

## Ergonomics– rok 2012, ročník 55

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**M. Saffarian, R. Happee & J.C.F. de Winter. *Why do drivers maintain short headways in fog? A driving-simulator study evaluating feeling of risk and lateral control during automated and manual car following.* Pages 971-985.**

Drivers in fog tend to maintain short headways, but the reasons behind this phenomenon are not well understood. This study evaluated the effect of headway on lateral control and feeling of risk in both foggy and clear conditions. Twenty-seven participants completed four sessions in a driving simulator: clear automated (CA), clear manual (CM), fog automated (FA) and fog manual (FM). In CM and FM, the drivers used the steering wheel, throttle and brake pedals. In CA and FA, a controller regulated the distance to the lead car, and the driver only had to steer. Drivers indicated how much risk they felt on a touchscreen. Consistent with our hypothesis, feeling of risk and steering activity were elevated when the lead car was not visible. These results might explain why drivers adopt short headways in fog.

**Practitioner Summary:** Fog poses a serious road safety hazard. Our driving-simulator study provides the first experimental evidence to explain the role of risk-feeling and lateral control in headway reduction. These results are valuable for devising effective driver assistance and support systems.

- **Keywords:** transportation safety, human-machine systems, driving, virtual environments

**Natassia Goode, Michael G. Lenné & Paul Salmon. *The impact of on-road motion on BMS touch screen device operation.* Pages 986-996.**

This study investigates the effect of vehicle motion on performance, usability and workload for a touch screen in-vehicle Battle Management System (BMS). Participants performed a series of battle management tasks while a vehicle was driven over sealed (characteristic of 'normal' vehicle motion) and unsealed (characteristic of 'high' vehicle motion) roads. The results indicate that unsealed road conditions impair the performance of information input tasks (tasks that require the user to enter information, e.g. text entry) but not information extraction tasks (tasks that require the user to retrieve information from the system, e.g. reading coordinates). Participants rated workload as higher and the system as less usable on the unsealed road. In closing, the implications

for in-vehicle touch screen design and use in both military and civilian driving contexts are discussed.

**Practitioner Summary:** The effect of motion on interacting with in-vehicle touch screen devices remains largely unexplored. This study examines the effect of different levels of vehicle motion on the use of a BMS. Using the system under off-road conditions had a detrimental impact on workload, performance and usability.

- **Keywords:** motion, human-computer interaction, vehicle, touch screen

**Naomi Dunn & Ann Williamson. *Driving monotonous routes in a train simulator: the effect of task demand on driving performance and subjective experience.* Pages 997-1008.**

Although monotony is widely recognised as being detrimental to performance, its occurrence and effects are not yet well understood. This is despite the fact that task-related characteristics, such as monotony and low task demand, have been shown to contribute to performance decrements over time. Participants completed one of two simulated train-driving scenarios. Both were highly monotonous and differed only in terms of the level of cognitive demand required (i.e. low demand or high demand). These results highlight the seriously detrimental effects of the combination of monotony and low task demands and clearly show that even a relatively minor increase in cognitive demand can mitigate adverse monotony-related effects on performance for extended periods of time. Monotony is an inherent characteristic of transport industries, including rail, aviation and road transport, which can have adverse impact on safety, reliability and efficiency. This study highlights possible strategies for mitigating these adverse effects.

**Practitioner Summary:** This study provides evidence for the importance of cognitive demand in mitigating monotony-related effects on performance. The results have clear implications for the rapid onset of performance deterioration in low demand monotonous tasks and demonstrate that these detrimental performance effects can be overcome with simple solutions, such as making the task more cognitively engaging.

