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N. A. Stanton, P. M. Salmon, G. H. Walker, E. Salas & P. A. Hancock.
State-of-science: situation awareness in individuals, teams and systems.
Pages: 449-466.

Our review addresses one of the most used, but debated, topics in Ergonomics: Situation Awareness (SA). We examine and elaborate upon key SA models. These models are divided into individual SA, team SA and systems SA categories. Despite, or perhaps because of, the debates surrounding SA it remains an enduring theme for research and practice in the domain of Ergonomics, now for over two decades. A contingent approach, which seeks to match different models of SA to different types of ergonomics problem, enables the differences between positions to be revealed and reconciled, and the practitioner guided towards optimum methodological solutions. **Practitioner Summary:** Measuring SA in individuals, teams and systems has become a key objective in Ergonomics. One single approach to SA does not fit all problems encountered. This review shows the importance of considering all three types of models and achieving a match between them and the problem at hand.

- **Keywords:** Situation awareness, theory, models, team SA, distributed cognition

Christina Wohlers & Guido Hertel. ***Choosing where to work at work – towards a theoretical model of benefits and risks of activity-based flexible offices.*** **Pages: 467-486**

Although there is a trend in today's organisations to implement activity-based flexible offices (A-FOs), only a few studies examine consequences of this new office type. Moreover, the underlying mechanisms why A-FOs might lead to different consequences as compared to cellular and open-plan offices are still unclear. This paper introduces a theoretical framework explaining benefits and risks of A-FOs based on theories from work and organisational psychology. After deriving working conditions specific for A-FOs (territoriality, autonomy, privacy, proximity and visibility), differences in working conditions between A-FOs and alternative office types are proposed. Further, we suggest how these differences in working conditions might affect work-related consequences such as well-being, satisfaction, motivation and performance on the individual, the team and the organisational level. Finally, we consider task-related (e.g. task variety), person-

related (e.g. personality) and organisational (e.g. leadership) moderators. Based on this model, future research directions as well as practical implications are discussed. **Practitioner Summary:** Activity-based flexible offices (A-FOs) are popular in today's organisations. This article presents a theoretical model explaining why and when working in an A-FO evokes benefits and risks for individuals, teams and organisations. According to the model, A-FOs are beneficial when management encourages employees to use the environment appropriately and supports teams.

- **Keywords:** Activity-based flexible offices, new ways of working, flex-office, theoretical framework, desk sharing, office design

Simone Nyholm Andersen & Ole Broberg. *A framework of knowledge creation processes in participatory simulation of hospital work systems.* Pages: 487-503.

Participatory simulation (PS) is a method to involve workers in simulating and designing their own future work system. Existing PS studies have focused on analysing the outcome, and minimal attention has been devoted to the process of creating this outcome. In order to study this process, we suggest applying a knowledge creation perspective. The aim of this study was to develop a framework describing the process of how ergonomics knowledge is created in PS. Video recordings from three projects applying PS of hospital work systems constituted the foundation of process mining analysis. The analysis resulted in a framework revealing the sources of ergonomics knowledge creation as sequential relationships between the activities of simulation participants sharing work experiences; experimenting with scenarios; and reflecting on ergonomics consequences. We argue that this framework reveals the hidden steps of PS that are essential when planning and facilitating PS that aims at designing work systems.

Practitioner Summary: When facilitating participatory simulation (PS) in work system design, achieving an understanding of the PS process is essential. By applying a knowledge creation perspective and process mining, we investigated the knowledge-creating activities constituting the PS process. The analysis resulted in a framework of the knowledge-creating process in PS.

- **Keywords:** Participative ergonomics, health care ergonomics, process mining,

Miles Richardson. *An efficient approach to understanding and predicting the effects of multiple task characteristics on performance.* Pages: 504-511.

In ergonomics there is often a need to identify and predict the separate effects of multiple factors on performance. A cost-effective fractional factorial approach to understanding the relationship between task characteristics and task performance is presented. The method has been shown to provide sufficient independent variability to reveal and predict the effects of task characteristics on performance in two domains. The five steps outlined are: selection of performance measure, task characteristic identification, task design for user trials, data collection, regression model development and task characteristic analysis. The approach can be used for furthering knowledge of task performance, theoretical understanding, experimental control and prediction of task performance. **Practitioner Summary:** A cost-effective method to identify and predict the separate effects of multiple factors on performance is presented. The five steps allow a better understanding of task factors during the design process.

- **Keywords:** Task design, performance, orthogonal, fractional factorial

Christine Kirchner, Otmar Leo Bock & Ina Völker. *The effects of priming with age stereotypes on a PC-based mail-sorting task.* Pages: 512-517.

