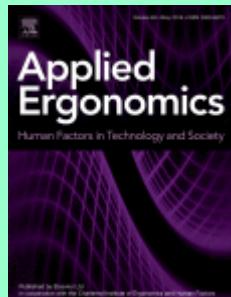


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Sofie Beier, Chiron A.T. Oderkerk. *High letter stroke contrast impairs letter recognition of bold fonts.* 103499.

To make graphical user interfaces look more fashionable, designers often make use of high-stroke-contrast fonts. We are yet to understand how these fonts affect reading. We examined the effect of letter-stroke contrast on three bold fonts, one with extreme contrast between thick and thin strokes, one with no contrast, and one in between. The fonts were designed for this experiment to enable control of font variables. Participants identified the middle letter in a lowercase letter trigram in each trial, briefly presented in the parafovea (at 2° left and right of fixation) and at the foveal fixation point. There was evidence for letter recognition impairment for the font with high stroke contrast compared to the fonts with low and medium stroke contrast, while there was no significant difference in performance between the medium- and low-stroke-contrast fonts. The results suggest that bold fonts with high stroke contrast should not be considered for designs where letter recognition is a priority.

- **Keywords:** Crowding; Font; Reading; Letter features; Visual acuity

Ryan Sers, Steph Forrester, Massimiliano Zecca, Stephen Ward, Esther Moss. *The ergonomic impact of patient body mass index on surgeon posture during simulated laparoscopy.* 103501.

Laparoscopy is a cornerstone of modern surgical care, with clear advantages for the patients. However, it has also been associated with inducing upper body musculoskeletal disorders amongst surgeons due to their propensity to assume non-neutral postures. Further, there is a perception that patients with high body mass indexes (BMI) exacerbate these factors. Therefore, surgeon upper body postures were objectively quantified using inertial measurement units and the LUBA ergonomic framework was used to assess posture during laparoscopic training on patient models that simulated BMIs of 20, 30, 40 and 50 kg/m². In all surgeons the posture of the upper body significantly worsened during simulated laparoscopic surgery on the BMI 50 kg/m² model as compared to the baseline BMI model of 20 kg/m². These findings suggest that performing laparoscopic surgery on patients with high BMIs increases the prevalence of non-neutral posture and may further increase the risk of musculoskeletal disorders in surgeons.

- **Keywords:** Laparoscopic surgery; Posture; Inertial measurement units; Ergonomics

Hossein Motabar, Ashish D. Nimbarde. *The effect of task rotation on activation and fatigue response of rotator cuff muscles during overhead work.* 103461.

Overhead work is known as one of the ergonomic risk factors that can lead to shoulder overload and injury. Anatomical alignment of rotator cuff muscles makes them the most vulnerable to injuries during overhead work. In this study, the effect of task rotation, as one of the administrative controls to reduce the risk of injury during overhead work, on the fatigue response of rotator cuff muscles was investigated. Twelve participants performed three submaximal exertions (5, 20, and 35% of maximum voluntary contraction (MVC)) using four task rotation sequences (increasing, decreasing, upward parabolic, and downward parabolic). Median frequency of surface electromyography (EMG), shoulder strength, and ratings of perceived exertion (RPE) were used to study the fatigue response of rotator cuff muscles. Although the average normalized muscle activity was similar in all sequences, the task rotation sequence had a significant effect on the median frequency. The effect of task rotation sequence on the strength and RPE was similar to that of the median frequency but was statistically not significant. The upward parabolic task rotation sequence resulted in the lowest fatigue among all the task sequences. Performing intense exertions apart from each other, warm-up exertions, and the presence of active recovery after the intense exertions could be the factors that produced the lowest fatigue during this sequence.

- **Keywords:** Rotator cuff muscles; Overhead work; Task rotation; Muscle fatigue

Christopher A. Sanchez, Tyler Read, Amanda Crawford. *Smartphone display size can cause distortions in perceptual estimates of size.* 103524.

Everyday we consume massive amounts of visual information on mobile devices like smartphones. However, are there consequences for viewing information on these devices? In 2 experiments, participants viewed several target objects on two differently sized virtual smartphone displays, and then made a judgment of the size of each target item. Results from both experiments confirm that smartphone display size does impact user perceptions of size, such that larger displays cause users to significantly underestimate the size of objects. This effect held when target items were presented alone, or concurrently with a non-target referent. This is the first study to confirm such an effect and suggests that the size of a smartphone display can negatively influence the accuracy of users' visual perception. Thus, beyond aesthetics or cost, it must be realized that the choice of device might have additional perceptual consequences for consumers.

- **Keywords:** Smartphones; Display size; Visual perception

Yaqin Cao, Yun Zhang, Yi Ding, Vincent G. Duffy, Xuefeng Zhang. *Is an anthropomorphic app icon more attractive? Evidence from neuroergonomics.* 103545.

Exploring what types of app icons are attractive has been a topic of great interest in recent years. The main purpose of this study was to explore the neural mechanism of attention capturing of the anthropomorphic app icons based on neuroergonomics. Participants' perception of different app icons was investigated by using event-related potentials (ERPs) and attractiveness evaluation. The results showed that anthropomorphic app icons were evaluated more attractive and elicited larger P2, P3 and LPP amplitude than non-anthropomorphic app icons, which indicated an attention bias to attractive anthropomorphic app icons. The time course of the attention towards anthropomorphic app icons includes three main processes: an early stimulus-driven perceptual detection of app icon features (P2 during 160–200 ms), an involuntary

allocation of attention to evaluate and categorize app icons (P3 during 300–500 ms), and experiencing different emotions to anthropomorphic versus non-anthropomorphic app icons (LPP during 500–800 ms). That is, the process of users' perception and attention toward app icons combines "bottom-up" and "top-down" processes. Our findings suggest a new perspective to use ERP components (P2, P3, and LPP) to deep understanding of app icon design. A practical implication is that app icons could be designed using anthropomorphic elements to attract users.

- **Keywords:** App icon; Anthropomorphism; Neuroergonomics

Katsumi Minakata, Sofie Beier. *The effect of font width on eye movements during reading.* 103523.

Certain font features (e.g., letter width) can change the amount of space occupied by text in published works. Font styles/features are also known to affect reading eye movements (EM); however, few studies have examined these effects – and none used high-resolution displays. We examined the effects of font width on EMs by utilizing four fonts, from the Univers family, which varied in letter-width magnitude. Participants' ($n = 25$) reading speed, saccade velocity, and the duration/number of fixations and saccades were recorded. The Ultra Condensed font significantly influenced readability and yielded: fewer fixations and saccades; longer fixation durations than the Roman and Extended fonts; and shorter saccade durations, relative to the other fonts. Readers efficiently adjusted their EMs such that no reading-speed differences were observed. The eye-tracking metrics revealed two trade-off effects: (1) fewer and shorter EMs and (2) more and longer EMs, which were revealed by the font-width manipulation.

