; Accelerometer; Asymmetry

**Jodi Oakman, Wendy A. Macdonald, Kate McCredie. *Psychosocial hazards play a key role in differentiating MSD risk levels of workers in high-risk occupations*. 104053.**

**Objectives:** Workplace management practices targeting risk of musculoskeletal disorders (MSDs) fail to reflect evidence that risk is affected by psychosocial as well as physical hazards. To promote improved practices in occupations where MSD risk is highest, better information is needed on how psychosocial hazards, combined with physical hazards, affect risk of workers in these occupations. **Methods:** Survey ratings of physical and psychosocial hazards by 2329 Australian workers in occupations with high MSD risk were subjected to Principal Components Analysis. Latent Profile Analysis of hazard factor scores identified different combinations of hazards to which latent subgroups of workers were typically exposed. Survey ratings of frequency and severity of musculoskeletal discomfort or pain (MSP) generated a pre-validated MSP score and its relationship with subgroup membership was analysed. Demographic variables associated with group membership were investigated using regression modelling and descriptive statistics. **Results:** Analyses identified three physical and seven psychosocial hazard factors and three participant subgroups with differing hazard profiles. Profile group differences were greater for psychosocial than physical hazards, and MSP scores out of 60 ranged from 6.7 for the low hazard profile (29% of participants) to 17.5 for the high hazard profile (21%). Differences between occupations in hazard profiles were not large. **Conclusions:** Both physical and psychosocial hazards affect MSD risk of workers in high-risk occupations. In workplaces such as this large Australian sample where risk management has focused on physical hazards, actions targeting psychosocial hazards may now be the most effective way to reduce risk further.

- **Keywords:** Musculoskeletal disorders; Workplace risk management; APHIRM toolkit; Latent profile analysis

**Jie Zhang, Junjian Chen, Fang Fu, Yan Luximon. *A 3D anthropometry-based quantified comfort model for children's eyeglasses design*. 104054.**

Modeling the quantified relationships between anthropometric/product parameters and human perceptions provides research-driven guidelines for mass customization and personalization of ergonomic products. In particular, such models are critical for designing children's eyeglasses; however, they are still underexplored. This study examined children's comfort perceptions for eyeglasses with two variables (i.e., nose pads width and temple clamping force), and established quantified linkage models between subjective human perceptions and objective 3D anthropometric/product parameters. To the best of our knowledge, this is the first work to quantify these relationships for ergonomic eyeglasses design. A psychological experiment with thirty child participants was performed, and our analyses showed that two eyeglasses variables significantly influenced the children's comfort perceptions; static vs. dynamic conditions caused slight differences. The mathematical trendlines and trend surfaces established by our findings can estimate perceived component-specific and overall comfort scores based on 3D anthropometric/product parameters. This also allows for calculation of parameter's allowances for sizing and grading eyeglasses while maintaining satisfactory comfort.

- **Keywords:** Eyeglasses frames design; Comfort and fit; Ophthalmic anthropometry; Children's perceptions

**Siobhan E. Merriman, Kirsten M.A. Revell, Katherine L. Plant. *Training for the safe activation of Automated Vehicles matters: Revealing the benefits of online training to creating glaringly better mental models and behaviour*. 104057.**

Automated Vehicle (AV) systems are expected to reduce the frequency and severity of on-road collisions. Unless drivers have an appropriate mental model for the capabilities and limitations of the automation, they may not activate the automation safely or appropriately on the road, potentially leading to a collision. As such, a training package (L4DTP) was developed to improve drivers' decisions and behaviour when activating an AV system and this was evaluated in a between-subjects simulator experiment. Drivers received no training (NT, control group), read an owner's manual (OM, experimental group 1: current training provision) or underwent the L4DTP (experimental group 2: new training programme). All drivers then experienced five scenarios in a driving simulator where they encountered road conditions which were safe and unsafe for activation. Their activation decisions, behaviour, trust in automation, workload and mental models were measured. This experiment found that drivers who read the OM or underwent the L4DTP made better activation decisions and showed better activation behaviour compared to drivers who received NT. Additionally, drivers who underwent the L4DTP found it easier, less demanding and felt under less time pressure when making their decisions, had to expend less effort to reach the same activation performance and had more appropriate and comprehensive mental models for when the automation can be activated compared to drivers who read the OM. This L4DTP can make roads safer by reducing collisions linked to poor activation decisions and behaviour. Therefore, there is the potential for a real benefit for society if this training programme is adopted into mandatory AV driver training.

