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Warawoot Chuangchai, Wiraporn Pothisiri & Apiruck Wonghempoom. *Measuring effects of height on the autonomic nervous system in middle-aged adolescents using the very low frequency band of heart rate variability*. Pages: 569-579.

Previous studies have revealed the association between falling accidents and stress, measured via heart rate variability (HRV). However, none have studied this association using the very low frequency (VLF) band of HRV in adolescent populations. This study aimed to fill this gap by recruiting 90 adolescents to perform a light physical task at varying heights. Heart rates were used to calculate short-term HRV. The results showed a positive correlation between VLF bands and parasympathetic indices and a negative correlation with sympathetic indices, demonstrating the balancing effects of the autonomic modulation associated with height. The lowest VLF bands were obtained as 79.25 ms^2 at 10 m ($p < 0.001$) and 62.87 ms^2 at 9 m ($p < 0.001$) for the experienced and non-experienced male groups, respectively, and 28.09 ms^2 at 6 m ($p = 0.001$) for the female group. The results also suggested the need for a relatively lower height restriction for female adolescents than for males. **Practitioner summary:** Increased working heights can cause stress, which leads to falling accidents. The very low frequency band was shown to be associated with parasympathetic and sympathetic indices. Furthermore, the results suggested that the height limit necessary for providing a safe working environment may be lower for female adolescents than for males.

- **Keywords:** Parasympathetic nervous system, sympathetic nervous systém, working at height, adolescent workers, occupational safety

Tina Buker, Teresa Schmitt, Jörg Miehling & Sandro Wartzack. *Exploring the importance of a usable and emotional product design from the user's perspective*. Pages: 580-591.

Usability and emotionality are important components of user experience. However, an equal consideration of both constructs in product design is not always possible due to sometimes competitive objectives. In order to foster a user-oriented design decision in such conflicting situations, this paper examines the general importance of both constructs and their dimensions from the user's perspective while taking into account

socio-demographic variables. Examination was realised by conducting a product independent anonymous online survey ($n = 130$). The findings confirm that both constructs are important, yet in a direct comparison, usability is perceived as more important than emotionality. Taking selected dimensions of both constructs into account, an intuitive, easy and learnable usage, suitability for the user's task and freedom from impairment are particularly important in terms of usability. An aesthetic and pleasurable product design as well as originality is essential in terms of emotionality. **Practitioner summary:** This paper aims for supporting user-oriented design decisions in the context of conflicting objectives occurring in the consideration of usability and emotionality in product design. The conducted survey ($n = 130$) revealed usability as perceived more important than emotionality. Usability may thus be prioritised within conflicting design decisions.

- **Keywords:** Usability, emotional design, product design, user-centred design, empirical study

Elmira Zahmat Doost & Wei Zhang. *Mental workload variations during different cognitive office tasks with social media interruptions*. Pages: 592-608.

Interruption at work by social media (SM) is a pervasive phenomenon. This study investigated the impact of SM interruptions and task cognitive levels on mental workload (MWL) and physiological indexes. Each subject performed six simulated computer tasks differentiated by two factors: task cognitive level and performing condition. MWL was reflected through three categories of data: perceived mental workload, physiological indexes, and primary task performance. The results revealed significant effects of SM interruptions on heart rate, low-frequency/high-frequency (LF/HF) ratio, and skin conductance. ANOVA results showed there were main effects of task cognitive level on LF/HF and skin conductance. These effects during interrupted tasks were more profound. In addition, participants experienced higher MWL and recorded lower primary task performance in the knowledge-based task than the rule- and skill-based tasks. Our findings can guide managers and employees regarding appropriate use of SM in the workplace and better managing interruption and workload. **Practitioner Summary:** Office workers suffer from increased overall mental workload due to unpredictable interruptions while working. This study shows that participants' mental workload increased when receiving SM interruptions, which was more profound during complex tasks. This highlights the importance of SM interruptions management for employees' health, performance, and mobile application developers.

- **Keywords:** Mental workload, social media, interruption, office work, psychophysiology

Peter McCormack, Gemma J. M. Read, Adam Hulme, Ben R. Lane, Scott McLean & Paul M. Salmon. *Using systems thinking-based risk assessment methods to assess hazardous manual tasks: a comparison of Net-HARMS, EAST-BL, FRAM and STPA.* Pages: 609-626.