- **Keywords:** Letter width; Font; Typography; Reading; Eye movements

Jennifer L. Hein, Nicolas N. Sesno, Richard F. Armenta, Jeff A. Nessler, Deanna S. Asakawa. *Upper limb manual dexterity, strength and blood flow after walking with backpack load.* 103505.

This study aimed to characterize the effects of walking with backpack load on upper limb function. Fifteen males participated in 3 conditions: no load, 40% body weight loaded backpack (BP) and loaded backpack with simulated rifle (BRC). Pinch strength, grip strength, sensory threshold, blood flow volume, and a manual dexterity test were assessed before and after a 45-min walking trial. Pinch strength in the BP condition was significantly different than the control ($p < 0.05$). Grooved pegboard times were faster after a seated recovery ($p = 0.026$) than immediately after walking with load. Blood flow was significantly decreased to $<53\%$ of baseline ($p \leq 0.001$) in BP and BRC immediately after donning the backpack. No significant changes in grip strength or sensory threshold were measured among conditions or time points. In conclusion, pinch strength, manual dexterity and blood flow were affected by backpack carriage, but other upper limb measures remained unaffected.

- **Keywords:** Load carriage; Pinch strength; Pegboard

Kirsten Dillon, Madison Hiemstra, Marc Mitchell, Nina Bartmann, Scott Rollo, Paul A. Gardiner, Harry Papavassilis. *Validity of the occupational sitting and physical activity questionnaire (OSPAQ) for home-based office workers during the COVID-19 global pandemic: A secondary analysis.* 103551.

High levels of occupational sitting is an emerging health concern. As working from home has become a common practice as a result of COVID-19, it is imperative to validate an appropriate self-report measure to assess sitting in this setting. This secondary analysis

study aimed to validate the occupational sitting and physical activity questionnaire (OSPAQ) against an activPAL4™ in full-time home-based 'office' workers ($n = 148$; mean age = 44.90). Participants completed a modified version of the OSPAQ and wore an activPAL4™ for a full work week. The findings suggest that the modified OSPAQ has fair levels of validity in terms of correlation for sitting and standing ($p = 0.35\text{--}0.43$, all $p < 0.05$) and agreement (bias = 2–12%) at the group level; however, estimates were poor at an individual level, as suggested by wide limits of agreement ($\pm 22\text{--}30\%$). Overall, the OSPAQ showed to be an easily administered and valid questionnaire to measure group level sitting and standing in this sample of adults.

- **Keywords:** OSPAQ; activPAL™; Measurement-of-agreement

Andrew Gilbey, Stephen Walmsley, Kawtar Tani, Savern Reweti. *Decision making dyads and judgement overconfidence: Implications for high-risk industries.* 103529.

In the workplace, overconfidence is generally considered undesirable as it may increase people's propensity to take risks. In many areas (e.g., aviation, shipping, nuclear control, and driving), risk-taking is detrimental to safety. We hypothesised that decision-makers would be overconfident and, due to group polarisation, decision-making pairs would be more overconfident than single decision-makers. As was predicted, when answering a 24-item general knowledge questionnaire ($d = 0.94$) and a task exploring how they might reorient themselves if lost ($d = 1.93$), participants ($N = 63$) were overconfident about their performance; importantly, participants in pairs ($n = 32$) were more overconfident on general knowledge (Hedges' $g = 0.51$) and lost procedures (Hedges' $g = 0.52$), than were participants who completed the tasks alone ($n = 31$). The findings imply that in some situations, single decision-makers may exhibit less overconfidence. The safety implications for a number of areas are discussed.

- **Keywords:** Group polarisation; Overconfidence; Aviation; Safety; Decision quality

Rebai Soret, Ana-Maria Montes-Solano, Chiara Manzini, Vsevolod Peysakhovich, Eve Floriane Fabre. *Pushing open the door to reality: On facilitating the transitions from virtual to real environments.* 103535.

The recent rise of virtual reality technology has led researchers to investigate how to adapt transitions to virtual environments. Transitions play a key role in facilitating the return to reality, which is of particular importance when the virtual world is far more agreeable than the real world. In the present study, the efficacy of a door transition – an almost "transparent" door falling out the top of the virtual environment and controlled by the user – was evaluated and compared to two basic transitions: a direct transition and a fading transition. Participants reported a strong preference for the door transition that was evaluated as being smoother, more controllable, and greatly facilitated the return to reality. Moreover, the results showed that the door transition triggered no greater sickness in participants than the two other types of transition.

- **Keywords:** Virtual reality; Transition; Stress management; Door; ECG; Heart rate

SueAnn Woods, Eduardo M. Sosa, Amy Kurowski-Burt, Marissa Fleming, Kristen Matheny, Ashlyn Richardson, Heather Scott, Brooke Perry, Isabella Zornes. *Effects of wearing of metacarpal gloves on hand dexterity, function, and perceived comfort: A pilot study.* 103538.

Metacarpal gloves are commonly used in heavy-duty industries such as mining and are typically thicker and bulkier than manufacturing or assembly industrial gloves. This pilot

study investigates the impact of wearing metacarpal gloves on hand dexterity, functional capabilities, and perceived comfort. Four types of commercially available metacarpal gloves were selected for evaluation in a randomized controlled trial. Evaluations included turning and placing tests, also grip, pinch, and screwdriver tests, and rating of the perceived level of effort. Dexterity test results showed that metacarpal gloves significantly reduced the ability to perform motor tasks requiring coordination compared to bare hands. Hand functions such as gripping, pinching, and forearm rotations were not significantly affected. However, the perceived level of effort needed to complete those hand functions increased as the metacarpal glove's bulkiness increased. High levels of mechanical protection typically offered by metacarpal gloves can inversely affect hand dexterity and hand exertion.

- **Keywords:** Hand protection; Grasp; Grip; Pinch; Torque

Hunter Rogers, Kapil Chalil Madathil, Anjali Joseph, Christine Holmstedt, Suparna Qanungo, Nathan McNeese, Tara Morris, Richard J. Holden, James T. McElligott. An exploratory study investigating the barriers, facilitators, and demands affecting caregivers in a telemedicine integrated ambulance-based setting for stroke care. 103537.

Telemedicine implementation in ambulances can reduce time to treatment for stroke patients, which is important as "time is brain" for these patients. Limited research has explored the demands placed on acute stroke caregivers in a telemedicine-integrated ambulance system. This study investigates the impact of telemedicine on workload, teamwork, workflow, and communication of geographically distributed caregivers delivering stroke care in ambulance-based telemedicine and usability of the system. Simulated stroke sessions were conducted with 27 caregivers, who subsequently completed a survey measuring workload, usability, and teamwork. Follow-up interviews with each caregiver ascertained how telemedicine affected workflow and demands which were analyzed for barriers and facilitators to using telemedicine. Caregivers experienced moderate workload and rated team effectiveness and usability high. Barriers included frustration with equipment and with the training of caregivers increasing demands, the loss of personal connection of the neurologists with the patients, and physical constraints in the ambulance. Facilitators were more common with live visual communication increasing teamwork and efficiency, the ease of access to neurologist, increased flexibility, and high overall satisfaction and usability. Future research should focus on eliminating these barriers and supporting the distributed cognition of caregivers.

