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**J.C.F. de Winter, D. Dodou & P.A. Hancock. *On the paradoxical decrease of self-reported cognitive failures with age.* Pages 1471-1486.**

The science of Human Factors and Ergonomics (HF/E) often relies on self-report. This is a cause for concern because subjective methods are inherently susceptible to bias. Here, we present, examine and discuss a puzzling association between age and self-reported cognitive failures as assessed with Broadbent's Cognitive Failures Questionnaire (CFQ). Despite many well-established age-associated forms of cognitive decline, older persons actually report almost equivalent, or even less, cognitive failures on the CFQ than younger persons. Our present analysis indicates that this paradox may be resolved through the fact that people show age-related learning/adaptation/compensation and by the observation that the CFQ measures peoples' beliefs with respect to an individually idiosyncratic reference. Yet, at the heart of the paradox may be the idea that people cannot remember their own cognitive failures, pointing to even greater concerns with all forms of subjective self-report and its use in HF/E. **Practitioner Summary:** Scientists and practitioners often try to understand and improve human performance with the help of self-report questionnaires. Our paper discusses the validity of self-reported errors measured with the Cognitive Failures Questionnaire (CFQ). We look to resolve the curious paradox that older persons tend to report fewer failures than younger persons do.

- **Keywords:** ergonomics tools and methods, memory, human error, cognitive impairment

**James M. Bailey. *The implications of probability matching for clinician response to vital sign alarms: a theoretical study of alarm fatigue.* Pages 1487-1495.**

Alarm fatigue has been recognised as a significant health technology safety risk. 'Probability matching', in which clinicians respond to the alarm at a rate identical to the perceived reliability of the alarm, has been postulated as a model to explain alarm fatigue. In this article, we quantitatively explore the implications of probability matching for systolic blood pressure alarms. We find that probability matching could have a profound effect on clinician response to the alarm, with a response rate of only 8.6% when the alarm threshold is 90 mm Hg and the optimal threshold for a systolic blood

pressure alarm would only be 77 mm Hg. We use the mathematical framework to assess a mitigation strategy when clinicians have a limit to the capacity to respond. We find that a tiered alarm in which clinicians receive information on the severity of vital sign perturbation significantly improves the opportunity to rescue patients. **Practitioner Summary:** Using a theoretical model, we predict that probability matching, a postulated model of clinician behaviour, can result in a profound decrease in clinician response to alarms for decreased blood pressure. A mitigating strategy is to create alarms that convey information on the degree of vital sign perturbation.

- **Keywords:** clinical alarms, alarm fatigue, probability matching, Bayesian model, systolic blood pressure

**Peter G. Renden, Annemarie Landman, Geert J.P. Savelsbergh & Raoul R.D. Oudejans. Police arrest and self-defence skills: performance under anxiety of officers with and without additional experience in martial arts. Pages 1496-1506.**

We investigated whether officers with additional martial arts training experience performed better in arrest and self-defence scenarios under low and high anxiety and were better able to maintain performance under high anxiety than officers who just rely on regular police training. We were especially interested to find out whether training once a week would already lead to better performance under high anxiety. Officers with additional experience in kickboxing or karate/jiu-jitsu (training several times per week), or krav maga (training once a week) and officers with no additional experience performed several arrest and self-defence skills under low and high anxiety. Results showed that officers with additional experience (also those who trained once a week) performed better under high anxiety than officers with no additional experience. Still, the additional experience did not prevent these participants from performing worse under high anxiety compared to low anxiety. Implications for training are discussed.

**Practitioner summary:** Dutch police officers train their arrest and self-defence skills only four to six hours per year. Our results indicate that doing an additional martial arts training once a week may lead to better performance under anxiety, although it cannot prevent that performance decreases under high anxiety compared to low anxiety.

