

## **Ergonomics– rok 2011, ročník 54**

### **Číslo 2**



**Daniel P. Jenkins; Paul M. Salmon; Neville A. Stanton; Guy H. Walker; Laura Rafferty. *What could they have been thinking? : how sociotechnical system design influences cognition: a case study of the Stockwell shooting.* Pages 103 – 119.**

Understanding why an individual acted in a certain way is of fundamental importance to the human factors community, especially when the choice of action results in an undesirable outcome. This challenge is typically tackled by applying retrospective interview techniques to generate models of what happened, recording deviations from a 'correct procedure'. While such approaches may have great utility in tightly constrained procedural environments, they are less applicable in complex sociotechnical systems that require individuals to modify procedures in real time to respond to a changing environment. For complex sociotechnical systems, a formative approach is required that maps the information available to the individual and considers its impact on performance and action. A context-specific, activity-independent, constraint-based model forms the basis of this approach. To illustrate, an example of the Stockwell shooting is used, where an innocent man, mistaken for a suicide bomber, was shot dead. Transferable findings are then presented.

**Statement of Relevance:** This paper presents a new approach that can be applied proactively to consider how sociotechnical system design, and the information available to an individual, can affect their performance. The approach is proposed to be complementary to the existing tools in the mental models phase of the cognitive work analysis framework.

- **Keywords:** accidents; accident analysis; cognitive work analysis; command and control; decision making; error; perception

**J. Bourbousson; G. Poizat; J. Saury; C. Seve. *Description of dynamic shared knowledge : an exploratory study during a competitive team sports interaction.* Pages 120 – 138.**

This exploratory case study describes the sharedness of knowledge within a basketball team (nine players) and how it changes during an official match. To determine how knowledge is mobilised in an actual game situation, the data were collected and processed following course-of-action theory (Theureau 2003). The results were used to characterise the contents of the shared knowledge (i.e. regarding teammate

characteristics, team functioning, opponent characteristics, opposing team functioning and game conditions) and to identify the characteristic types of change: (a) the reinforcement of a previous element of shared knowledge; (b) the invalidation of an element of shared knowledge; (c) fragmentation of an element of shared knowledge; (d) the creation of a new element of shared knowledge. The discussion deals with the diverse types of change in shared knowledge and the heterogeneous and dynamic nature of common ground within the team. **Statement of Relevance:**The present case study focused on how the cognitions of individual members of a team coordinate to produce a team performance (e.g. surgical teams in hospitals, military teams) and how the shared knowledge changes during team activity. Traditional methods to increase knowledge sharedness can be enhanced by making use of 'opportunities for coordination' to optimise team adaptiveness.

- **Keywords:** course of action; shared knowledge; team cognition; team sport; teamwork

**Misty Blue-Terry; Tomasz Letowski. *Effects of white noise on Callsign Acquisition Test and Modified Rhyme Test scores.* Pages 139 – 145.**

The Callsign Acquisition Test (CAT) is a speech intelligibility test developed by the US Army Research Laboratory. The test has been used to evaluate speech transmission through various communication systems but has not been yet sufficiently standardised and validated. The aim of this study was to compare CAT and Modified Rhyme Test (MRT) performance in the presence of white noise across a range of signal-to-noise ratios (SNRs). A group of 16 normal-hearing listeners participated in the study. The speech items were presented at 65 dB(A) in the background of white noise at SNRs of -18, -15, -12, -9 and -6 dB. The results showed a strong positive association (75.14%) between the two tests, but significant differences between the CAT and MRT absolute scores in the range of investigated SNRs. Based on the data, a function to predict CAT scores based on existing MRT scores and vice versa was formulated. **Statement of Relevance:**This work compares performance data of a common speech intelligibility test (MRT) with a new test (CAT) in the presence of white noise. The results here can be used as a part of the standardisation procedures and provide insights to the predictive capabilities of the CAT to quantify speech intelligibility communication in high-noise military environments.

- **Keywords:** Callsign Acquisition Test; Modified Rhyme Test; speech intelligibility; white noise

**Hiroyuki Sakai; Duk Shin; Yuji Uchiyama; Ryuta Terashima; Toshihiro Wakita. *Slow eye movement as a possible predictor of reaction delays to auditory warning alarms in a drowsy state.* Pages 146 – 153.**

In recently developed intelligent vehicles, warning alarms are often used to prompt avoidance behaviours from drivers facing imminent hazardous situations. However, when critical reaction delays to auditory stimulation are anticipated, the alarm should be activated earlier to compensate for such delays. It was found that reaction times to an auditory stimulus significantly increased in the presence of slow eye movement (SEM), which is known to occur frequently during the wake-sleep transition. The reaction delay could not be attributed to temporal effects such as fatigue and was invariant regardless of response effectors (finger or foot). Moreover, it was found that applied pedal force decreased immediately after an auditory stimulus interrupted SEM. Consequently, it was concluded that SEM can be a good predictor of reaction delays to auditory warning alarms when drivers are in a drowsy state. **Statement of Relevance:**The present study demonstrated that simple auditory reaction time significantly increased when SEM emerged. In the design of vehicle safety systems using warning alarms to prompt avoidance behaviours from drivers, such reaction delays during SEM must be taken into account.