- **Keywords:** monotony, task demand, alertness, performance, train driver

**Lynn Huestegge & Ralph Radach. *Visual and memory search in complex environments: determinants of eye movements and search performance.* Pages 1009-1027.**

Previous research on visual and memory search revealed various top down and bottom up factors influencing performance. However, utilising abstract stimuli (e.g. geometrical shapes or letters) and focussing on individual factors has often limited the applicability of research findings. Two experiments were designed to analyse which attributes of a product facilitate search in an applied environment. Participants scanned displays containing juice packages while their eye movements were recorded. The familiarity, saliency, and position of search targets were systematically varied. Experiment 1 involved a visual search task, whereas Experiment 2 focussed on memory search. The results showed that bottom up (target saliency) and top down (target familiarity) factors strongly interacted. Overt visual attention was influenced by cultural habits, purposes, and current task demands. The results provide a solid database for assessing the impact and interplay of fundamental top down and bottom up determinants of search processes in applied fields of psychology.

**Practitioner Summary:** Our study demonstrates how a product (or a visual item in general) needs to be designed and placed to ensure that it can be found effectively and

efficiently within complex environments. Corresponding product design should result in faster and more accurate visual and memory based search processes.

- **Keywords:** visual search, memory search, saccade, eye movements, familiarity, saliency, search strategy

**Steve N.H. Tsang, Alan H.S. Chan & R.F. Yu. *Effect of display polarity and luminance contrast on visual lobe shape characteristics.* Pages 1028-1042.**

The effect of display polarity and luminance contrast on visual lobe (effective visual field) shape characteristics was studied using three levels of luminance contrast with combinations of positive and negative polarities. The binocular effective visual field for a detection task, with a peripherally presented target (V) embedded in a homogeneous competing background (Xs), was mapped on 24 imaginary axes passing through the fixation point. The results showed that visual lobes mapped using positive polarity were statistically larger in area, rounder and more regular in shape than those for negative polarity. The medium contrast condition lobes were more symmetric and regular than low contrast condition lobes, and lobe area and perimeter increased with increasing luminance contrast ratio. Under the interaction of positive polarity and high luminance contrast, visual lobes were found to be larger, smoother and rounder. The high level of luminance and contrast however resulted in a higher degree of visual discomfort. The results indicated that positive polarity and contrast of medium (26:1) to high (41:1) levels are possible display settings for better visual lobe characteristics and better anticipated search performance.

**Practitioner Summary:** The effect of display polarity and luminance contrast on visual lobe shape characteristics was examined with uniform stimulus materials in this study. The results help to identify the optimum display settings for luminance contrast and display polarity to enhance lobe shape characteristics and hence search performance in industrial inspection tasks.

- **Keywords:** industrial ergonomics, vision and lighting, general ergonomics, information displays

**Jessie Y.C. Chen & Michael J. Barnes. *Supervisory control of multiple robots in dynamic tasking environments.* Pages 1043-1058.**

A military targeting environment was simulated to examine the effects of an intelligent route-planning agent RoboLeader, which could support dynamic robot re-tasking based on battlefield developments, on the performance of robotics operators. We manipulated the level of assistance (LOAs) provided by RoboLeader as well as the presence of a visualisation tool that provided feedback to the participants on their primary task (target encapsulation) performance. Results showed that the participants' primary task benefited from RoboLeader on all LOAs conditions compared to manual performance; however, visualisation had little effect. Frequent video gamers demonstrated significantly better situation awareness of the mission environment than did infrequent gamers. Those participants with higher spatial ability performed better on a secondary target detection task than did those with lower spatial ability. Finally, participants' workload assessments were significantly lower when they were assisted by RoboLeader than when they performed the target entrapment task manually.

**Practitioner Summary:** This study demonstrated the utility of an intelligent agent for enhancing robotics operators' supervisory control performance as well as reducing their workload during a complex urban scenario involving moving targets. The results

furthered the understanding of the interplay among level-of-autonomy, multitasking performance and individual differences in military tasking environments.