- **Keywords:** anxiety, deliberate practice, perceptual-motor skills, pressure, skill acquisition

**Baiduri Widanarko, Stephen Legg, Jason Devereux & Mark Stevenson. Interaction between physical and psychosocial risk factors on the presence of neck/shoulder symptoms and its consequences. Pages 1507-1518.**

This study aimed to quantify the interaction between physical and psychosocial factors on the presence of neck/shoulder symptoms (NSS) and its consequences (reduced activities and absenteeism) among 1294 coal mining workers in Indonesia. A self-administered questionnaire was used to obtain information on current workplace exposure and NSS and its consequences. Participants were grouped into one of four combination exposure groups: low physical and low psychosocial (as the reference group); low physical and high psychosocial; high physical and low psychosocial, and high physical and high psychosocial (HPhyHPsy). The attributable proportion (AP) due to interaction between both factors was examined. Individuals in the HPhyHPsy group were most likely to report NSS [odds ratio (OR) 4.83, 95% confidence interval (CI) 2.43–9.58], reduced activities (OR 3.90, 95% CI 2.36–6.43), and absenteeism (OR 3.91, 95% CI 2.11–7.25). This study has shown an interaction between physical and psychosocial factors that increases the OR of NSS (AP 0.49, 95% CI 0.08–0.89). **Practitioner Summary:** Although physical and psychosocial factors are known to be predictors for NSS, little is known about their

interaction. Self-reported questionnaire was used to obtain information about physical and psychosocial factors at work. This study found an interaction between the physical and psychosocial risk factors that increases the odds ratio of NSS.

- **Keywords:** musculoskeletal discomfort, interaction, developing countries, work stress, sick leave

**Dirk Jonker, Ewa Gustafsson, Bo Rolander, Inger Arvidsson & Catarina Nordander. *Health surveillance under adverse ergonomics conditions : validity of a screening method adapted for the occupational health service. Pages 1519-1528.***

A new health surveillance protocol for work-related upper-extremity musculoskeletal disorders has been validated by comparing the results with a reference protocol. The studied protocol, Health Surveillance in Adverse Ergonomics Conditions (HECO), is a new version of the reference protocol modified for application in the Occupational Health Service (OHS). The HECO protocol contains both a screening part and a diagnosing part. Sixty-three employees were examined. The screening in HECO did not miss any diagnosis found when using the reference protocol, but in comparison to the reference protocol considerable time savings could be achieved. Fair to good agreement between the protocols was obtained for one or more diagnoses in neck/shoulders (86%,  $k = 0.62$ ) and elbow/hands (84%,  $k = 0.49$ ). Therefore, the results obtained using the HECO protocol can be compared with a reference material collected with the reference protocol, and thus provide information of the magnitude of disorders in an examined work group.

**Practitioner Summary:** The HECO protocol is a relatively simple physical examination protocol for identification of musculoskeletal disorders in the neck and upper extremities. The protocol is a reliable and cost-effective tool for the OHS to use for occupational health surveillance in order to detect workplaces at high risk for developing musculoskeletal disorders.

- **Keywords:** physical examination, OHS, neck/shoulder, upper extremities, upper limb, HECO

**Judy Village, Cory Searcy, Filipo Salustri & W. Patrick Neumann. *Design for human factors (DfHF) : a grounded theory for integrating human factors into production design processes. Pages 1529-1546.***

The 'design for human factors' grounded theory explains 'how' human factors (HF) went from a reactive, after-injury programme in safety, to being proactively integrated into each step of the production design process. In this longitudinal case study collaboration with engineers and HF Specialists in a large electronics manufacturer, qualitative data (e.g. meetings, interviews, observations and reflections) were analysed using a grounded theory methodology. The central tenet in the theory is that when HF Specialists acclimated to the engineering process, language and tools, and strategically aligned HF to the design and business goals of the organisation, HF became a means to improve business performance. This led to engineers 'pulling' HF Specialists onto their team. HF targets were adopted into engineering tools to communicate HF concerns quantitatively, drive continuous improvement, visibly demonstrate change and lead to benchmarking. Senior management held engineers accountable for HF as a key performance indicator, thus integrating HF into the production design process. **Practitioner Summary:** Research and practice lack explanations about how HF can be integrated early in design of production systems. This three-year case study and the theory derived demonstrate how ergonomists changed their focus to align with design and business goals to integrate HF into the design process.

