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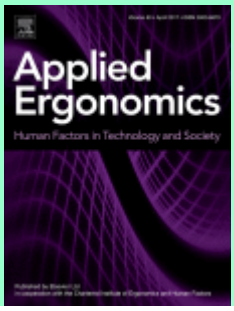


**Coco C.T. Guo, Daniel J.Z. Chen, Isabella Y. Wei, Richard H.Y. So, Raymond T.F. Cheung. *Correlations between individual susceptibility to visually induced motion sickness and decaying time constant of after-nystagmus*. Pages 1-8.**

This study examines the correlations between optokinetic after-nystagmus (OKAN) parameters and individual susceptibility to visually induced motion sickness (VIMS). Twenty-seven participants were exposed to vertical black-and-white stripes drifting along the yaw axis at 60° per second for 30 min to collect individual VIMS data (Phase 1). Two weeks after the exposure, OKANs were measured (Phase 2). 19 out of 27 participants (i.e., 70%) exhibited consistent OKAN patterns. Significant correlations between the time constants of OKAN and levels of VIMS experienced by the same viewers were found. Four months later, these 27 participants were invited back for a second OKAN measurement (Phase 3). Twenty-one participants came back. Their two OKAN measurements were significantly correlated ($r = 0.69$, $p = 0.001$). Rated levels of VIMS in phase 1 significantly correlated with the time constant of OKAN in both Phase 2 ($r = 0.51$, $p = 0.044$) and Phase 3 ($r = 0.74$, $p = 0.006$). The implications of the correlation results are discussed.

- **Keywords:** Optokinetic after-nystagmus; Visually induced motion sickness; Velocity storage mechanism

**Drew M. Morris, June J. Pilcher, Joseph B. Mulvihill, Melissa A. Vander Wood. *Performance awareness: predicting cognitive performance during simulated shiftwork using chronobiological measures*. Pages 9-16.**

Physiological tracers of circadian rhythms and a performance awareness index were examined as predictors of cognitive performance during two sleep deprivation conditions common to occupational shiftwork. Study 1: Thirty-three sleep-deprived participants completed a simulated nightshift. Study 2: Thirty-two partially sleep-deprived participants completed a simulated dayshift. A standardized logic test was used to measure cognitive performance. Body temperature and heart rate were measured as chronobiological indices of endogenous circadian rhythms. Performance awareness was calculated as a correlation between actual and perceived performance. These studies demonstrated a parallelism between performance awareness and the circadian rhythm. Chronobiological changes were predictive of performance awareness during the simulated nightshift but not dayshift. Only oral temperature was a significant independent predictor. Oral temperature predicted an individual's awareness of their own performance

better than their own subjective awareness. These findings suggest that using circadian rhythms in applied ergonomics may reduce occupational risk due to low performance awareness.

- **Keywords:** Circadian rhythm; Body temperature; Occupational health

**Maryam Zahabi, Patricia Machado, Carl Pankok Jr., Mei Ying Lau, Yi-Fan Liao, Joseph Hummer, William Rasdorf, David B. Kaber. *The role of driver age in performance and attention allocation effects of roadway sign count, format and familiarity*. Pages 17-30.**

White-on-blue logo signs are used to inform drivers of food, gas, lodging, and attraction businesses at highway interchanges. In this study, 60 drivers were asked to look for food and attraction targets on logo signs while driving in a realistic freeway simulation. The objective of the study was to quantify effects of the number of sign panels (six vs. nine), logo familiarity (familiar vs. unfamiliar), logo format (text vs. pictorial), and driver age (young, middle, and elderly) on performance, attention allocation and target identification accuracy. Results revealed elderly drivers to exhibit worse performance in comparison to middle-age and young groups even though they adopted a more conservative driving strategy. There was no significant effect of the number of panels, logo familiarity, and logo format on driver performance or attention allocation. In target identification, drivers were more accurate with familiar or text-based panels appearing in six-panel signs.