- **Keywords:** Telemedicine; Qualitative interviews; Stroke caregiving; Teamwork

Aaron P.J. Roberts, Neville A. Stanton, Kiome A. Pope, Daniel Fay. To utilize automation or not to utilize automation, that is the question: An evaluation of how drills and procedures impact optronics mast usage from a sociotechnical systems perspective. 103543.

The delegation of tasks to a non-human agent in a sociotechnical system can extend human capabilities and performance. Effective performance is, however, reliant on a successful relationship between human operators and automation. Optronics is a partially automated system which has replaced periscope on board some modern submarine platforms, operating modes permit the completion of tasks either manually or utilizing automation. A reluctance to utilize automated functionality within the optronics system has been due to operator familiarity with legacy manual procedures based upon the use of a physical periscope. This highlights the gap that is prevalent between innovation, design, training and governance of automation utilization. The current work examined current (Control group) utilization of optronics technology using an expert population in a high fidelity simulator. Findings were utilized to guide the development of novel optronics

specific standard operating procedures (Intervention group). Results indicate that automaton disuse was greatly reduced, which had had a positive overall impact on overall system performance with regard to productivity and accuracy. The current work highlights the importance of incorporating governance of use and training as part of an automation design and implementation program is critical to help 'maximize what you have'.

- **Keywords:** Automation; Teamwork; Communication; Networks; Command and control

Enid Montague, Mary Bungum, Lauren Sherman, Stephanie Gravenor, D. Mark Courtney, Alyssa Czerniak, Mike Wolf, Danielle McCarthy. Using a sociotechnical systems analysis to evaluate an intervention to improve opioid prescribing in emergency medicine. 103495.

The United States is facing an unprecedented epidemic of opioid addiction and death due to opioid overdose. In an effort to improve patient knowledge and safe use about opioids, an Electronic Medication Complete Communication (EMC2) opioid strategy was developed targeting opioid naïve patients in the Emergency Department (ED). We conducted pre and post sociotechnical systems analyses to evaluate the variance between the process before the intervention and whether or not the process changed as expected with the new intervention. Results were analyzed using thematic qualitative analysis. Sociotechnical systems modeling illustrates the complexity of designing interventions for emergency medicine that affect multiple patients, providers, work systems, technologies, and processes. The post work systems model illustrates that several elements in the external ED environment can affect the effectiveness of the intervention. Sociotechnical systems analysis is an effective tool to illustrate the opportunities for designing health system interventions and evaluating the fidelity of such interventions.

- **Keywords:** Emergency medicine; Macroergonomics; Health information technology; Opioids

Hayeon Yu, Keonwoo Nam, Seokwon Shin, Minjung Choi, Youngdoo Son, Joonho Chang. Repetitive patterns in the locations of touch errors for two-thumb text entry on a smartphone. 103541.

This study investigated repetitive patterns in the locations of touch errors as a function of the shapes and positions of soft buttons on a smartphone for two-thumb text entry. Forty-three right-handed college students with smartphone-use experience were recruited for testing. An experimental application was developed, and the locations and frequencies of touch errors were measured for the button combinations of seven shapes and eight positions. More than 70.0 % of touch errors occurred within 2 mm from the boundaries of the buttons. In terms of direction, touch errors were primarily observed below the buttons, across all the button shapes and positions. Simultaneously, touch errors often appeared on the lateral sides of the buttons: (1) close to the proximal phalange of the thumbs when the buttons were placed near the initial positions of the thumbs and (2) close to the initial positions of the thumbs when the buttons were placed near the top and bottom ends of the keyboard.

- **Keywords:** Locations of touch errors; Soft keyboard; Smartphone

Megan Kamachi, Mohammadhasan Owlia, Tilak Dutta. Evaluating a wearable biofeedback device for reducing end-range sagittal lumbar spine flexion among home caregivers. 103547.

Caregivers who work in the home environment are at risk of back injury due to the awkward postures they have to adopt while providing care. Real-time biofeedback provided by a recently developed wearable device (PostureCoach) may be able to reduce this risk. The effectiveness of a two-day training intervention (including PostureCoach and an educational video) was evaluated for its ability to decrease the amount of time spent in end-range spine flexion. Twenty novice caregivers repeated a series of simulated care tasks. Real-time auditory biofeedback was provided to the intervention group ($n = 10$) when participants' sagittal lumbar spine flexion exceeded a preset threshold during training trials. Participants in the control group ($n = 10$) received no feedback. Participants repeated the tasks again two weeks and two months post-intervention. The intervention group maintained decreased end-range (80th and 95th percentile) spine flexion compared to controls at both post-intervention time points.

- **Keywords:** Biofeedback; Back injury; Spine flexion

Mieke A.A. De Bruyne, Lieven Danneels, Véronique Braet, Evelyn Van De Sijpe, Maaike Vanwijnsberghe, Lieselot Verhenne, Tine Willems. *Do stool types have an influence on cervicothoracic muscle activity and cervicothoracic posture among dentists/dental students? 103519.*

It has been shown that the type of stool influences lumbar posture and muscle activity during dental work. Studies investigating the effect on cervicothoracic muscle activity and posture are scarce though. The present study investigated the effect of different stool types on cervicothoracic muscle activity and posture during a dental procedure. Twenty five participants completed a simulated periodontal screening whilst sitting on the Ghopec, Salli MultiAdjuster saddle and A-dec dental stool. Muscle activity of M. Splenius Capitis, M. Sternocleidomastoideus, M. Trapezius Pars Descendens and M. Trapezius Pars Ascendens was measured using surface electromyography. Cervicothoracic posture was evaluated by means of a strain gauge (BodyGuard™) fixed between C5 and T2. No differences in muscle activity and posture were found between the three stools. Although the type of stool influences lumbar posture and muscle activity, it seems these differences are not continued at the cervicothoracic region.

- **Keywords:** Muscle activity; Posture; Dental ergonomics; Stool; Seated posture

Marko Bjelica, Iris C. Levine, Alison C. Novak. *Increasing the contrast of tread edge highlighters improves stair descent safety in older adults with simulated visual impairment. 103525.*

Falls during stair descent are dangerous and costly. Contrasting tread edge highlighters improve measures of stair safety, however the necessary contrast level of these interventions has not been investigated. Thirteen older adults (67.7 ± 5.5 years) completed stair descent trials under normal (300lx) and low (30lx) lighting conditions, blurred and normal vision, and four different contrast levels (0%, 30%, 50%, 70%) between the tread edge highlighter and the neighbouring tread surface. Cadence and heel clearance decreased for 0% contrast compared to 50% and 70% contrast conditions, but contrast had no effect on foot overhang. Blurred vision was observed to be a greater factor influencing biomechanical measures of fall risk than low ambient lighting. Results suggest higher contrast highlighters improve measures of safety, even more so during simulated vision impairment, and that at least 50% contrast difference provides adequate visual information for safer stair ambulation.