- **Keywords:** auditory reaction; drowsy driving; slow eye movement; warning alarm

**T. Bosch; S. E. Mathiassen; B. Visser; M.P. de Looze; J.H. van Dieën. *The effect of work pace on workload, motor variability and fatigue during simulated light assembly work. Pages 154 – 168.***

This study investigated the effect of work pace on workload, motor variability and fatigue during light assembly work. Upper extremity kinematics and electromyography (EMG) were obtained on a cycle-to-cycle basis for eight participants during two conditions, corresponding to “normal” and “high” work pace according to a predetermined time system for engineering. Indicators of fatigue, pain sensitivity and performance were recorded before, during and after the task. The level and variability of muscle activity did not differ according to work pace, and manifestations of muscle fatigue or changed pain sensitivity were not observed. In the high work pace, however, participants moved more efficiently, they showed more variability in wrist speed and acceleration, but they also made more errors. These results suggest that an increased work pace, within the range addressed here, will not have any substantial adverse effects on acute motor performance and fatigue in light, cyclic assembly work. **Statement of Relevance:** In the manufacturing industry, work pace is a key issue in production system design and hence of interest to ergonomists as well as engineers. In this laboratory study, increasing the work pace did not show adverse effects in terms of biomechanical exposures and muscle fatigue, but it did lead to more errors. For the industrial engineer, this observation suggests that an increase in work pace might diminish production quality, even without any noticeable fatigue being experienced by the operators.

- **Keyword:** work pace; industrial ergonomics; variability; electromyography; fatigue

**Vincent Verhaert; Bart Haex; Tom De Wilde; Daniel Berckmans; Johan Verbraecken; Elke de Valck; Jos Vander Sloten. *Ergonomics in bed design : the effect of spinal alignment on sleep parameters. Pages 169 – 178.***

This study combines concepts of bed design and sleep registrations to investigate how quality of spine support affects the manifestation of sleep in healthy subjects. Altogether, 17 normal sleepers (nine males, eight females; age 24.3±7.1 years) participated in an anthropometric screening, prior to the actual sleep experiments, during which personalised sleep system settings were determined according to individual body measures. Sleep systems (i.e. mattress and supporting structure) with an adjustable stiffness distribution were used. Subjects spent three nights of 8 h in bed in the sleep laboratory in a counterbalanced order (adaptation, personalised support and sagging support). During these nights, polysomnography was performed. Subjective sleep data were gathered by means of questionnaires. Results show that individual posture preferences are a determinant factor in the extent that subjects experience a negative effect while sleeping on a sagging sleep system. **Statement of Relevance:** This study investigated how spine support affects sleep in healthy subjects, finding that the relationship between bedding and sleep quality is affected by individual anthropometry and sleep posture. In particular, results indicate that a sagging sleep system negatively affects sleep quality for people sleeping in a prone or lateral posture.

- **Keywords:** bed design; sleep posture; sleep quality; sleep system; spinal alignment

**Stephen J. Edmondston; Michael Sharp; Andrew Symes; Nawaf Alhabib; Garry T. Allison. *Changes in mechanical load and extensor***

***muscle activity in the cervico-thoracic spine induced by sitting posture modification. Pages 179 – 186.***

The influence of whole body sitting posture on cervico-thoracic posture, mechanical load and extensor muscle activity was examined in 23 asymptomatic adults. Cervical and upper thoracic extensor muscle activity measured in guided slouched and lumbo-pelvic neutral postures was normalised to that measured in a self-selected habitual posture. Head and neck posture and gravitational load moment measurements were obtained in each posture. Sagittal head translation, upper cervical extension and load moment were significantly greater in the slouched posture ( $p < 0.001$ ). Contrasting patterns of cervical and thoracic extensor activity were observed in the slouched and neutral postures, with cervical extensor activity 40% higher in the slouched posture ( $p < 0.0001$ ). Thoracic extensor activity was significantly higher in the lumbo-pelvic neutral posture than the habitual posture ( $p = 0.002$ ). The significant changes in extensor muscle activity with postural modification appear to be induced by the associated change in mechanical load moment of the head. **Statement of Relevance:** More neutral sitting postures reduce the demand on the cervical extensor muscles and modify the relative contribution of cervical and thoracic extensors to the control of head and neck posture. Postures that promote these patterns of muscular activity may reduce cervical spine loading and the development of posture-related neck pain.