- **Keywords:** human-robot interaction, supervisory control, level of autonomy, intelligent agent, military, individual differences

**Richard Pak, Nicole Fink, Margaux Price, Brock Bass & Lindsay Sturre. *Decision support aids with anthropomorphic characteristics influence trust and performance in younger and older adults. Pages 1059-1072.***

This study examined the use of deliberately anthropomorphic automation on younger and older adults' trust, dependence and performance on a diabetes decision-making task. Research with anthropomorphic interface agents has shown mixed effects in judgments of preferences but has rarely examined effects on performance. Meanwhile, research in automation has shown some forms of anthropomorphism (e.g. etiquette) have effects on trust and dependence on automation. Participants answered diabetes questions with no-aid, a non-anthropomorphic aid or an anthropomorphised aid. Trust and dependence in the aid was measured. A minimally anthropomorphic aid primarily affected younger adults' trust in the aid. Dependence, however, for both age groups was influenced by the anthropomorphic aid. Automation that deliberately embodies person-like characteristics can influence trust and dependence on reasonably reliable automation. However, further research is necessary to better understand the specific aspects of the aid that affect different age groups. Automation that embodies human-like characteristics may be useful in situations where there is under-utilisation of reasonably reliable aids by enhancing trust and dependence in that aid.

**Practitioner Summary:** The design of decision-support aids on consumer devices (e.g. smartphones) may influence the level of trust that users place in that system and their amount of use. This study is the first step in articulating how the design of aids may influence user's trust and use of such systems

- **Keywords:** automation, trust, ageing, personification, health, diabetes

**Kirsten M.A. Revell & Neville A. Stanton. *Models of models: filtering and bias rings in depiction of knowledge structures and their implications for design. Pages 1073-1092.***

Mental models are poorly specified in three ways: in their defining criteria, their source and the bias to which they have been subjected. Literature from psychology, HCI and human factors sources was reviewed to determine the utility of 'mental models' as a design tool. The definitions and theories offered by key contributors to the notion of mental models were compared. Schematics, representing both the knowledge structures proposed in cognitive processing, as well as the layers of bias evident when forming or accessing mental models, were constructed. Fundamental similarities and differences in the use of this notion, as well as ambiguities in definition, were highlighted graphically. The need for specificity in the use of mental models was emphasised as essential for pragmatic application in design. The use of graphical comparison was proposed as a means of identifying the risk of bias and a means to categorise approaches to mental model research.

**Practitioner Summary:** Mental models are considered significant in user centred design. To apply this notion pragmatically, its definition and methods of construction and access need to be sufficiently specified. This article offers a graphical method to compare existing research in mental models, highlighting similarities, differences and ambiguities.

- **Keywords:** mental models, design, schema, schematic, knowledge structure, bias, filtering information

**Xu Xu, Chien-Chi Chang & Ming-Lun Lu. *Two linear regression models predicting cumulative dynamic L5/S1 joint moment during a range of lifting tasks based on static postures.* Pages 1093-1103.**

Previous studies have indicated that cumulative L5/S1 joint load is a potential risk factor for low back pain. The assessment of cumulative L5/S1 joint load during a field study is challenging due to the difficulty of continuously monitoring the dynamic joint load. This study proposes two regression models predicting cumulative dynamic L5/S1 joint moment based on the static L5/S1 joint moment of a lifting task at lift-off and set-down and the lift duration. Twelve men performed lifting tasks at varying lifting ranges and asymmetric angles in a laboratory environment. The cumulative L5/S1 joint moment was calculated from continuous dynamic L5/S1 moments as the reference for comparison. The static L5/S1 joint moments at lift-off and set-down were measured for the two regression models. The prediction error of the cumulative L5/S1 joint moment was  $21 \pm 14 \text{ Nm} \times \text{s}$  (12% of the measured cumulative L5/S1 joint moment) and  $14 \pm 9 \text{ Nm} \times \text{s}$  (8%) for the first and the second models, respectively.

**Practitioner Summary:** The proposed regression models may provide a practical approach for predicting the cumulative dynamic L5/S1 joint loading of a lifting task for field studies since it requires only the lifting duration and the static moments at the lift-off and/or set-down instants of the lift.