- **Keywords:** Fall prevention; Contrast; Visual impairment; Stair descent; Built environment

Scales James, Coleman Damian, Brown Mathew. Energy cost and knee extensor strength changes following multiple day military load carriage. 103503.

Military exercises and recruit training requires soldiers, including new recruits, to undergo multiple days of substantial physical stress. The aim of this study was to evaluate the physiological impact of multiple days of military load carriage by addressing the hypothesis: A second day of load carriage increases oxygen uptake and reduces knee extensor torque compared to a single day of load carriage. A load carriage group ($n = 12$) (carrying 32 kg) and unloaded group ($n = 14$) walked on a treadmill for 2 h on two consecutive days. Knee extensor and flexor torque were assessed by dynamometry at speeds of: $0^\circ \cdot s^{-1}$, $60^\circ \cdot s^{-1}$ and $180^\circ \cdot s^{-1}$ before and after load carriage on day one and two, and 24 h following day 2. Oxygen uptake was assessed via respiratory gas assessment at the 6th and 119th minute of load carriage on day one and two. When assessed by mixed methods ANOVA (alpha: 0.05), an interaction effect was observed for oxygen uptake ($p < 0.001$), with post hoc assessment highlighting second day of load carriage significantly increased oxygen uptake compared to day one post in the loaded group ($28.9(3.0)$ vs $25.8(3.4)$, $p = 0.048$). An interaction effect was observed for all knee extensor variables (all $p < 0.05$). All knee extensor peak torque variables were significantly associated to oxygen uptake at $0^\circ \cdot s^{-1}$ ($r = -0.576$, $p < 0.05$), $60^\circ \cdot s^{-1}$ ($r = -0.552$, $p < 0.05$), and $180^\circ \cdot s^{-1}$ ($r = -0.589$, $p < 0.05$). Two days of load carriage significantly increases oxygen uptake and reduces knee extensor and flexor torque compared to a single day of load carriage. Subsequently, physical training programmes aimed at increasing knee extensor strength may protect against increases in oxygen uptake.

- **Keywords:** Military load carriage; Movement economy; VO₂; Isokinetic dynamometry

Thomas Goodge, Victoria Kroll, Mike Vernon, Petya Ventsislavova, David Crundall. A comparison of cybersickness symptoms across 360-degree hazard perception and hazard prediction tests for drivers. 103549.

Hazard perception assessment may benefit from VR-presentation by removing field-of-view restrictions imposed by single-screen tests. One concern is whether VR-induced 'cybersickness' will offset any benefits. Self-reported cybersickness ratings were recorded from 77 participants viewing two variants of a 360-degree hazard test: hazard perception and hazard prediction. The latter was hypothesised to be particularly susceptible as clips abruptly cut to a probe question at hazard onset. Such sudden occlusions are thought to increase cybersickness. Overall cybersickness levels were low, with only four participants excluded for above-threshold sickness ratings. The remaining participants showed unexpectedly lower symptoms for the hazard prediction test and rated this test format as more comfortable and engaging. These findings mitigate concerns over the use of 360-degree videos in formative hazard assessments, even when clips involve sudden occlusions. Nonetheless, removal of any participants due to cybersickness raises problems for using VR for formal assessments of hazard perception skill.

- **Keywords:** Virtual reality; Cybersickness; Hazard perception; Hazard prediction

Peter Simeonov, Hongwei Hsiao, Ashish Nimbarde, Richard Current, Douglas Ammons, Hee-Sun Choi, Md Mahmudur Rahman, Darlene Weaver. Evaluation of advanced curve speed warning system for fire trucks. 103527.

A curve speed warning system (CSWS) for firetrucks was developed and tested in this study. The CSWS algorithm was developed based on guidelines in the public domain for

general vehicles and modified for firetrucks for their configuration and emergency driving. Twenty-four firefighters participated in the test in a driving simulator. The results show that the CSWS was effective in issuing preemptive warnings when the drivers were approaching curves with unsafe speed during emergency responses. Drivers reduced their driving speed at curve approaching and entering phases for most challenging curves, without affecting the overall time in completing the test route. Drivers had reduced number of severe braking and decreased average in-curve distance traveled over the safety speed limits, when the CSWS was in use. Drivers also rated the CSWS as assisting, effective and useful. In summary, the CSWS can enhance firetruck safety during emergency driving without sacrificing drivers' precious response time.

- **Keywords:** Firetruck; Speed; Warning; Rollover

Prajna Bhat, Emmanuel Senft, Michael Zinn, Michael Gleicher, Bilge Mutlu, Rebecca Cook, Robert G. Radwin. Assessing limited visibility feedback for overhead manufacturing assembly tasks. 103531.

Worker posture, task time and performance are often affected when one-handed manual dexterous tasks are performed in small overhead spaces under an obscured view. A common method used for supplementing visual feedback in these cases is a hand-held telescopic mirror, but that involves working with both arms extended overhead, and is often accompanied by awkward neck and shoulder postures. A video camera was considered as an alternative to using a mirror for visual feedback and reducing overhead reach. A mirror, a borescope and an omnidirectional camera were evaluated while laboratory participants performed three one-handed simulated manufacturing tasks in a small overhead enclosure. Videos were recorded for quantifying the time that postures were assumed while performing the tasks. The average time that both arms were above mid-shoulder height for the omnidirectional camera was more than 2.5 times less than for the mirror and borescope. The average proportion of neck strain time was 0.01% (or less) for both the omnidirectional camera and the borescope, compared to 83.68% for the mirror. No significant differences were observed in task completion times between the three modalities. Hence, an omnidirectional camera can provide visibility while reducing straining postures for manufacturing operations involving overhead work.

- **Keywords:** Visibility modalities; Telescopic mirror; Borescope; Omnidirectional camera; Musculoskeletal disorders

Yukiko Kuboshima, Jacqueline McIntosh. Housing design that improves the independence and safety for older adults using a walker. 103539.

Globally, the walker is one of the most common assistive technologies used by older adults with mobility impairments, which is also the case in New Zealand. However, there is a scarcity of knowledge regarding their specific requirements in housing design. Adopting an ethnographic approach, the perceptions and spatial use of 16 older adults who used a walker were investigated as part of a larger study on quality of life and housing design. Five emergent themes for walker user perception and spatial use were identified, from which design considerations were distilled and then categorised into 10 design elements. The study highlights differences between the requirements for accommodating walkers and those for accommodating wheelchair users. It provides new insights into improved housing design for older adults, which have the potential to be incorporated into existing frameworks for accessible design and universal design thereby improving the independence and safety of older adults.