- **Keywords:** cervical spine; cervico-thoracic muscle activity; electromyography; sitting posture

***Joseph F. Seay; Leif Hasselquist; Carolyn K. Bense. Carrying a rifle with both hands affects upper body transverse plane kinematics and pelvis-trunk coordination. Pages 187 – 196.***

The purpose of this study was to assess how carrying a rifle in both hands affects upper body motion and coordination during locomotion. In total, 11 male soldiers walked (1.34 m/s) and ran (2.46 m/s) with a weapon (M4 condition) and without a weapon (NW condition) while kinematic pelvis and trunk data were collected. Two-way ANOVA was used to compare segmental ranges of motion (ROM), pelvis-trunk coordination (continuous relative phase) and coordination variability between gait mode and weapon combinations. Carrying a weapon decreased sagittal plane trunk ROM at both speeds and increased trunk rotation during running. Mean ( $\pm$ SD) transverse plane coordination was more in-phase while carrying a weapon (M4 =  $83^\circ \pm 31$ , NW =  $60^\circ \pm 36$ ,  $p = 0.027$ ) and transverse plane coordination variability decreased (M4 =  $23^\circ \pm 3.6$ , NW =  $15^\circ \pm 4.4$ ,  $p = 0.043$ ). Coordination differences between M4 and NW were similar to differences reported in the literature between individuals with and without back pain. Long-term injury implications due to decreased coordination variability are discussed. **Statement of Relevance:** Knowledge of the effects of rifle carriage on pelvis-trunk coordination may provide insight into short-term protective strategies and long-term injury mechanisms. These should be considered in occupations requiring individuals to carry torso loads in combination with holding an object in both hands that restricts arm swing.

- **Keywords:** biomechanics; coordination; locomotion; relative phase; rifle carriage

***Patricia L. Weir; David M. Andrews; Paula M. van Wyk; Jack P. Callaghan. The influence of training on decision times and errors associated with classifying trunk postures using video-based posture assessment methods. Pages 197 – 205.***

The purpose of this study was to examine the influence of training on the decision times and errors associated with video-based trunk posture classifications. Altogether, 30 amateur and 30 knowledge-based participants completed a three-phase study (pre-

training, training, post-training) that required them to classify static trunk postures in images on a computer screen into a posture category that represented the angle of the trunk depicted. Trunk postures were presented in both flexion/extension and lateral bend views and at several distances from the boundaries of the posture categories. Both decision time and errors decreased as distance from the boundaries increased. On average, amateur analysts experienced a larger decrease in decision time per posture classification than knowledge-based analysts (amateur: 0.79 s, knowledge-based: 0.60 s;  $p < 0.05$ ) suggesting that training can have beneficial effects on classification performance. The implications are that the analysis time associated with video-based posture assessment methods can be reduced with appropriate training, making this type of approach feasible for larger-scale field studies. **Statement of Relevance:** Understanding the role that training can play in reducing errors associated with the use of video-based posture assessment methods may result in more efficient use of these tools by ergonomic practitioners. Reducing decision time and misclassification errors will provide a more efficient, accurate and representative assessment of injury risk.

- **Keywords:** decision time; posture classification errors; posture matching; training; trunk posture perception; video

**K. Jacobs; G. Foley; L. Punnett; V. Hall; R. Gore; E. Brownson; E. Ansong; J. Markowitz; M. McKinnon; S. Steinberg; A. Ing. *University students' notebook computer use : lessons learned using e-diaries to report musculoskeletal discomfort. Pages 206 – 219.***

The objective of this pilot study was to identify if notebook accessories (ergonomic chair, desktop monitor and notebook riser) combined with a wireless keyboard, mouse and participatory ergonomics training would have the greatest impact on reducing self-reported upper extremity musculoskeletal discomfort in university students. In addition to pre-post computing and health surveys, the Ecological Momentary Assessment was used to capture change in discomfort over time using a personal digital assistant (PDA) as the e-diary. The PDA was programmed with a survey containing 45 questions. Four groups of university students were randomised to either intervention (three external computer accessories) or to control. Participants reported less discomfort with the ergonomic chair and notebook riser based on the pre-post survey data and the e-diary/PDA ANOVA analysis. However, the PDA data, adjusted for the effect of hours per day of computer use, showed no benefit of the chair and limited benefit from the riser. **Statement of Relevance:** University students' use of notebook computers has increased. This study found evidence of a positive effect of an adjustable chair or notebook riser when combined with ergonomic training on reducing discomfort. Daily notebook computer use of 4 h was confirmed as a risk factor. Without some form of ergonomic intervention, these students are likely to enter the workforce with poor computing habits, which places them on the road to future injuries as technology continues to play a dominant role in their *lives*.

- **Keywords:** human-computer interaction; musculoskeletal; office ergonomics; participative ergonomics