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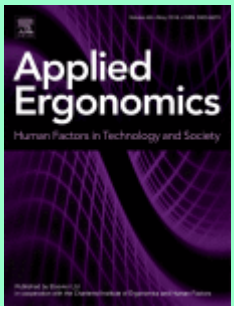

Kelly Hinckfuss, Penelope M. Sanderson, Birgit Brecknell, Robert G. Loeb, David Liu, Helen Liley. *Evaluating enhanced pulse oximetry auditory displays for neonatal oxygen targeting: A randomized laboratory trial with clinicians and non-clinicians*. 103918.

Standard pulse oximeter auditory tones do not clearly indicate departures from the target range of oxygen saturation (SpO2) of 90%–95% in preterm neonates. We tested whether acoustically enhanced tones would improve participants' ability to identify SpO2 range. Twenty-one clinicians and 23 non-clinicians used (1) standard pulse oximetry variable-pitch tones plus alarms; (2) beacon-enhanced tones without alarms in which reference tones were inserted before standard pulse tones when SpO2 was outside target range; and (3) tremolo-enhanced tones without alarms in which pulse tones were modified with tremolo when SpO2 was outside target range. For clinicians, range identification accuracies (mean (SD)) in the standard, beacon, and tremolo conditions were 52% (16%), 73% (14%) and 76% (13%) respectively, and for non-clinicians 49% (16%), 76% (13%) and 72% (14%) respectively, with enhanced conditions always significantly more accurate than standard. Acoustic enhancements to pulse oximetry clearly indicate departures from preterm neonates' target SpO2 range.

- **Keywords:** Sonification; Auditory displays; Pulse oximetry; Neonatal oxygen saturation

Sean L. Corrigan, Spencer S.H. Roberts, Stuart A. Warmington, Jace R. Drain, Jamie L. Tait, Sean Bulmer, Luana C. Main. *Overnight heart rate variability responses to military combat engineer training*. 103935.

The study aimed to determine if overnight heart rate variability (HRV) is reflective of workload and stress during military training. Measures of cognitive load, perceived exertion, physical activity, nocturnal HRV, cognitive performance and sleep were recorded for a 15-day assessment period in 32 combat engineers. The assessment period consisted of 4 phases, PRE, FIELD, BASE and RECOVERY that exposed trainees to periods of sleep deprivation and restriction. The FIELD phase was characterised by an increase in mood disturbance, perceived exertion, physical activity, HRV and a reduction in sleep quantity ($p < 0.05$). Measures of HRV returned to PRE-values quicker than subjective wellbeing responses. The combination of sleep duration ($\beta = -0.002$, $F = 13.42$, $p < 0.001$) and physical activity (metabolic equivalents, $\beta = -0.483$, $F = 5.95$, $p = 0.017$), the main stressors of the exercise, provided a significant effect in the best

predictive model of HRV. The different recovery rates of HRV and subjective wellbeing suggest a different physiological and psychological response.

- **Keywords:** Sleep; Stress; Soldiers

Ben Meadley, Matthew Rogers, Kelly-Ann Bowles, Joanne Caldwell. *The bookmark method to establish minimum performance standards for intensive care flight paramedics performing helicopter winch rescue*. 103934.

We aimed to use the bookmark method to establish minimum standards for selecting intensive care flight paramedics. Two subject matter expert (SME) focus groups reviewed nine videos of decreasing duration showing land and water helicopter rescue tasks. Focus Group 1 (FG1, n = 10) viewed videos individually off-site, whilst Focus Group 2 (FG2, n = 9) attended a face-to-face session. All SMEs selected the video they judged as the appropriate pace for the task then reviewed feedback. For both groups, the process was repeated until 80% agreement was achieved, or three rounds were completed (whichever occurred first). FG1 and FG2 achieved agreement after two rounds for the land task. For the water task, FG1 did not reach agreement. FG2 reached consensus after two rounds. The selected task durations were similar. The bookmark method is valuable to determine performance standards for performing winch rescue, and SMEs are more likely to reach consensus when face-to-face.

- **Keywords:** Physical employment standards; Task analysis; Physical work capacity; Search and rescue

Shahrzad Timman, Markus Landgraf, Christoph Haskamp, Stephanie Lizy-Destrez, Frederic Dehais. *Effect of time-delay on lunar sampling tele-operations: Evidences from cardiac, ocular and behavioral measures*. 103910.