Formal risk assessment is a component of safety management relating to hazardous manual tasks (HMT). Systems thinking approaches are currently gaining interest for supporting safety management. Existing HMT risk assessment methods have been found to be limited in their ability to identify risks across the whole work system; however, systems thinking-based risk assessment (STBRA) methods were not designed for the HMT context and have not been tested in this area. The aim of this study was to compare the performance of four state-of-the-art STBRA methods: Net-HARMS, EAST-BL, FRAM and STPA to determine which would be most useful for identifying HMT risks. Each method was independently applied by one of four analysts to assess the risks associated

with a hypothetical HMT system. The outcomes were assessed for alignment with a benchmark analysis. Using signal detection theory (SDT), overall STPA was found to be the best performing method having the highest hit rate, second lowest false alarm rate and highest Matthews Correlation Coefficient of the four methods. **Practitioner summary:** A comparison of four systems thinking risk assessment methods found that STPA had the highest level of agreement with the benchmark analysis and is the most suitable for practitioners to use to identify the risks associated with HMT systems.

- **Keywords:** Systems thinking, hazardous manual tasks, risk assessment, signal detection theory

Zhibing Gao, Ziang Li, Xiangling Zhuang & Guojie Ma. *Advantages of graphical nutrition facts label: faster attention capture and improved healthiness judgement*. Pages: 627-643.

Consumers have to rely on the traditional back-of-package nutrition facts label (NFL) to obtain nutrition information in many countries. However, traditional NFLs have been criticised for their poor visualisation and low efficiency. This study redesigned back-of-package NFLs integrated with bar graphs (black or coloured) to visually indicate nutrient reference values (NRVs). Two eye movement studies were performed to evaluate the ergonomic advantages of the graphical NFLs. Our findings suggested that the newly designed NFLs led to faster and better healthiness evaluation performance. The newly designed graphical labels led to a shorter time to first fixation duration and offered a higher percentage of fixation time in the nutrient reference values region compared with that observed using traditional text labels. Nowadays, many chronic diseases are associated with poor eating habits, therefore, the importance of visualisation design to nudge healthier food choices could be paid more attention to by policymakers and food manufacturers. **Practitioner summary:** To improve the ergonomic design of traditional nutrition facts panel (NFL), this study assessed a newly designed graphical NFL. The results showed that graphical NFL captured consumers' attention faster and improved their healthiness judgement. Moreover, a brief nutrition education can improve consumers' attention and understanding of nutrition information.

- **Keywords:** Nutrition label, bar grapheye tracking, healthiness evaluation

Paul M. Salmon, Adam Hulme, Guy H. Walker, Patrick Waterson & Neville A. Stanton. *Towards a unified model of accident causation: refining and validating the systems thinking safety tenets*. Pages: 644-657.

The systems thinking tenets were developed based on a synthesis of contemporary accident causation theory, models and approaches and encapsulate 15 features of complex systems that interact to create both safety and adverse events. Whilst initial testing provided supportive evidence, the tenets have not yet been subject to formal validation. This article presents the findings from a three-round Delphi study undertaken to refine and validate the tenets and assess their suitability for inclusion in a unified model of accident causation. Participants with expertise in accident causation and systems thinking provided feedback on the tenets and associated definitions until an acceptable level of consensus was achieved. The results reduced the original 15 tenets to 14 and 10 were identified as important to include in unified model of accident causation. The refined systems thinking tenets are presented along with future research directions designed to facilitate their use in safety practice. **Practitioner summary:** This article presents a refined and validated set of systems thinking tenets which describe features of complex systems that interact to create adverse events. The tenets can be used by practitioners to proactively identify safety leading indicators and contributory factors during adverse event analysis.

- **Keywords:** Accident causation, accident analysis and prevention, complexity, safety, systems thinking

Daan Kropman, Rianne Appel-Meulenbroek, Lisanne Bergefurt & Pascale LeBlanc. *The business case for a healthy office; a holistic overview of relations between office workspace design and mental health*. Pages: 658-675.

The role of the physical workspace in employee mental health is often overlooked. As a (mentally) healthy workforce is vital for an organisation's success, it is important to optimise office workspace conditions. Previous studies on the effects of the physical workspace on mental health tended to focus on the effects of a specific element of the physical workspace on one or only a few mental health indicators. This study takes a more holistic approach by addressing the relationship of physical workspace characteristics with ten broad indicators of work-related mental health. Results of a systematic review of empirical evidence show that many aspects of (day)light, office layout/design, and temperature and thermal comfort have been proven to be related to many mental health indicators. Less tacit workspace characteristics (e.g., noise, use of colours) have been explored too, but so far have only been related to a few mental health indicators. **Practitioner summary:** The absence of holistic insights regarding the empirical proof of the effects of workspace design on employee mental health prevents a clear business case for workplace investments. This paper presents a content analysis of existing studies and shows how seven elements of workspace design relate to 10 mental health indicators.