- **Keywords:** manual materials handling, low back pain, cumulative L5/S1 moment, static moment

**Peter Le, Jonathan Dufour, Heath Monat, Joseph Rose, Zachary Huber, Emma Alder, Radin Zaid Radin Umar, Bryan Hennessey, Mohini Dutt & William S. Marras. *Association between spinal loads and the psychophysical determination of maximum acceptable force during pushing tasks.* Pages 1104-1114.**

The objective of this study was to investigate potential associations between an individual's psychophysical maximum acceptable force (MAF) during pushing tasks and biomechanical tissue loads within the lumbar spine. Ten subjects (eight males, two females) pushed a cart with an unknown weight at one push every two minute for a distance of 3.9 m. Two independent variables were investigated, cart control and handle orientation while evaluating their association with the MAF. Dependent variables of hand force and tissue loads for each MAF determination and preceding push trial were assessed using a validated, electromyography-assisted biomechanical model that calculated spinal load distribution throughout the lumbar spine. Results showed no association between spinal loads and the MAF. Only hand forces were associated with the MAF. Therefore, MAFs may be dependent upon tactile sensations from the hands, not the loads on the spine and thus may be unrelated to risk of low back injury.

**Practitioner Summary:** Pushing tasks have become common in manual materials handling (MMH) and these tasks impose different tissue loads compared to lifting tasks. Industry has commonly used the psychophysical tables for job assessment and decision of MMH tasks. However, due to the biomechanical complexity of pushing tasks, psychophysics may be misinterpreting risk.

- **Keywords:** psychophysics, maximum acceptable weight, low back, push

**Gunther Paul & Sascha Wischniewski. *Standardisation of digital human models.* Pages 1115-1118.**

Digital human models (DHM) have evolved as useful tools for ergonomic workplace design and product development, and found in various industries and education. DHM systems which dominate the market were developed for specific purposes and differ significantly, which is not only reflected in non-compatible results of DHM simulations, but also provoking misunderstanding of how DHM simulations relate to real world problems. While DHM developers are restricted by uncertainty about the user need and lack of model data related standards, users are confined to one specific product and cannot exchange results, or upgrade to another DHM system, as their previous results would be rendered worthless. Furthermore, origin and validity of anthropometric and biomechanical data is not transparent to the user. The lack of standardisation in DHM systems has become a major roadblock in further system development, affecting all stakeholders in the DHM industry. Evidently, a framework for standardising digital human models is necessary to overcome current obstructions.

**Practitioner Summary:** This short communication addresses a standardisation issue for digital human models, which has been addressed at the International Ergonomics Association Technical Committee for Human Simulation and Virtual Environments. It is the outcome of a workshop at the DHM 2011 symposium in Lyon, which concluded steps towards DHM standardisation that need to be taken.

- **Keywords:** digital human model, standardisation, computer manikin, body template, virtual human

**Marie-Christine J. Plat, Monique H.W. Frings-Dresen & Judith K. Sluiter. *Diminished health status in firefighters.* Pages 1119-1122.**

The objective was to assess the diminished health status of firefighters in the Netherlands. Two hundred and seventy-eight firefighters were tested during a workers' health surveillance. Psychological, physical, sense-related and cardiovascular markers vital to job performance were investigated and the relative frequency of deficiencies in health markers was determined. Deficiencies were found in all health markers investigated. The most prevalent deficiencies were (1) physical status when not passing a job-specific test (25%) and (2) cardiovascular disease risk factors – BMI (57%), systolic hypertension (23%) and smoking (22%). Diminished health status of firefighters typically involved deficiencies in physical markers and cardiovascular disease risk factors. It is recommended that occupational physicians initiate interventions for individual firefighters to address diminished health in these respects.

**Practitioner Summary:** In this study, health markers required for firefighter job performance were assessed. Diminished health status typically involved deficiencies in physical markers and cardiovascular disease risk factors. This study makes ergonomists and other health-care professionals aware of the most prevalent health marker deficiencies in firefighters and results highlight the relevance of performing workers' health surveillance in firefighters.

- **Keywords:** firefighters, prevalence, diminished health status, workers', health surveillance

**Richard Clewley. *Human performance on the flightdeck.* Pages 1123-1124.**

**Gordon Baxter. *Human factors and ergonomics in consumer product design: methods and techniques.* Pages 1125-1126.**