Objective: This study examines whether unconscious priming of attitudes towards older age might change the self-efficacy of older employees, and thus modify their performance at work. **Methods:** Three age- and gender-matched groups of 20 participants were primed with positive, negative or no age stereotypes by means of the scrambled sentence task, and were then transferred to a cognitively demanding PC-based mail-sorting task. **Results:** Participants' accuracy on the latter task was significantly higher in the positively primed group than in the unprimed group, and was significantly lower in the negatively primed group than in the unprimed group, except for one parameter. **Conclusions:** These findings indicate that the performance of older workers may indeed be modifiable by unconscious priming. **Practitioner Summary:** This study analyses whether unconscious priming attitudes towards older age might modify work performance. Participants were primed with the scrambled sentence task and then conducted a cognitive mail-sorting task. The findings indicate that the performance of older workers may indeed be modifiable by unconscious negative as well as positive priming.

- **Keywords:** Unconscious priming, work efficiency, self-efficacy

Richard Pak, Anne Collins McLaughlin, William Leidheiser & Ericka Rovira. *The effect of individual differences in working memory in older adults on performance with different degrees of automated technology.* Pages: 518-532.

A leading hypothesis to explain older adults' overdependence on automation is age-related declines in working memory. However, it has not been empirically examined. The purpose of the current experiment was to examine how working memory affected performance with different degrees of automation in older adults. In contrast to the well-supported idea that higher degrees of automation, when the automation is correct, benefits performance but higher degrees of automation, when the automation fails, increasingly harms performance, older adults benefited from higher degrees of automation when the automation was correct but were not differentially harmed by automation failures. Surprisingly, working memory did not interact with degree of automation but did interact with automation correctness or failure. When automation was correct, older adults with higher working memory ability had better performance than those with lower abilities. But when automation was incorrect, all older adults, regardless of working memory ability, performed poorly. **Practitioner Summary:** The design of automation intended for older adults should focus on ways of making the correctness of the automation apparent to the older user and suggest ways of helping them recover when it is malfunctioning.

- **Keywords:** Working memory, degree of automation, older adults, trust, complacency, automation bias

Sukru Karali, Diane E. Gyi & Neil J. Mansfield. [Driving a better driving experience: a questionnaire survey of older compared with younger drivers.](#) Pages: 533-540.

A questionnaire survey of drivers ($n = 903$) was conducted covering musculoskeletal symptoms, the vehicle seat, access to specific vehicle features, ingress/egress, driving performance and driving behaviours. Significantly, more discomfort was reported by older drivers (aged 65+) in the hips/thighs/buttocks and knees. Older drivers reported more difficulty parallel parking ($p \leq 0.01$), driving on a foggy day ($p \leq 0.01$), and turning their head and body to reverse ($p \leq 0.001$). They also reported that their reactions were slower than they used to be ($p \leq 0.01$). Dissatisfaction was found by all drivers with adjusting the headrest (height and distance), seat belt height and opening/closing the boot. There is a growing population of older people globally, and the number of older

drivers is showing a parallel increase. Clearly, efforts are needed to ensure car design of the future is more inclusive of older drivers. **Practitioner Summary:** This paper describes a questionnaire survey of drivers on their driving experience – the vehicle seat, access to specific vehicle features, ingress/egress, driving performance and driving behaviours. Comparisons are made by age and gender. Issues with driving and vehicle design particularly for older drivers in the UK are identified.

Keywords: Vehicle ergonomics, ageing, ergonomics methods and tools, driving

Mathilde François, François Osiurak, Alexandra Fort, Philippe Crave & Jordan Navarro. *Automotive HMI design and participatory user involvement: review and perspectives.* Pages: 541-552.

Automotive human-machine interface (HMI) design is facing new challenges due to the technological advances of the last decades. The design process has to be adapted in order to address human factors and road safety challenges. It is now widely accepted that user involvement in the HMI design process is valuable. However, the current form of user involvement in industry remains at the stages of concept assessment and usability tests. Moreover, the literature in other fields (e.g. information systems) promotes a broader user involvement with participatory design (i.e. the user is fully involved in the development process). This article reviews the established benefits of participatory design and reveals perspectives for automotive HMI quality improvement in a cognitive ergonomic framework. **Practitioner Summary:** Automotive HMI quality determines, in part, drivers' ability to perform primary driving tasks while using in-vehicle devices. User involvement in the design process is a key point to contribute to HMI quality. This article reports the potential benefits of a broad involvement from drivers to meet automotive HMI design challenges.

- **Keywords:** Human-machine interface, user involvement, user-centred design, participatory design

Dong-Yuan Debbie Wang, F. Dan Richard, Cullen R. Cino, Trevin Blount & Joseph Schmuller. *Bipedal vs. unipedal: a comparison between one-foot and two-foot driving in a driving simulator.* Pages: 553-562.