- **Keywords:** Logo signs; Driving simulation; Driver performance; Driver distraction; Highway safety

**Nikki Olsen, Ann Williamson. *Application of classification principles to improve the reliability of incident classification systems: a test case using HFACS-ADF*. Pages 31-40.**

Accident classification systems are important tools for safety management. Unfortunately, many of the tools available have demonstrated poor reliability of coding, making their validity and usefulness questionable. This paper demonstrates the application of four strategies to improve the reliability of accident and incident classification systems. The strategies include creating a domain-specific system with limitations on system size and careful selection of codes, specifically the reduction of abstract concepts and bias-causing terminology. Using HFACS-ADF as a test case, the system was adapted using the strategies and validated using comprehension and comprehensiveness testing. The new system was then assessed for reliability. The reliability of the system increased by at least 20% at all levels of the classification system following the changes made. The results provide evidence that the application of theoretically and empirically-derived classification principles are effective for improving the reliability of accident and incident classification systems in high hazard industries.

- **Keywords:** Accident and incident classification; Reliability; Safety

**Andreas Holtermann, Vera Schellewald, Svend Erik Mathiassen, Nidhi Gupta, Andrew Pinder, Anne Punakallio, Kaj Bo Veiersted, Britta Weber, Esa-Pekka Takala, Francesco Draicchio, Henrik Enquist, Kevin Desbrosses, Maria Peñahora García Sanz, Marzena Malińska, María Villar, Michael Wichtl, Michaela Strebl, Mikael Forsman, Sirpa Lusa, Tomasz Tokarski, Peter Hendriksen, Rolf Ellegast. *A practical guidance for assessments of sedentary behavior at work: a PEROSH initiative*. Pages 41-52.**

Sedentary behavior is defined as sitting or lying with low energy expenditure. Humans in industrialized societies spend an increasing amount of time in sedentary behaviors every day. This has been associated with detrimental health outcomes. Despite a growing interest in the health effects of sedentary behavior at work, associations remain unclear, plausibly due to poor and diverse methods for assessing sedentary behavior. Thus, good practice guidance for researchers and practitioners on how to assess occupational sedentary behavior are needed. The aim of this paper is to provide a practical guidance for practitioners and researchers on how to assess occupational sedentary behavior. Ambulatory systems for use in field applications (wearables) are a promising approach for sedentary behavior assessment. Many different small-size consumer wearables, with long battery life and high data storage capacity are commercially available today. However, no stand-alone commercial system is able to assess sedentary behavior in accordance with its definition. The present paper offers decision support for practitioners and researchers in selecting wearables and data collection strategies for their purpose of study on sedentary behavior. Valid and reliable assessment of occupational sedentary behavior is currently not easy. Several aspects need to be considered in the decision process on how to assess sedentary behavior. There is a need for development of a cheap and easily useable wearable for assessment of occupational sedentary behavior by researchers and practitioners.


- **Keywords:** Sedentary work; Wearables; Guideline; Sitting; Technical; Measurements


**David R. Large, Leigh Clark, Annie Quandt, Gary Burnett, Lee Skrypchuk. *Steering the conversation: alinguistic exploration of natural language interactions with a digital assistant during simulated driving*. Pages 53-61.**

Given the proliferation of 'intelligent' and 'socially-aware' digital assistants embodying everyday mobile technology – and the undeniable logic that utilising voice-activated controls and interfaces in cars reduces the visual and manual distraction of interacting with in-vehicle devices – it appears inevitable that next generation vehicles will be embodied by digital assistants and utilise spoken language as a method of interaction. From a design perspective, defining the language and interaction style that a digital driving assistant should adopt is contingent on the role that they play within the social fabric and context in which they are situated. We therefore conducted a qualitative, Wizard-of-Oz study to explore how drivers might interact linguistically with a natural language digital driving assistant. Twenty-five participants drove for 10 min in a medium-fidelity driving simulator while interacting with a state-of-the-art, high-functioning, conversational digital driving assistant. All exchanges were transcribed and analysed using recognised linguistic techniques, such as discourse and conversation analysis, normally reserved for interpersonal investigation. Language usage patterns demonstrate that interactions with the digital assistant were fundamentally social in nature, with participants affording the assistant equal social status and high-level cognitive processing capability. For example, participants were polite, actively controlled turn-taking during the conversation, and used back-channelling, fillers and hesitation, as they might in human communication. Furthermore, participants expected the digital assistant to understand and process complex requests mitigated with hedging words and expressions, and peppered with vague language and deictic references requiring shared contextual information and mutual understanding. Findings are presented in six themes which emerged during the analysis – formulating responses; turn-taking; back-channelling, fillers and hesitation; vague language; mitigating requests and politeness and praise. The results can be used to inform the design of future in-vehicle natural language systems, in particular to help manage the tension between designing for an engaging dialogue (important for technology acceptance) and designing for an effective dialogue (important to minimise distraction in a driving context).