- **Keywords:** Automated vehicles; Driver training; Mental models; Trust in automation; Workload; Mental demand

**Emma Knight, Penelope Sanderson, Andrew Neal, Timothy Ballard. *Interruptions in healthcare: Modeling dynamic processes and effects at a team level*. 104051.**

Interruptions are associated with increases in medical errors amongst healthcare professionals, yet interventions to reduce interruptions have not been widely successful. While interruptions can be problematic for the interruptee, they may be necessary for the interrupter to maintain patient safety. To understand the emergent effects of interruptions within a dynamic environment, we develop a computational model that describes how nurses make decisions about interruptions and the effects those decisions have at a team level. Simulations reveal the dynamic interplay between urgency, task importance, the cost of being interrupted and team efficiency, depending on the consequences of clinical or procedural error, and shed light on the ways that the risks from interruptions can be better managed.

- **Keywords:** Interruptions; Decision making; Computational modeling

**Adam T. Biggs, Joseph A. Hamilton, Andrew G. Thompson, Andrew Jensen, Joel Suss, Karen Kelly, Rachel R. Markwald. *Not according to plan: Cognitive failures in marksmanship due to effects of expertise, unknown environments, and the likelihood of shooting unintended targets*. 104058.**

Shooting errors have multi-faceted causes with contributing factors that include sensorimotor activity and cognitive failures. Empirical investigations often assess mental errors through threat identification, yet other cognitive failures could contribute to poor

outcomes. The current study explored several possible sources of cognitive failures unrelated to threat identification with live fire exercises. Experiment 1 examined a national shooting competition to compare marksmanship accuracy, expertise, and planning in the likelihood of hitting no-shoot or unintended targets. Experts demonstrated an inverse speed/accuracy trade-off and fired upon fewer no-shoot targets than lesser skilled shooters, yet overall, greater opportunity to plan produced more no-shoot errors, thereby demonstrating an increase in cognitive errors. Experiment 2 replicated and extended this finding under conditions accounting for target type, location, and number. These findings further dissociate the roles of marksmanship and cognition in shooting errors while suggesting that marksmanship evaluations should be re-designed to better incorporate cognitive variables.

- **Keywords:** Marksmanship; Expertise; Unintended casualties; Firearms; Cognition; Speed/accuracy trade-off

**Alexandra Neary, Simon Y.W. Li, Isaac Salisbury, Robert G. Loeb, Penelope M. Sanderson. *Effects of multitasking on interpreting a spearcon sequence display for monitoring multiple patients*. 104072.**

Spearcons are time-compressed speech phrases. When arranged in a sequence representing vital signs of multiple patients, spearcons may be more informative than conventional auditory alarms. However, multiple resource theory suggests that certain timeshared tasks might interfere with listeners' ability to understand spearcons. We tested the relative interference with spearcon identification from the following ongoing tasks: (1) manual tracking, (2) linguistic detection of spoken target words, (3) arithmetic true-false judgments, or (4) an ignored background speech control. Participants were 80 non-clinicians. The linguistic task worsened spearcon identification more than the tracking task, $p < .001$, and more than ignored background speech, $p = .012$. The arithmetic task worsened spearcon identification more than the tracking task, $p < .001$. The linguistic task and arithmetic task both worsened performance, $p = .674$. However, no ongoing task affected participants' ability to detect which patient(s) in a sequence had abnormal vital signs. Future research could investigate whether timeshared tasks affect non-speech auditory alerts.

- **Keywords:** Auditory displays; Time-compressed speech; Multiple resource theory

**Marian Obuseh, Lora Cavuoto, Dimitrios Stefanidis, Denny Yu. *A sensor-based framework for layout and workflow assessment in operating rooms*. 104059.**

Due to their large sizes and impediments to personnel workflows, integrating robotic technologies into the existing operating rooms (OR) is a challenge. In this study, we developed an ultra-wideband sensor-based human-machine-environment framework for layout and workflow assessments within the OR. In addition to providing best practices for use of the framework, we also demonstrated its effectiveness in understanding layout and workflow inefficiencies in 12 robotic-assisted surgeries (RAS) across 4 different surgical specialties. We found avoidable movements as the circulating nurse covers at least twice the distance of any other OR personnel before the patient cart (robot) is docked. OR areas of congestion and undesirable personnel-pair proximities across RAS phases that impose extra non-technical skill challenges were determined. Our findings highlight several implications for the added complexity of integrating robotic technologies into the OR, which can serve as drivers for objective evidence-based recommendations to combat RAS OR layout and workflow inefficiencies.

- **Keywords:** Robotic-assisted surgery; Personnel workflow; Operating room layout

**Kristina Eliasson, Charlotte Lewis, Therese Hellman, Gunilla Dahlgren, Magnus Svartengren, Teresia Nyman. *Does occupational health surveillance lead to risk reduction for workers exposed to hand-intensive work?* 104074.**

This mixed method study aimed to describe what risk-reducing actions were proposed by ergonomists after the execution of a guided process for occupational health surveillance for workers exposed to hand-intensive work in ten companies. Another aim was to describe the exposed workers' proposals for risk-reducing actions, including their perceptions of potential changes in the self-assessed exposure levels and work-related pain. Several actions, targeting organizational, technical, and/or individual measures were proposed. Proposals from the ergonomists more often targeted the personal measures, whereas the workers' proposals targeted technology or organizational changes. Six companies implemented at least one of the action proposals. These action proposals were not related to evaluation metrics, nor were they evaluated. This study indicates that both ergonomists and companies need guidance on how to improve to work in a participatory process for the implementation and evaluation of risk-reducing actions, e.g., by how to better include workers' experiences.