Is it better to drive with one foot or with two feet? Although two-foot driving has fostered interminable debate in the media, no scientific and systematic research has assessed this issue and federal and local state governments have provided no answers. The current study compared traditional unipedal (one-foot driving, using the right foot to control the accelerator and the brake pedal) with bipedal (two-foot driving, using the right foot to control the accelerator and the left foot to control the brake pedal) responses to a visual stimulus in a driving simulator study. Each of 30 undergraduate participants drove in a simulated driving scenario. They responded to a STOP sign displayed on the centre of the screen by bringing their vehicle to a complete stop. Brake RT was shorter under the bipedal condition, while throttle RT showed advantage under the unipedal condition. Stopping time and distance showed a bipedal advantage, however. We discuss further limitations of the current study and implications in a driving task. Before drawing any conclusions from the simulator study, further on-road driving tests are necessary to confirm these obtained bipedal advantages. **Practitioner Summary:** Traditional unipedal (using the right foot to control the accelerator and the brake pedal) with bipedal (using the right foot to control the accelerator and the left foot to control the brake pedal) responses to a visual stimulus in a driving simulator were compared. Our results showed a bipedal advantage. **Promotion:** Although two-foot driving has fostered interminable debate in the media, no scientific and systematic research has assessed this issue and federal and local state governments have provided no answers. Traditional (one-foot driving, using the right foot to control the accelerator and the brake pedal) with bipedal (using the right foot to control the accelerator and the left foot to control the

brake pedal) responses to a visual stimulus in a simulated driving study were compared. Throttle reaction time was faster in the unipedal condition whereas brake reaction time, stopping time and stopping distance showed a bipedal advantage. We discuss further theoretical issues and implications in a driving task.

- **Keywords:** Driving safety, bipedal, unipedal, driving simulator

Hyun-Kyung Kim & Yanxin Zhang. *Estimation of lumbar spinal loading and trunk muscle forces during asymmetric lifting tasks: application of whole-body musculoskeletal modelling in OpenSim.* Pages: 563-576.

Large spinal compressive force combined with axial torsional shear force during asymmetric lifting tasks is highly associated with lower back injury (LBI). The aim of this study was to estimate lumbar spinal loading and muscle forces during symmetric lifting (SL) and asymmetric lifting (AL) tasks using a whole-body musculoskeletal modelling approach. Thirteen healthy males lifted loads of 7 and 12 kg under two lifting conditions (SL and AL). Kinematic data and ground reaction force data were collected and then processed by a whole-body musculoskeletal model. The results show AL produced a significantly higher peak lateral shear force as well as greater peak force of psoas major, quadratus lumborum, multifidus, iliocostalis lumborum pars lumborum, longissimus thoracis pars lumborum and external oblique than SL. The greater lateral shear forces combined with higher muscle force and asymmetrical muscle contractions may have the biomechanical mechanism responsible for the increased risk of LBI during AL.

Practitioner Summary: Estimating lumbar spinal loading and muscle forces during free-dynamic asymmetric lifting tasks with a whole-body musculoskeletal modelling in OpenSim is the core value of this research. The results show that certain muscle groups are fundamentally responsible for asymmetric movement, thereby producing high lumbar spinal loading and muscle forces, which may increase risks of LBI during asymmetric lifting tasks.

- **Keywords:** Biomechanics, injury risks, manual handling, musculoskeletal disorders, back pain

Yaser Zerehsaz, Jionghua (Judy) Jin, Sheila M. Ebert & Matthew P. Reed. *Development of seating accommodation models for soldiers in vehicles.* Pages: 589-596.

Data from a previous study of soldier driving postures and seating positions were analysed to develop statistical models for defining accommodation of driver seating positions in military vehicles. Regression models were created for seating accommodation applicable to driver positions with a fixed heel point and a range of steering wheel locations in typical tactical vehicles. The models predict the driver-selected seat position as a function of population anthropometry and vehicle layout. These models are the first driver accommodation models considering the effects of body armor and body-borne gear. The obtained results can benefit the design of military vehicles, and the methods can also be extended to be utilised in the development of seating accommodation models for other driving environments where protective equipment affects driver seating posture, such as vehicles used by law-enforcement officers and firefighters. **Practitioner Summary:** A large-scale laboratory study of soldier driving posture and seating position was designed to focus on tactical vehicle (truck) designs. Regression techniques are utilised to develop accommodation models suitable for tactical vehicles. These are the first seating accommodation models based on soldier data to consider the effects of personal protective equipment and body-borne gear.

- **Keywords:** Anthropometry, posture, vehicle occupants, accommodation