The purpose of this study is to quantify performance in human-robot interaction under time-delay conditions in a lunar tele-operations sampling task, by testing the hypothesis that an increase of time-delay would lead to higher perceived workload and lower human performance in human-robotic integrated operations. Tele-operation is key in the exploration of the Moon, and allows for robotic elements to be controlled from orbital infrastructure and other planetary bodies such as the Earth. Considering that future missions aim to control rovers (amongst others for sampling tasks) from Earth (delay: 3s), the Gateway (delay: 0.5s) and the Moon (delay: 0s), control under the time-delay conditions for these locations must be studied. Time-delay can affect performance, and understanding the performance means that mission operations can be planned bottom-up, which benefits both the preparation of the crew and the design of rovers. An experiment was conducted with 18 engineers who were assigned to control a robotic arm under three time-delay conditions, representing the three control locations. Several metrics were derived from cardiac, ocular, subjective and behavioral measures. The analyses disclosed that the large time-delay condition statistically increased the perceived workload, the time to complete the mission and decreased heart rate variability compared to the other conditions. However, no effect of time-delay was found on attentional and executive abilities. The metrics proved to be effective in the study of performance quantification in human-robot interaction for tele-operations in lunar control scenarios. This approach can be implemented for a larger range of robotic activities, such as tele-operated driving.

- **Keywords:** Space exploration; Human-robotic interaction; Lunar operations; Human performance; Sampling operations; Eye-tracking; ECG; Human factors

Nathalie M.C.W. Oomen, Ryan B. Graham, Steven L. Fischer. *Exploring the relationship between kinematic variability and fatigue development during repetitive lifting*. 103922.

To investigate the variability-fatigue and repeaters-replacers hypotheses, motor variability (MV) and indicators of fatigue were assessed during repetitive lifting. Eighteen participants performed sequential repetitive bouts of lifting divided into a short bout, and three phases of a prolonged bout until volitional fatigue (or until a 1-h time limit). Whole-body kinematics were collected to calculate variability in three-dimensional joint angles and in continuous relative phase (CRP) of sagittal joint angle couplings, which were summed for the upper and lower body, and whole-body. Excellent individual consistency (ICC = 0.95–0.97) was demonstrated across lifting bouts as fatigue developed. Therefore, strong evidence was obtained for MV as an individual trait in support of the repeaters-replacers hypothesis. Associations were found for endurance and baseline effort with lower body variability, while no associations were found for rate of fatigue. Thus, some support was found for the variability-fatigue hypothesis which suggests that repeaters are less fatigue-resistant than replacers.

- **Keywords:** Motor variability; Fatigue; Individual consistency

Tomás Espinoza-Palavicino, Patricio Mena-Chamorro, Javier Albayay, Arlette Doussoulin, Germán Gálvez-García. *The use of transcutaneous Vagal Nerve Stimulation as an effective countermeasure for Simulator Adaptation Syndrome*. 103921.

This research focused on investigating the effectiveness of Transcutaneous Vagal Nerve Stimulation (tVNS) as compared to Galvanic Cutaneous Stimulation (GCS) at mitigating Simulator Adaptation Syndrome (SAS). Fifty drivers (mean age = 23.04 ± 17.71 years old, twenty-two men) participated in a driving simulation experiment. The total scores of the Simulator Sickness Questionnaire, head movements (body balance index), and driving performance variables were measured under five stimulation conditions: i) baseline (no stimulation delivered), ii) sham GCS, iii) sham tVNS, iv) active GCS, and v) active tNVS. The results showed that tVNS alleviated SAS and improved driving performance variables more effectively than GCS. We conclude that GCS and tVNS have similar neurological mechanisms to reduce SAS, providing possible explanations for the greater effectiveness of tVNS. We encourage the use of tVNS to decrease SAS.

- **Keywords:** Simulator adaptation syndrome; Transcutaneous vagal nerve stimulation; Galvanic cutaneous stimulation

Soichiro Koyama, Tsuyoshi Tatemoto, Nobuhiro Kumazawa, Shigeo Tanabe, Yuki Nakagawa, Yohei Otaka. *The effect of differences in powered wheelchair joystick shape on subjective and objective operability*. 103920.

Various-shaped joysticks steer electric-powered wheelchairs (EPWs); however, an operability evaluation has not been fully conducted. This study evaluated the subjective and objective operability of various-shaped joysticks in 22 younger and 22 older adults. Participants operated an EPW on an experimental course using nine different-shaped joysticks, before ranking each joystick by their operability (1 = best, 9 = worst) as a primary outcome. Movement time (MT) and driving accuracy (DA) were also measured. Despite no significant differences in the primary outcome between joysticks, the I-shaped joystick with rounded tips (neutral grip) was ranked higher than the others. MT did not differ between joysticks, but DA was higher for the thin-columnar I-shaped joystick (pinch grip) than for the U- and T-shaped joysticks (pronated grip). MT and DA scores for

young adults were significantly better than those for older adults. Further studies should be conducted to clarify possible factors related to EPW operability.