- **Keywords:** Walker; Senior housing design; Accessibility; Mobility impairments; Inclusive design

Valentina Marques da Rosa, Tarcísio Abreu Saurin, Guilherme Luz Tortorella, Flávio S. Fogliatto, Leandro M. Tonetto, Daniel Samson. *Digital technologies: An exploratory study of their role in the resilience of healthcare services.* **103517.**

Descriptions of resilient performance in healthcare services usually emphasize the role of skills and knowledge of caregivers. At the same time, the human factors discipline often frames digital technologies as sources of brittleness. This paper presents an exploratory investigation of the upside of ten digital technologies derived from Healthcare 4.0 (H4.0) in terms of their perceived contribution to six healthcare services and the four abilities of resilient healthcare: monitor, anticipate, respond, and learn. This contribution was assessed through a multinational survey conducted with 109 experts. Emergency rooms (ERs) and intensive care units (ICUs) stood out as the most benefited by H4.0 technologies. That is consistent with the high complexity of those services, which demand resilient performance. Four H4.0 technologies were top ranked regarding their impacts on the resilience of those services. They are further explored in follow-up interviews with ER and ICU professionals from hospitals in emerging and developed economies to collect examples of applications in their routines.

- **Keywords:** Resilient healthcare; Resilience abilities; Healthcare 4.0

Steven A. Lavender, Chunyi Sun, Yilun Xu, Carolyn M. Sommerich. *Ergonomic considerations when slotting piece-pick operations in distribution centers.* **103554.**

Many warehouse slotting algorithms have overlooked worker ergonomics. This research aimed to develop ergonomics slotting guidelines based upon the back and shoulder postures and electromyographic (EMG) responses of the deltoid and erector spinae muscles when individual items are picked from, or full cases replenished to, different shelf heights. In the first study of two studies, participants lifted small items representative of piece-pick tasks from seven shelf heights. In the second study, participants performed a simulated full case replenishment task in which they lifted boxes weighing between 2.7 and 10.9 kg from a cart into a flow rack. Shelf height significantly affected all postural and EMG variables and there was a trade-off between back and shoulder muscle activity across the varying shelf heights. Together, these studies were used to develop some general ergonomic slotting guidelines that could be implemented to reduce biomechanical load exposures experienced by distribution center workers.

- **Keywords:** Ergonomics; Human factors; Slotting; Musculoskeletal disorders (MSD); Safety

Yunxian Pan, Xianliang Ge, Liezhong Ge, Jie Xu. *Using eye-controlled highlighting techniques to support both serial and parallel processing in visual search.* **103522**

Recent research has developed two eye-controlled highlighting techniques, namely, block highlight display (BHD) and single highlight display (SHD), that enhance information presentation based on a user's current gaze position. The present research aimed to investigate how these techniques facilitate mental processing of users' visual search in high information-density visual environments. In Experiment 1, 60 participants performed 3-, 6-, 9-, and 12-icon visual search tasks. The search times significantly increased as the number of icons increased with the SHD but not with the BHD. In Experiment 2, 40 participants performed a 49-icon visual search task. The search time was faster, and the fixation spatial density was lower with the BHD than with the SHD. These results suggested that the BHD supported parallel processing in the highlighted

area and serial processing in the broader display area; thus, the BHD improved search performance compared to the SHD, which primarily supported serial processing.

- **Keywords:** Eye-controlled highlighting techniques; Visual search; Serial processing; Parallel processing

Per Øivind Braarud. Comparing control room operators' and experts' assessment of team performance using structured task-specific observation protocols and scenario replay. 103500.

Operators' self-assessment has received limited interest within process control or human-system evaluation. Research on self-assessment has been criticised for poor assessment methodology, and consequently, its status is unclear. This study hypothesised that, given adequate assessment methods (such as task-specific assessment items and scenario replay), we could observe relatively accurate self-assessment results. Eighteen licensed operators and two experts assessed team performance in six nuclear control room scenarios. The results reveal an overall agreement between operators and experts, measured by the intraclass correlation coefficient, ranging from 0.60 to 0.70, which lies close to the intraclass correlation coefficient of 0.75 for the experts. This demonstrates potential for achievement of relatively accurate operator self-assessment for complex work. The agreement varied in a similar manner for both expert agreement and operator-expert agreement across eight performance dimensions. In addition, the operators' self-assessment provided additional information beyond observer assessment in identifying non-acceptable performance items.

- **Keywords:** Self-assessment; Expert assessment; Assessment method; Team performance

Tessy Luger, Mona Bär, Robert Seibt, Pia Rimmeli, Monika A. Rieger, Benjamin Steinhilber. A passive back exoskeleton supporting symmetric and asymmetric lifting in stoop and squat posture reduces trunk and hip extensor muscle activity and adjusts body posture: a laboratory study. 103530.

The influence of a passive exoskeleton was assessed during repetitive lifting with different lifting styles (squat, stoop) and orientations (frontal/symmetric, lateral/asymmetric) on trunk and hip extensor muscle activity (primary outcomes), abdominal, leg, and shoulder muscle activity, joint kinematics, and heart rate (secondary outcomes). Using the exoskeleton significantly and partially clinically relevant reduced median/peak activity of the erector spinae ($\leq 6\%$), biceps femoris ($\leq 28\%$), rectus abdominis ($\leq 6\%$) and increased median/peak activity of the vastus lateralis ($\leq 69\%$), trapezius descendens ($\leq 19\%$), and median knee ($\leq 6\%$) and hip flexion angles ($\leq 11\%$). Using the exoskeleton had only limited influence on muscular responses. The findings imply the exoskeleton particularly supports hip extension and requires an adjusted body posture during lifting with different styles and orientations. The potential of using exoskeletons for primary/secondary prevention of musculoskeletal disorders should be investigated in future research including a greater diversity of users in terms of age, gender, health status.

- **Keywords:** Assistive device; Repetitive lifting; Electromyography; Industry; Working posture

M. Frey, M. Barrett, D. De Carvalho. Effect of a dynamic seat pan design on spine biomechanics, calf circumference and perceived pain during prolonged sitting. 103546.

This study investigates the effects of a dynamic seat pan design on sitting biomechanics, perceived pain and seat movement compared to a control. Thirty male participants were recruited for two experimental sessions consisting of a 2-h sitting exposure (standardized typing task). Spine angles, back muscle activity, perceived pain and calf circumference were measured pre and post exposure. Sitting in the dynamic condition resulted in lower pain ratings ($p = 0.031$), decreased calf circumference ($p < 0.001$), lower average seat pressure ($p < 0.001$), and greater seat contact area ($p = 0.003$) compared to the control. Spine angles and low back EMG for all 6 muscles showed no significant differences between chair conditions. These results suggest this dynamic seat pan design is effective at decreasing several negative components associated with sitting for the occupant. Future work should examine the longer-term effects of dynamic office chair features in the field setting with a more generalizable population.