- **Keywords:** theory, human factors, design, manufacturing, macro ergonomics

**Errol R. Hoffmann & Alan H.S. Chan. *Movement of loads with trunk rotation*. Pages 1547-1556.**

Movements with participants standing at a bench and moving loads up to 6 kg were studied, with participants using two hands to hold the load and trunk rotation in order to move the loads to specified locations. Tasks were performed with rapid ballistic movements and also with ongoing visual control. Data for ballistic movements were modelled in terms of a modified form of the (Gan, K.-C. and Hoffmann, E.R. 1988. "Geometrical conditions for ballistic and visually controlled movements." *Ergonomics* 5 (31): 829-839) model for ballistic movements, taking into account the inertial properties of trunk rotation. Visually-controlled movements were modelled in terms of Fitts' law and a term that allowed for the ballistic form of the first submovement of the visually-controlled movement. **Practitioner Summary:** Movement times to move masses up to 6 kg, for workers at a bench using trunk rotation, are given. Theoretical models fit the experimental data very well and allow prediction of movement times.

- **Keywords:** heavy load, trunk rotation, Fitts' law, trunk inertia effects

**Jiahong Song, Xingda Qu & Chun-Hsien Chen. *Lifting motion simulation using a hybrid approach*. Pages 1557-1570.**

In this study, a hybrid dynamic model for lifting motion simulation is presented. The human body is represented by a two-dimensional (2D) five-segment model. The lifting motions are predicted by solving a nonlinear optimisation problem, the objective function of which is defined based on a minimal-effort performance criterion. In the optimisation procedure, the joint angular velocities are bounded by time-functional constraints that are determined by actual motions. Symmetric lifting motions performed by younger and older adults under varied task conditions were simulated. Comparisons between the simulation results and actual motion data were made for model evaluation. The results showed that the mean and median joint angle errors were less than 10°, which suggests the proposed model is able to accurately simulate 2D lifting motions. The proposed model is also comparable with the existing motion simulation models in terms of the prediction accuracy. Strengths and limitations of this hybrid model are discussed. **Practitioner Summary:** Human motion simulation is a useful tool in assessing the risks of occupational injuries. Lifting motions are associated with low-back pain. A hybrid model for lifting motion simulation was constructed. The model was able to accurately simulate 2D lifting motions in varied task scenarios for younger and older subjects.

- **Keywords:** lifting, hybrid motion simulation, minimum effort, data-based constraints, optimisation

**Robert D. Catena & Xu Xu. *Lower extremity kinematics that correlate with success in lateral load transfers over a low friction surface*. Pages 1571-1580.**

We previously studied balance during lateral load transfers, but were left without explanation of why some individuals were successful in novel low friction conditions and others were not. Here, we retrospectively examined lower extremity kinematics between successful (SL) and unsuccessful (UL) groups to determine what characteristics may improve low friction performance. Success versus failure over a novel slippery surface was used to dichotomise 35 healthy working-age individuals into the two groups (SL and UL). Participants performed lateral load transfers over three sequential surface conditions: high friction, novel low friction, and practiced low friction. The UL group used a wide stance with rotation mostly at the hips during the high and novel low friction conditions. To successfully complete the practiced low friction task, they narrowed their stance and pivoted both feet and torso towards the direction of the load, similar to the SL group in all conditions. This successful kinematic method potentially results in reduced

muscle demand throughout the task. **Practitioner Summary:** The reason for this paper is to retrospectively examine the different load transfer strategies that are used in a low friction lateral load transfer. We found stance width to be the major source of success, while sagittal plane motion was altered to potentially maintain balance.