- **Keywords:** Natural language interface; Digital assistant; Social AIs; Driving; Simulation; Wizard-of-Oz

### **Andreas Haslbeck, Bo Zhang. *I spy with my little eye: analysis of airline pilots' gaze patterns in a manual instrument flight scenario*. Pages 62-71.**

The aim of this study was to analyze pilots' visual scanning in a manual approach and landing scenario. Manual flying skills suffer from increasing use of automation. In addition, predominantly long-haul pilots with only a few opportunities to practice these skills experience this decline. Airline pilots representing different levels of practice (short-haul vs. long-haul) had to perform a manual raw data precision approach while their visual scanning was recorded by an eye-tracking device. The analysis of gaze patterns, which are based on predominant saccades, revealed one main group of saccades among long-haul pilots. In contrast, short-haul pilots showed more balanced scanning using two different groups of saccades. Short-haul pilots generally demonstrated better manual flight performance and within this group, one type of scan pattern was found to facilitate the manual landing task more. Long-haul pilots tend to utilize visual scanning behaviors that are inappropriate for the manual ILS landing task. This lack of skills needs to be addressed by providing specific training and more practice.

- **Keywords:** Gaze pattern; Manual flying; Visual scanning

### **Sangeun Jin, Gary A. Mirka. *Combined effect of low back muscle fatigue and passive tissue elongation on the flexion-relaxation response*. Pages 72-78.**

Previous literature has documented the alterations in the flexion-relaxation response of the lumbar extensor musculature to passive tissue elongation (PTE) and muscle fatigue (MF). There is no study, however, that has explored this response as a function of the combined effect of both PTE and MF, which is often seen in occupational settings. Twelve participants performed three experimental protocols on three different days to achieve (1) PTE, (2) MF and (3) PTE&MF (combined). Trunk kinematics and muscle activities were monitored to assess the effects of these protocols on the peak lumbar flexion angle and the lumbar angle of the flexion-relaxation of the trunk extensor muscles. Results showed responses to the uni-dimensional stresses (PTE and MF) consistent with those seen in the previous literature, while the combined protocol elicited responses that more closely matched the PTE protocol.

- **Keywords:** Flexion-relaxation phenomenon; Passive tissue elongation; Muscle fatigue

### **Iina Aaltonen, Jari Laarni. *Field evaluation of a wearable multimodal soldier navigation system*. Pages 79-90.**

Challenging environments pose difficulties for terrain navigation, and therefore wearable and multimodal navigation systems have been proposed to overcome these difficulties. Few such navigation systems, however, have been evaluated in field conditions. We evaluated how a multimodal system can aid in navigating in a forest in the context of a military exercise. The system included a head-mounted display, headphones, and a tactile vibrating vest. Visual, auditory, and tactile modalities were tested and evaluated using unimodal, bimodal, and trimodal conditions. Questionnaires, interviews and observations were used to evaluate the advantages and disadvantages of each modality and their multimodal use. The guidance was considered easy to interpret and helpful in navigation. Simplicity of the displayed information was required, which was partially conflicting with the request for having both distance and directional information available.