- **Keywords:** Lumbar spine; Multiaxial chair; Sitting; Calf circumference

Yuko Kaneko Yokubo, Tetsuo Ota, Katsuyuki Shibata. *Relationship between chopstick manipulation and cross-sectional shape in the developmental stages from infancy to early school age.* 103507.

Motor development was investigated in 114 children aged 4–9 years, and the effects of different cross-sectional shapes of chopsticks (octagonal, square, and triangular) on manipulation ability were examined. Children's chopstick manipulation was found to be related to the developmental stage and their way of holding them. Manipulation was enhanced when they transmitted the optimal force to the tips when closing, the bottom chopstick was stabilized when opening, and the upper chopstick was encouraged to rotate moderately. In addition, opening chopsticks is more difficult than closing them. Square chopsticks increase the force of the tips, whereas octagonal chopsticks encourage more rotation of the upper chopstick, indicating that differences in the ability to manipulate chopsticks during development affect the preference for cross-sectional shapes. We plan to examine the effectiveness of chopsticks with different cross-sectional shapes of the upper and bottom chopsticks by focusing on the opening operation.

- **Keywords:** Children; Motor development; Chopsticks

Tjaša Kermavnar, Alice Shannon, Leonard W. O'Sullivan. *The application of additive manufacturing / 3D printing in ergonomic aspects of product design: A systematic review.* 103528.

Additive Manufacturing (AM) facilitates product personalization and iterative design, which makes it an ideal technology for ergonomic product development. In this study, a systematic review was conducted of the literature regarding the use of AM in ergonomic-product design, and methodological aspects of the studies were analyzed. A literature search was performed using the keywords "3D print*," "additive manufacturing," "ergonomic*" and "human factors". Included were studies reporting the use of AM specifically in ergonomic design of products/prototypes including the detailing of an ergonomic testing methodology used for evaluation. Forty studies were identified pertaining to the fields of medicine, assistive technology, wearable technology, hand tools, testing devices and others. The most commonly used technology was fused deposition modeling with polylactic acid, but the overall preferred material was acrylonitrile butadiene styrene. Various combinations of objective/subjective and qualitative/quantitative product evaluation methods were used. Based on the findings, recommendations were developed to facilitate the choice of most suitable AM technologies and materials for specific applications in ergonomics.

- **Keywords:** 3D printing; Additive manufacturing; Ergonomics; Human factors

Aaron P.J. Roberts, Neville A. Stanton, Daniel Fay, Kiome A. Pope. *It's a circular argument: Examining how a novel configuration impacts information flow in submarine control rooms.* 103534.

The continuing advancement of technology means that sociotechnical systems are primed for revolutionary changes to ways of working that can increase capability. It is critical to consider the unintended impact technology can have on human operators particularly regarding information flow and interactions within teams. Previous research revealed that the co-location of operator's dependent on each other for task relevant information can optimise information flow previously constrained by engineering considerations. The current work compared a novel circular configuration to that of a contemporary submarine control room. In the circular configuration, consoles faced inwards, permitting eye contact between operators, and three large screen displays were introduced to provide all operators with the same information. Ten teams participated in low and high demand dived tracking scenarios in a simulated submarine control room. All communications between operators were recorded in order to generate social, information, and task networks. These were statistically compared to networks generated from a baseline study of contemporary operation. Overall, the volume of verbal communications significantly reduced, information exchange was more structured, and the volume of tasks completed by operators significantly increased when operating in an inward facing circle configuration. The current work provides support for a data driven evidence-based approach to design that is information centric but endorsed by the end user to optimise performance and increase productivity. Implications of the work and future research ideas are discussed.

- **Keywords:** Teamwork; Communication; Networks; Command and control

Jingya Guo, Tianrong Chen, Zhenzhen Xie, Calvin Kalun Or. *Effects of interventions to reduce the negative consequences of interruptions on task performance: A systematic review, meta-analysis, and narrative synthesis of laboratory studies.* 103506.

A systematic review was conducted to examine the effects of interventions aimed at reducing the negative consequences of interruptions on task performance. Medline, PsycINFO, PsycARTICLES, and the ABI/INFORM Collection were searched for relevant publications. Thirty-three laboratory-based experiments, containing 49 interventions, were reviewed. Seven types of interventions were identified. Overall, the use of interventions significantly increased primary task accuracy (standardized mean difference (SMD) = 1.03, P = 0.001) and reduced resumption lag (SMD = -0.51, P < 0.001), whereas no significant difference was observed for interrupting task accuracy. Subgroup analyses indicated that intervention effects varied by (i) the type of intervention and (ii) the type of primary task (procedural, decision-making, or problem-solving tasks). The narrative synthesis provided additional evidence regarding interruption lag and time spent on a primary task. In sum, this review identified the types of interventions that were particularly effective and provided implications for application and further investigation.

- **Keywords:** Interruption; Intervention; Meta-analysis

Andrew Brown, Simon Baldwin, Brittany Blaskovits, Craig Bennell. *Examining the impact of grip strength and officer gender on shooting performance.* 103536.

Background: Effective shooting performance relies heavily on sufficient grip strength. However, some standard issue pistols used by police services may have a trigger weight that causes problems for officers with insufficient grip strength, including female officers.

The current study aimed to replicate previous findings, which show that grip strength is positively related to shooting performance. We also sought to determine what grip strength is required to achieve proficient scores on a standard police pistol qualification (PPQ) when a heavy trigger weight (i.e., 8lbs-12lbs) is used. Finally, we explored the relationship between officer gender and PPQ scores to determine if grip strength plays a mediating role in this relationship. **Method:** The dominant hand grip strength (in lbs) of 86 male and 32 female officers were recorded prior to their participation in their agency mandated annual PPQ. Officer gender, grip strength, and PPQ scores were analyzed to explore how they related to one another. **Results:** Grip strength significantly impacted officers' ability to pass the PPQ, with female officers possessing lower grip strength compared to male officers, as well as achieving poorer scores on the PPQ. We determined that grip strengths in the range of 80lbs and 125lbs were needed to score approximately 85 % and 90 % on the PPQ, respectively; exceeding that of the average grip strength for the female officers in the study ($M = 77.5$ lbs). Mediation analysis suggested that grip strength may mediate the relationship between officer gender and shooting performance, but studies with more power are needed to confirm that. **Conclusion:** To improve shooting performance as well as public and police safety, law enforcement agencies may need to consider including grip strength training in their conditioning regime or examine the adoption pistols with a lighter trigger pull weight (e.g., 6lbs).