- **Keywords:** Musculoskeletal disorders; Risk assessment; Risk control

**Christina Pfeifer, Peter Leinen, Johannes Puhl, Stefan Panzer. *Visual behavior and road traffic hazard situations when using a bike computer on a racing bike: An eye movement study*. 104070.**

Bike computers are an important equipment, especially on race bikes where athletes can monitor output parameters. The purpose of the present experiment was to determine the effect of visually monitoring the cadence of a bike computer and to perceive hazard traffic situations in a virtual environment. In a within subject-design individuals (N = 21) were instructed to perform the riding task in two single-task conditions (only watching the traffic at the video with occluded or without occluded bike computer), two dual-task conditions (monitoring the cadence of 70 RPM or 90 RPM and observing the traffic) and one control condition (no instructions). Percentage dwell time of the eye movements, the constant error from the target cadence, and percentage of the recognized hazard traffic situations were analyzed. The analysis indicated that the visual behavior to monitor the traffic was not reduced when individuals used a bike computer to control the cadence.

- **Keywords:** Road hazard; Cycling; Attention; Dual-task interference

**Daphne C. Ho, Dianne Tolgyesi, Cheryl Beech, Steven L. Fischer. *Identifying the critical physically demanding tasks performed by personal support workers in Canada*. 104069.**

Due to increased work demands, personal support workers (PSWs) are experiencing more work-related injuries. However, little is known about PSW work tasks and their corresponding physical demand. The purpose of this study was to identify critical tasks that are physically demanding and completed frequently as identified by PSWs. Additionally, we identified contextual factors (i.e., environmental-, situational-, patient-related) that influenced physical demands. We surveyed 443 community-based PSWs working in Canada who rated the physical demand associated with client care tasks and identified contextual factors that can increase task specific physical demands. Transferring/repositioning patients, dressing, and bathing were perceived as most demanding. Patient weight and mobility influenced the level of physical demand required for most tasks. These data provide a foundation to develop physical employment standards and task specific education and training to prevent PSW injuries.

- **Keywords:** Survey; Musculoskeletal disorders; Patient handling; Health care aide

### K.E. Bridges, P.M. Corballis. *Direct peer pressure may be a causal factor in mistaken-for-game hunting accidents*. 104071.

**Introduction:** Mistaken-for-game or failure-to-identify hunting incidents refer to a hunter shooting an animal, often in haste, only to discover they have mistakenly targeted and shot a human. We sought to explore if individual differences, reaction times, peer or social pressure influence a decision to shoot quicker. **Method:** We conducted a computer-based test involving volunteer participants (n = 202). All participants were shown videos of approaching stag, in which they had to indicate the moment they would shoot. The independent variables involved peer pressure, social media or reaction 'influencers' added before each video. Participants were also requested to complete individual difference surveys. **Results:** Direct peer pressure and quick reaction test conditions presented quicker shooting times, whereas social media increased shooting times. No associations with individual differences were found. **Conclusions:** The results suggest that hunters must ensure they minimise their distraction and influence from other people.

- **Keywords:** Deer hunting; Decision making; Mistaken-for-game

### Estefany Rey-Becerra, Lope H. Barrero, Rolf Ellegast, Annette Kluge. *Improvement of short-term outcomes with VR-based safety training for work at heights*. 104077.

Serious games and virtual reality offer engaging learning opportunities and a cost-effective solution within an immersive and safe environment for safety training in construction. However, there have been few examples of safety training for work at heights developed using these technologies, especially commercial training. To fill this literature gap, a new VR-based safety training was developed and compared with lecture-based training across time. We conducted a quasi-experiment with a non-equivalent group design with 102 workers from six construction sites in Colombia. Learning objectives, observations from training centers, and national regulations were considered during the design of the training methods. Training outcomes were assessed using Kirkpatrick's model. We found that both training approaches were effective in improving knowledge test results and self-reported attitudes in the short-term; and risk-perception, self-reported behavior and safety climate in the long-term. In particular, participants of the VR-based training got significantly higher results in knowledge and reported higher attitudes (commitment and motivation) than participants of the lecture-based training. We suggest that safety managers and practitioners should invest in VR using serious games as an alternative to training programs based on short-term outcomes. Future work is needed to test VR for long-term outcomes.

- **Keywords:** Serious games; Virtual environment; Construction industry