- **Keywords:** Navigation; Multimodal; Wearable

**Pieter Coenen, Amity Campbell, Kevin Kemp-Smith, Peter O'Sullivan, Leon Straker. *Abdominal bracing during lifting alters trunk muscle activity and body kinematics*. Pages 91-98.**

We assessed whether participants are able to perform abdominal bracing during lifting, and described its effects on trunk muscle activity and body kinematics. Fourteen participants performed 10 lifts (symmetrical lifting of a 15 kg load from floor level), 5 with abdominal bracing and 5 without. Activity of the lumbar multifidus (LM) and internal oblique (IO) muscles, and trunk and lower body kinematics were obtained. During non-bracing lifting, IO activity did not increase beyond rested standing levels (with average muscle activity ranging between 8.2 and 9.1% maximum voluntary contraction; %MVC), while LM activity did (range: 8.5–21.0 %MVC). During bracing lifting, muscle activity was higher compared to non-bracing in IO and LM at the start of the lift (with average between condition differences up to 10.9 %MVC). Upper leg, pelvis and lumbar spine angles were smaller, but thorax flexion angles were larger while lifting with bracing compared to without (with average between condition differences ranging from 0.7° to 4.3°). Although participants do not typically brace their abdominal muscles while lifting, they can be trained to do so. There appears to be no clear advantage of abdominal bracing during lifting, leaving its value for low-back pain prevention unclear.

- **Keywords:** Back pain; Prevention; Abdominal bracing; Lifting

**J. Van Houcke, A. Schouten, G. Steenackers, D. Vandermeulen, C. Pattyn, E.A. Audenaert. *Computer-based estimation of the hip joint reaction force and hip flexion angle in three different sitting configurations*. Pages 99-105.**

Sitting is part of our daily work and leisure activities and can be performed in different configurations. To date, the impact of different sitting configurations on hip joint loading has not been studied. We therefore evaluated the hip joint reaction force (HJRF) and hip flexion angle in a virtual representative male Caucasian population by means of musculoskeletal modelling of three distinct sitting configurations: a simple chair, a car seat and a kneeling chair configuration. The observed median HJRF in relation to body weight and hip flexion angle, respectively, was 22.3% body weight (%BW) and 63° for the simple chair, 22.5%BW and 79° for the car seat and 8.7%BW and 50° for the kneeling chair. Even though the absolute values of HJRF are low compared to the forces generated during dynamic activities, a relative reduction of over 50% in HJRF was observed in the kneeling chair configuration. Second, the hip flexion angles were both in the kneeling chair (−29°) and simple chair configuration (−16°) lower compared to the car seat and, as such, did not reach the threshold value for femoroacetabular conflict. In conclusion, the kneeling chair appears to hold the greatest potential as an ergonomic sitting configuration for the hip joint.

- **Keywords:** Hip joint; Biomechanics; Sitting configuration

**Wei Guo, Qing Zheng, Weijin An, Wei Peng. *User roles and contributions during the new product development process in collaborative innovation communities*. Pages 106-114.**

Collaborative innovation (co-innovation) community emerges as a new product design platform where companies involve users in the new product development (NPD) process. Large numbers of users participate and contribute to the process voluntarily. This exploratory study investigates the heterogeneous roles of users based on a global co-innovation project in online community. Content analysis, social network analysis and

cluster method are employed to measure user behaviors, distinguish user roles, and analyze user contributions. The study identifies six user roles that emerge during the NPD process in co-innovation community: project leader, active designer, generalist, communicator, passive designer, and observer. The six user roles differ in their contribution forms and quality. This paper contributes to research on co-innovation in online communities, including design team structure, user roles and their contribution to design task and solution, as well as user value along the process. In addition, the study provides practices guidance on implementing project, attracting users, and designing platform for co-innovation community practitioners.

- **Keywords:** Co-innovation process; User role; User contribution

### Christopher James Vincent, Ann Blandford. *Bags, batteries and boxes: a qualitative interview study to understand how syringe drivers are adapted and used by healthcare staff*. Pages 115-122.