- **Keywords:** Shooting performance; Grip strength; Trigger pull weight; Pistol

Ju-Yang Chi, Mark Halaki, Erica Booker, Rhonda Boyle, Bronwen J. Ackermann. *Interaction between hand span and different sizes of keyboards on EMG activity in pianists: An observational study.* **103518.**

The availability of keyboards with reduced key width has been recently promoted as an ergonomic aid for small-handed pianists to overcome any potential physical disadvantages that may restrict their piano repertoire. However, a lack of biomechanical data exists to support whether reduced piano key size is effective in achieving this outcome. This research investigates the effect of playing on three different key width size pianos (5.5-inch octave, 6.0-inch octave and conventional size with 6.5-inch octave) on hand, arm and shoulder muscle activity levels according to the hand size of the pianists. Results indicate that piano key size affects the muscle activity levels of selected muscles. Furthermore, this effect of different key sizes changed according to the players' hand spans. Small-handed pianists may benefit from using smaller-sized keyboards to reduce muscular exertion during performance. This investigation provides preliminary EMG data supporting the use of different size keyboards to improve the ergonomic fit according to the dimensions of individual pianists.

- **Keywords:** Hand span; Muscle activity; Piano keyboard

Nicole J. Chimera, Michael W. R. Holmes, David A. Gabriel. *Anthropometrics and electromyography as predictors for maximal voluntary isometric wrist torque: Considerations for ergonomists.* **103496.**

The purpose of this study was to evaluate anthropometry and forearm muscle activity as predictors of maximal isometric wrist torque. Thirteen anthropometric measures, forearm electromyography from flexor carpi radialis (FCR) and extensor carpi radialis (ECR), and maximal isometric wrist flexion/extension torque were obtained from 25 male participants. Pearson correlation coefficients assessed relationships between peak isometric torque and: (1) anthropometrics, (2) FCR and ECR activation, (3) FCR/ECR antagonist/agonist coactivation ratios. Based on significant correlations, linear regression equations were developed (SPSS v.25; $p < 0.05$). Hand thickness, forearm circumference and ECR activation or hand thickness, elbow circumference, FCR activation and body

weight were most highly correlated with extension or flexion torque, respectively. Hand thickness, forearm circumference, and ECR activation ($R^2 = 54.5\%$; $p = 0.001$) and hand thickness, elbow circumference, FCR activation ($R^2 = 68.3\%$; $p < 0.001$) explained similar variance in torque regressions as did the addition of body weight to extension ($R^2 = 58.0\%$; $p = 0.001$) and flexion ($R^2 = 69.9\%$; $p < 0.001$) torque regression equations, respectively. Circumference measurements, a pseudo for muscle size, and activation amplitude influenced wrist force output more than limb length or coactivation.

- **Keywords:** Wrist strength; Workplace evaluation; Forearm EMG

Seonghyeok Park, Shuping Xiong. *The effect of slider design and length on user performance and preference of smartphone versions of the visual analogue scale.* 103521.

This study aims to investigate the effect of slider design and length on user performance and preference of smartphone versions of Visual Analogue Scale (VAS). Twenty-eight participants performed a task to set random target values with 8 smartphone versions of VAS: 2 slider designs (traditional design, modern design) \times 4 slider lengths (4.3 cm, 5.8 cm, 10 cm landscape, 10 cm portrait). Experimental results showed that both slider design and length significantly affected the accuracy, task completion time and subject preference. Compared with the traditional slider design, the modern slider design showed significantly smaller bias in setting values, shorter task completion time, and higher subject preference. The slider length significantly affected all measures, and 5.8 cm was recommended due to small bias, short task completion time, dominant preference and excellent ability to closely fit the width of smartphone display with the portrait mode. These findings could provide mobile VAS and slider designers with useful references.

- **Keywords:** Visual analogue scale; Smartphone application; Slider design; Touch interaction

Mahiyar F. Nasarwanji, Patrick G. Dempsey, Jonisha Pollard, Ashley Whitson, Lydia Kocher. *A taxonomy of surface mining slip, trip, and fall hazards as a guide to research and practice.* 103542.

Slips, trips, and falls (STFs) are the second leading cause of non-fatal injuries and can lead to fatal incidents in the mining industry. Hazard identification is an essential first step in remediating STF hazards and creating a safer work environment. Previous research has identified industry-specific risk factors for STFs, evaluated exposures to those risk factors, and developed taxonomies of the hazards for the construction and farming sectors. In comparison, ErgoMine—a mobile device application-based ergonomics audit tool—is the only systematic evaluation tool that covers STF hazards in the mining industry. However, ErgoMine was not specifically developed to address STF hazards. This paper describes the development of a taxonomy that helps identify STF hazards at surface mining sites and provides recommendations to address these hazards to inform future evaluation tools. The objective was to develop a taxonomy that was self-explanatory, observable, repeatable, and solution oriented. In addition to current regulations, standards and guidelines were used to develop the taxonomy to ensure the focus was beyond basic compliance. A detailed description of how the STF hazard taxonomy was created for walkways, stairways, and fixed ladders is provided, along with two specific applications of its use. The STF hazard taxonomy can be used to develop tools like checklists and ergonomics audits to identify and remediate slip, trip, and fall hazards at surface mining facilities, thereby improving worker safety.

- **Keywords:** Slip; Trip; Fall; Taxonomy; Standards; Checklist; Audit; Mining

Parth Shah, Yan Luximon. *Assessment of pressure sensitivity in the head region for Chinese adults.* 103548.

Measurement of pressure threshold has found its applications in the fields of medical sciences and product design. Hence it has been a profound area of research interest for several decades. However, hardly any detailed investigation has been undertaken to measure the pressure threshold in the head region. In this study, Pressure Discomfort Threshold (PDT) and Pressure Pain Threshold (PPT) were measured for two hundred eighteen healthy Chinese adults at seventy-six anatomical locations, and further statistical analyses were performed on the acquired data to understand the relationship between different demographic parameters. The results suggest that the pressure sensitivity is low in the vertex region, moderate in the forehead and temporal area, and high in the facial and nasal region. From this study, pressure sensitivity maps were developed for PDT and PPT for Chinese adults. The measured pressure threshold data showed no significant relationship with age and Body Mass Index (BMI).

- **Keywords:** Human head; Pressure threshold; Pressure sensitivity maps

Kathrine Greby Schmidt, Andreas Holtermann, Marie Birk Jørgensen, Malene Jagd Svendsen, Charlotte Diana Nørregaard Rasmussen. *Developing a practice and evidence-based guideline for occupational health and safety professionals to prevent and handle musculoskeletal pain in workplaces.* 103520.

Practice guidelines can facilitate the translation of evidence-based knowledge into better occupational health and safety (OHS) prevention. This paper describes the development process, findings and content of a practice and evidence-based guideline for musculoskeletal pain (MSP) to OHS professionals in Denmark. We used a participatory process with involvement of more than 100 OHS professionals in the development of the guideline. The guideline contains three sections: 1) Rapid review of risk factors for MSP (Push/pull, Screen work, Lifting, Awkward postures and Psychosocial factors related to MSP) and single- and multi-stranded interventions targeting MSP. 2) Process recommendations for use of the guideline by a three-phase participatory process 3) Practical recommendations that contain advice and methods for the three-phase participatory process. This paper can promote future guideline development, as it provides specific insight into how OHS professionals can be included in the development of practice and evidence-based guideline through a participatory process.