- **Keywords:** Ergonomics; Electric wheelchair; Joystick

M. Smulders, L.N.M. van Dijk, Y. Song, P. Vink, T. Huysmans. *Dense 3D pressure discomfort threshold (PDT) map of the human head, face and neck: A new method for mapping human sensitivity*. 103919.

When designing wearables that interface with the human head, face and neck, designers and engineers consider human senses, ergonomics and comfort. A dense 3D pressure discomfort threshold map could be helpful, but does not exist yet. Differences in pressure discomfort threshold for areas of the head, neck and face were recorded, to create a 3D pressure discomfort threshold map. Between 126 and 146 landmarks were placed on the left side of the head, face and neck of twenty-eight healthy participants (gender balanced). The positions of the landmarks were specified using an EEG 10–20 system-based landmark-grid on the head and a self-developed grid on the face and neck. A 3D scan was made to capture the head geometry and landmark coordinates. In a randomised order, pressure was applied on each landmark with a force gauge until the participant indicated experiencing discomfort. By interpolating all collected pressure discomfort thresholds based on their corresponding 3D coordinates, a dense 3D pressure discomfort threshold map was made. A relatively low-pressure discomfort threshold was found in areas around the nose, neck front, mouth, chin-jaw, cheek and cheekbone, possibly due to the proximate or direct location of nerves, blood veins and soft (muscular) tissue. Medium pressure discomfort was found in the neck back, forehead and temple regions. High pressure discomfort threshold was found in the back of the head and scalp, where skin is relatively thin and closely supported by bone, making these regions interesting for mounting or resting head, face and neck related equipment upon.

- **Keywords:** Comfort; Digital human modelling; 3D scanning; Wearables; Pressure ulcers

Loïc Caroux. *Presence in video games: A systematic review and meta-analysis of the effects of game design choices*. 103936.

Sense of presence is a widely assessed dimension of video game player experience. A systematic literature review and a meta-analysis were conducted to provide a more comprehensive view of the elements of game design that have an effect on the sense of presence, as well as its different dimensions studied and assessment techniques. The review revealed that many major categories of game design aspects were well represented. The meta-analysis revealed that several game design factors have significant effects on different dimensions of presence. The largest revealed effects were that playing games with a head-mounted display and motion controller rather than a monitor display and non-motion controller has a large effect on global presence. Also, playing with human co-players rather than computer-controlled co-players and playing cooperatively rather than competitively have a very large and large effect on social presence, respectively. Implications for future research are discussed, such as investigating the effects of design factors on presence in a more targeted manner, systematically assessing presence with its most relevant sub-dimensions, and using more similar rating scales. Design recommendations, with their expected impact on players' sense of presence, are proposed.

- **Keywords:** Game user research; Player experience; Visual display; Multiplayer; Questionnaire; Scale

Guoyang Zhou, Ming-Lun Lu, Denny Yu. *Investigating gripping force during lifting tasks using a pressure sensing glove system*. 103917.

Lifting tasks remain one of the leading causes of musculoskeletal disorders (MSDs), primarily in the low back region. Lifting analysis tools are, therefore, designed for assessing the risk of low back pain. Shoulder musculoskeletal problems have emerged as common MSDs associated with manual handling tasks. It is hypothesized that gripping force is related to lifting conditions and may be used as a supplementary risk metric for MSDs in the shoulder and low back regions, because it measures additional hand exertions for coupling the lifted object during lifting. We assessed the capability tactile gloves for measuring the gripping force during lifting as a means for assessing different task conditions (lifting weight, lifting height, lifting direction, body rotation, and handle). Thirty participants wore the tactile gloves and performed simulated lifting tasks. Regression models were used to analyze the effects of the task variables on estimating the measured gripping force. Results demonstrated that 58% and 70% of the lifting weight variance were explained by the measured gripping force without and with considering the individual difference, respectively. In addition to the lifting risk measures commonly used by practitioners, this study suggests a potential for using gripping force as a supplementary or additional risk metric for MSDs.

- **Keywords:** Manual lifting tasks; Tactile glove sensor; Biomechanics