Syringe drivers are medical devices that are critical for end of life care. They deliver continuous medication over extended periods of time. Their design contributes to the quality of experience for both patients and healthcare professionals. Little research has been published about the factors that influence the usability of this type of equipment for frontline users (i.e. those in direct contact with patients) and how equipment gets introduced. Understanding how syringe drivers are used in practice can help improve the design of equipment. 27 semi-structured interviews were conducted across acute hospitals, community hospitals and hospices (4 organisations in total). All participating organisations used the same type of syringe driver. It was found that frontline staff needed to adapt this equipment to fit the circumstances of use. The analysis provided examples of this happening for aspects relating to the appearance of the device (bags), accessories (batteries) and security (the lockable box).

- **Keywords:** Interface; User computer; Purchasing; Medical device design; Palliative care

### Xavier Robert-Lachaine, Hakim Mecheri, Christian Larue, André Plamondon. *Effect of local magnetic field disturbances on inertial measurement units accuracy*. Pages 123-132.

Inertial measurement units (IMUs), a practical motion analysis technology for field acquisition, have magnetometers to improve segment orientation estimation. However, sensitivity to magnetic disturbances can affect their accuracy. The objective of this study was to determine the joint angles accuracy of IMUs under different timing of magnetic disturbances of various durations and to evaluate a few correction methods. Kinematics from 12 individuals were obtained simultaneously with an Xsens system where an Optotrak cluster acting as the reference system was affixed to each IMU. A handling task was executed under normal laboratory conditions and imposed magnetic disturbances. Joint angle RMSE was used to conduct a three-way repeated measures analysis of variance in order to contrast the following disturbance factors: duration (0, 30, 60, 120 and 240 s), timing (during the disturbance, directly after it and a 30-second delay after it) and axis (X, Y and Z). The highest joint angle RMSE was observed on rotations about the Y longitudinal axis and during the longer disturbances. It stayed high directly after a disturbance, but returned close to baseline after a 30-second delay. When magnetic disturbances are experienced, waiting 30 s in a normal condition is recommended as a way to restore the IMUs' initial accuracy. The correction methods performed modestly or poorly in the reduction of joint angle RMSE.

- **Keywords:** Distortion; Magnetometers; Error; Correction; Compensation

**John M. Flach, Markus A. Feufel, Peter L. Reynolds, Sarah Henrickson Parker, Kathryn M. Kellogg. *Decisionmaking in practice: the dynamics of muddling through*. Pages 133-141.**

An alternative to conventional models that treat decisions as open-loop independent choices is presented. The alterative model is based on observations of work situations such as healthcare, where decisionmaking is more typically a closed-loop, dynamic, problem-solving process. The article suggests five important distinctions between the processes assumed by conventional models and the reality of decisionmaking in practice. It is suggested that the logic of abduction in the form of an adaptive, muddling through process is more consistent with the realities of practice in domains such as healthcare. The practical implication is that the design goal should not be to improve consistency with normative models of rationality, but to tune the representations guiding the muddling process to increase functional perspicacity.

- **Keywords:** Abduction; Decisionmaking; Judgment; Heuristic; Adaptive control

**Sean Gallagher, Richard F. Sesek, Mark C. Schall Jr., Rong Huangfu. *Development and validation of an easy-to-use risk assessment tool for cumulative low back loading: the Lifting Fatigue Failure Tool (LiFFT)*. Pages 142-150.**

Recent evidence suggests that musculoskeletal disorders (MSDs) may be the result of a fatigue failure process in affected tissues. This paper describes a new low back exposure assessment tool (the Lifting Fatigue Failure Tool [LiFFT]), which estimates a "daily dose" of cumulative loading on the low back using fatigue failure principles. Only three variables are necessary to derive the cumulative load associated with a lifting task: the weight of the load, the maximum horizontal distance from the spine to the load, and the number of repetitions for tasks performed during the workday. The new tool was validated using two existing epidemiological databases: the Lumbar Motion Monitor (LMM) database, and a database from a U.S. automotive manufacturer. The LiFFT cumulative damage metric explained 92% of the deviance in low back disorders (LBDs) in the LMM database and 72–95% of the deviance in low back outcomes in the automotive database (depending on the outcome measure). Thus, LiFFT is practitioner friendly and its cumulative damage metric highly related to low back outcomes.

- **Keywords:** Low back pain; Cumulative loading; Fatigue failure