- **Keywords:** Corporate real estate, healthy office, intervention effectiveness, workspace design, psychological stress

Yutaka Tochihara, Joo-Young Lee, Su-Young Son & Ilham Bakri. *Heat strain of Japanese firefighters wearing personal protective equipment: a review for developing a test method*. Pages: 676-689.

The aim of this review was to develop a test method for the evaluation of heat strain for structural firefighters wearing personal protective equipment (PPE) in Japan. We analysed a series of our laboratory's questionnaires and experimental studies and reviewed international standards on test methods. We investigated the actual average working conditions (total firefighting time on one incidence, working time with full PPE, maximum temperature and humidity during firefighting) at structural firefighting site in Japan by conducting a large-scale questionnaire survey of Japanese firefighters. We discussed test subjects (firefighters vs. non-firefighters; body size; physical fitness), exercise intensity (absolutes vs. relative; light vs. heavy) and duration, experimental temperature and relative humidity, experimental clothing items including station uniforms (shorts vs. long), and measurement variables (physiological and subjective responses), and suggested a standard test method to evaluate the heat strain of firefighters in hot and humid environments. **Practitioner summary:** We reviewed studies on human wear trials of firefighting personal protective equipment (PPE) in hot environments and suggested a standard test method to evaluate the heat strain of firefighters. The test method can be internationally utilised to examine the comfort functions and heat stress of PPE in hot, humid environments.

- **Keywords:** Firefighters, protective clothing, personal protective equipment, heat stress, test method

Pin-Hsuan Chen & Pei-Luen Patrick Rau. *Using EEG to investigate the influence of boredom on prospective memory in top-down and bottom-up processing mechanisms for intelligent interaction*. Pages: 690-703.

We aimed to investigate the alpha (α) activity in operators experiencing boredom while performing prolonged monitoring and prospective memory tasks using different processing mechanisms. Fifty-four participants underwent electroencephalography (EEG) and were found to have poorer prospective memory performance under top-down conditions. Further, α power and synchronisation were higher during bottom-up than in top-down processes, revealing an inhibition effect of the former. Significant differences in brain regions and hemispheres were identified to distinguish different cognitive processes in both information-processing mechanisms. Thus, people are likely to cope with boredom differently in terms of top-down and bottom-up processes. Specifically, a higher attention level was reported during top-down processing, to mitigate the negative influences of boredom. Overall, this study provides EEG evidence which suggests that prospective memory can be enhanced in top-down processing during prolonged monitoring tasks by increasing the salience of cues. **Practitionary summary:** Boredom is a growing problem as tasks requiring monitoring increase. We explored how people process information to perform prospective memory tasks while monitoring. The prospective memory was poorer during top-down processing, but stronger cortical activation indicated an inhibitory effect on inattention. Information-processing mechanisms are suggested for designing boredom interventions.

- **Keywords:** Top-down processing, bottom-up processing, alpha power, alpha synchronisation, EEG

Jie Hao, Robin High & Ka-Chun Siu. *Gender-specific visual perturbation effects on muscle activation during incline treadmill walking: a virtual reality study*. Pages: 704-715.

This study investigated the effects of different visual rotation speeds and types of visual perturbation in virtual reality (VR) on lower extremity muscle activation during incline treadmill walking. Twenty healthy young adults walked on an incline treadmill with six different visual perturbation paradigms in VR (normal VR, 10°/s rotation, 20°/s rotation, 30°/s rotation, 60°/s rotation, and random speed rotation). Muscle activation of the lower extremity was measured by surface electromyography. Results showed an increased visual rotation speed induced higher vastus lateralis and lateral gastrocnemius activation. Females and males had different responses to increased visual rotation speed in vastus lateralis. Random speed rotation induced higher medial hamstring activation than constant speed rotation, in which was more pronounced in females. In conclusion, the amount of visual perturbation should be taken into consideration when developing future VR training for astronauts. **Practitioner summary:** Visual perturbation elicited higher muscle activation than normal condition during incline treadmill walking, and this perturbation effect was magnitude dependent and gender specific. These findings suggested that performance training with systematically manipulated visual perturbations might increase specific muscle activations. Gender differences should be considered in developing future performance training in space.

- **Keywords:** Gait, electromyography, visual flow, simulation, space medicine