- **Keywords:** general ergonomics, biomechanics, manual handling, slips, trips and falls

**Zhizhong Li, Chien-Chi Chang, Angela DiDomenico, Chen Qi & Shiu-Ling Chiu. *Investigating gait adjustments and body sway while walking across wooden scaffold boards.* Pages 1581-1588.**

The flexible wooden boards are still being used on the scaffolds at some construction worksites in China. We examined if the board dimension, acclimation phase and construction work experience influence workers' walking strategies on these boards. Among the 40 construction workers recruited, half of them had more than 1 year of construction work experience. The participants' body sway and the gait adjustments were captured and analysed. Our analysis showed the width and thickness of the boards had significant effects on walking speed. There is a significant interaction between construction experience and board width on stride width, whereas the interaction between construction experience and acclimation phase affects step length and walking speed. The body sway at the C6/C7 and L5/S1 locations are significantly affected by most of the factors. We also found that once the participants acclimated to the board condition, the sway variability increased. **Practitioner Summary:** This study investigated gait and postural adjustments of workers with different construction experience while walking over wooden scaffold boards, which is one of the activities highly associated with falling accidents in China.

- **Keywords:** balance control, construction safety, farmer construction worker

**Pui W. Kong, Chen Y. Lim, Rui Ding & Thorsten Sterzing. *Subjective evaluation of running footwear depends on country and assessment method : a bi-national study.* Pages 1589-1604.**

This study examined (1) the perception of running shoes between China (Beijing) and Singapore and (2) whether running shoe preference depended on assessment methods. One hundred ( $n = 50$  each country) Chinese males subjectively evaluated four shoe models during running by using two assessment procedures. Procedure 1 used a visual analogue scale (VAS) to assess five perception variables. Procedure 2 was a 'head-to-head' comparison of two shoes simultaneously (e.g. left foot: A and right foot: B) to decide which model was preferred. VAS scores were consistently higher in Beijing participants ( $p < .001$ ), indicating a higher degree of liking. Singapore participants used the lower end but a wider range of the 15 cm scale for shoe discrimination. Moderate agreement was seen between the VAS and 'head-to-head' procedures, with only 14 out of 100 participants matched all 6 pairwise comparisons (median = 4 matches). Footwear companies and researchers should be aware that subjective shoe preference may vary with assessment methods. **Practitioner Summary:** Footwear preference depends on country and assessment methods. Running shoe perception differed between Beijing and Singapore Chinese, suggesting that footwear recommendation should be country-specific. Individuals' shoe preference measured by visual analogue scale when wearing complete pairs may not reflect that when directly comparing different models in left and right feet.

- **Keywords:** shoes, Singapore, Beijing, visual analogue scale, head-to-head

**SHORT COMMUNICATION**

**Esther Pries, Marcel Dreischarf, Maxim Bashkuev & Hendrik Schmidt.**  
***Application of a novel spinal posture and motion measurement system in active and static sitting. Pages 1605-1610.***

The quantification of work-related musculoskeletal risk factors is of great importance; however, only a few tools allow objective, unrestricted measurements of spinal posture and motion in workplaces. This study was performed to evaluate the applicability of the Epionics system in a sedentary workplace. The system is mobile and wireless and assesses lumbar lordosis, pelvic orientation and spinal motion, without restricting subjects in their movements. In total, 10 males were monitored while sitting for 2 h on static and dynamic office chairs and on an exercise ball, to evaluate the effect of dynamic sitting. The volunteers were able to perform their work unhampered. No differences among the tested furniture could be detected with respect to either the lordosis or the number of spinal movements after habituation to the furniture; however, differences in pelvic orientation were statistically significant. The results of the present study indicate that Epionics may be useful for the quantitative assessment of work-related risk factors.

**Practitioner Summary:** Only a few tools allow objective, unrestricted measurements of spinal posture and motion in the workplace. Epionics SPINE measures lumbar lordosis, pelvic orientation and spinal motion under nearly unrestricted conditions and can be used to quantify work-related musculoskeletal risk factors. We demonstrated the use of this tool in the workplace-analysis.

- **Keywords:** workplace evaluation, ergonomics, active sitting, lumbar spine, pelvic orientation