- **Keywords:** Occupational health and safety; Guideline; Musculoskeletal pain

Yan Ge, Li Lu, Xinyue Cui, Zhe Chen, Weinan Qu. *How personal characteristics impact phishing susceptibility: The mediating role of mail processing.* 103526.

In the phishing email literature, recent researchers have given much attention to individual differences in phishing susceptibility from the perspective of the Big Five personality traits. Although the effectiveness and advantages of the phishing susceptibility measures in the signal detection theory (SDT) framework have been verified, the cognitive mechanisms that lead to individual differences in these measures remain unknown. The current study proposed and examined a theoretical path model to explore how the Big Five personality traits, related knowledge and experience and the cognitive processing of emails (i.e., mail elaboration) influence users' susceptibility to phishing emails. A sample of 414 Chinese participants completed the 44-item Big Five Personality Inventory (BFI-44), Mail Elaboration Scale (MES), Web Experience Questionnaire, Experience with Electronic Mail Scale, Knowledge and Technical Background Test and a demographic questionnaire. The phishing susceptibility measures

were calculated after the participants finished an email legitimacy task in a role-playing scenario. The results showed that the general profile of the “victim personality” included low conscientiousness, low openness and high neuroticism, and Internet experience and computer and web knowledge played an important role. All of these factors have significant indirect effects on phishing susceptibility by influencing mail elaboration. Moreover, the probabilities of checking for further information or deleting the email reflect the sensitivity of email judgment. These findings reveal the mediating role of cognitive processing between individual factors and phishing susceptibility. The theoretical implications of this study for the phishing susceptibility literature and its applications to phishing risk interventions or training programs are discussed.

- **Keywords:** Phishing susceptibility; Personality traits; Cognitive processing of emails; Signal detection theory

Megan E. Salwei, Pascale Carayon, Peter L. T. Hoonakker, Ann Schoofs Hundt, Douglas Wiegmann, Michael Pulia, Brian W. Patterson. Workflow integration analysis of a human factors-based clinical decision support in the emergency department. 103498.

Numerous challenges with the implementation, acceptance, and use of health IT are related to poor usability and a lack of integration of the technologies into clinical workflow, and have, therefore, limited the potential of these technologies to improve patient safety. We propose a definition and conceptual model of health IT workflow integration. Using interviews of 12 emergency department (ED) physicians, we identify 134 excerpts of barriers and facilitators to workflow integration of a human factors (HF)-based clinical decision support (CDS) implemented in the ED. Using data on these 134 barriers and facilitators, we distinguish 25 components of workflow integration of the CDS, which are described according to four dimensions of workflow integration: time, flow, scope of patient journey, and level. The proposed definition and conceptual model of workflow integration can be used to inform health IT design; this is the purpose of the proposed checklist that can help to ensure consideration of workflow integration during the development of health IT.

- **Keywords:** Workflow integration; Health IT; Clinical decision support; Usability; Emergency department

Kiana Kia, Jaejin Hwang, In-Sop Kim, Hakim Ishak, Jeong Ho Kim. The effects of target size and error rate on the cognitive demand and stress during augmented reality interactions. 103502.

This study investigated the effects of target size and error rate on cognitive demand during augmented reality (AR) interactions. In a repeated-measures laboratory study, twenty participants performed two AR tasks (omni-directional pointing and cube placing) with different target sizes and error rates. During the AR tasks, we measured cerebral oxygenation using functional near-infrared spectroscopy (fNIRS), perceived workload using the NASA-TLX questionnaire, stress using the Short Stress State Questionnaire, and task performance (task completion time). The results showed that the AR tasks with more interaction errors increased cerebral oxygenation, perceived workload, and task completion time while the target size significantly affected physical demand and task completion time. These results suggest that appropriate target sizes and low system errors may reduce potential cognitive demand in AR interactions.

- **Keywords:** Functional near infrared spectroscopy; NASA task Load index; Computer human interaction; Usability; Cerebral oxygenation

Younggeun Choi, Xiaopeng Yang, Jangwoon Park, Hayoung Jung, Wonsup Lee, Heecheon You. *Development of an ergonomic design process for smartphone hard key locations.* 103532.

Smartphone hard key locations need to be ergonomically determined to improve grip stability and operational efficiency for users' convenience. The present study proposed an ergonomic design process that determines smartphone hard key locations by statistically analyzing the preferred hard key control areas of users with various hand sizes based on users' preferred grip postures and hard key control areas. The proposed design process analyzes the characteristics of product design, user, task, and use context, the types of preferred grip posture, the preference distribution of grip posture, and the preference distribution of hard-key area, and then recommends the locations of hard keys by considering the preference distribution of hard-key area and design constraints. The proposed design process was applied to a smartphone with a 5-inch screen, resulting in 77–96 mm from the bottom of the device for a volume key to 20 mm on the left side and 88–97 mm for a power key to 10 mm on the right side. The proposed design process for the determination of smartphone hard-key locations would be of use to determine the locations of various portable product interfaces.

- **Keywords:** Smartphone; Hard-key location; Physical user interface; Grip posture; Preference distribution

Bereket H. Woldegiorgis, Chiuhsiang J. Lin, Riotaro Sananta. *Using Kinect body joint detection system to predict energy expenditures during physical activities.* 103540.

The purpose of this study was to explore the potential of Kinect body joint detection to facilitate the calculation of energy expenditure during exergame exercises. Two Kinect-based biomechanical models - mechanical energy (KineticE) and work (WorkE) were employed to estimate the energy expenditure during four Wii™ exergame session. Consequently, two stepwise regression models were developed from nineteen participants' data and then validated by five holdout participants. The data collected using an accelerometer ($r = 0.835$, $p < 0.001$) had the highest correlation as compared to that of the WorkE ($r = 0.805$, $p < 0.001$) and KineticE ($r = 0.466$, $p < 0.001$) correlations with the reference indirect calorimetry using Quark activity energy expenditure (QuarkAEE). The regression results show that KineticE and the weight of the participant were significant factors for mechanical energy prediction (AEEKinetic). However, according to the work prediction equation (AEEWork), only WorkE was significant. The new energy prediction models showed significant agreement with the standard QuarkAEE (AEEKinect, $r = 0.641$, $p = 0.02$; AEEWork, $r = 0.793$, $p < 0.001$), and they were comparable to accelerometer predictions ($r = 0.682$, $p = 0.001$). The findings indicate that Kinect can be a potentially viable alternative to measure energy expenditures. The models can be applied with higher accuracy, especially when the activity demands high body movements.

- **Keywords:** Physical activity; Exergames; Kinect; Indirect calorimetry