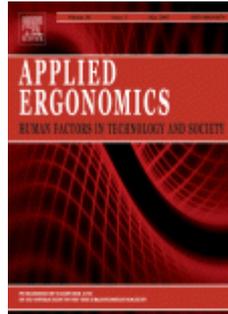


## **Applied Ergonomics - rok 2008, ročník 39**

### **Číslo 2 (March 2008)**



**Mary F. Lesch. *A comparison of two training methods for improving warning symbol comprehension.* Pages 135-143.**

This study compared the effectiveness of two different types of training in improving comprehension of warning symbols by younger (aged 20–35 years) and older adults (aged 50–70 years). The verbal label training paired the symbol with a label describing its meaning while the accident scenario training further expanded on the nature of the hazard, the required/prohibited actions, as well as the possible consequences of failing to comply. Contrary to prior research (e.g., [Lesch, M.F., 2003. Comprehension and memory for warning symbols: age-related differences and impact of training. *J. Safety Res.* 34, 495–505]), there was no difference in comprehension for younger and older adults prior to training, with both groups only obtaining about 40% correct responses. Both types of training improved performance on a subsequent comprehension test. However, the accident scenario training produced a higher percentage of correct responses, greater confidence in those responses, as well as a longer-lasting reduction of reaction times. In order to further improve symbol design, as well as training to address comprehension difficulties, future research should more closely examine symbol characteristics that influence comprehension.

- **Keywords:** Warning symbols; Training; Aging
- **Summary:**

**Daijiro Abe, Satoshi Muraki and Akira Yasukouchi. *Ergonomic effects of load carriage on energy cost of gradient walking.* Pages 144-149.**

We examined the effects of load on the energy cost of walking ( $C_w$ ), being defined as the ratio of the 2-min steady-state oxygen consumption to the speed, and economical speed (ES) during level and gradient walking. Ten men walked on a treadmill at various speeds with and without a load on their back at 0% and  $\pm 5\%$  gradients. Significantly lower  $C_w$  values were observed only when the load was carried on the back during level walking at slower speeds. The ES was significantly decreased by less than 5% when the load was carried on the back. Significant gradient differences were also observed in the ES in the load and no load conditions. These results would be applicable to a wider range of occupational and leisure tasks.

- **Keywords:** Optimal speed; *Free-ride*; Locomotion

- **Summary:**

**Jing Han, Sadao Nishiyama, Koetsu Yamazaki and Ryouiti Itoh. *Ergonomic design of beverage can lift tabs based on numerical evaluations of fingertip discomfort*. Pages 150-157.**

This paper introduces finite element analyses to evaluate numerically and objectively the feelings in the fingertip when opening aluminum beverage cans, in order to design the shape of the tab. Experiments of indenting vertically the fingertip pulp by a probe and by tabs of aluminum beverage can ends have allowed us to observe force responses and feelings in the fingertip. It was found that a typical force–displacement curve may be simplified as a combination of three curves with different gradients. Participants feel a touch at Curve 1 of the force–displacement curve, then feel a pressure and their pulse at Curve 2, finally feel discomfort followed by a pain in the fingertip at Curve 3. Finite element analyses have been performed to simulate indenting the tab with the fingertip vertically to confirm that the simulation results agree well with the experimental observations. Finally, numerical simulations of the finger pulling up the tab of the can end has also been performed and discomfort in the fingertip has been related to the maximum value of the contact stress of the finger model. Comparisons of three designs of tab ring shape showed that the tab with a larger contact area with finger is better.

- **Keywords:** Human fingertip indentation experiments; Numerical evaluation of pain; Finite element analyses; Aluminum beverage cans
- **Summary:**

**Nobuko Hashiguchi, Megumi Hirakawa, Yutaka Tochiara, Yumi Kaji and Chitake Karaki. *Effects of setting up of humidifiers on thermal conditions and subjective responses of patients and staff in a hospital during winter*. Pages 158-165.**

The purpose of this survey was to measure the thermal environment in a hospital during winter, and to investigate the subjective responses of patients and staff via a questionnaire. The air temperature and humidity in the sickrooms and nurse stations were measured for 3 months during winter. After 2 months, we introduced humidifiers into about half of the rooms and nurse stations as a method of improving the environment, and evaluated the effects of the installed humidifiers on the thermal conditions. In all, 36 patients and 45 staff members were asked once a week about subjective symptoms (dry and itchy skin, thirst, etc.). Before setting up the humidifiers, the existence of a low-humidity environment in the hospital during winter was confirmed, with the levels of relative humidity and humidity ratio reaching under 50% and 5 g/kg DA, respectively, which is known to promote the spread of influenza viruses. However, the introduction of the humidifiers increased the relative humidity in sickrooms from 32.8% to 43.9% on average, and the air humidity in sickrooms thus almost reached the optimum range suggested by the Hospital Engineering Association of Japan (HEAJ). Additionally, complaints of thermal discomfort and dryness of air decreased among the staff, though not among the patients, after the humidifiers were installed. These results suggest that introducing humidifiers into a hospital during winter is an effective method of improving the low-humidity environment and relieving the discomfort of staff members.

- **Keywords:** Low humidity; Hospital; Subjective response
- **Summary:**

**Soon-Cheol Chung, Bongsoo Lee, Gye-Rae Tack, Jeong-Han Yi, Hang-Woon Lee, Ji-Hun Kwon, Mi-Hyun Choi, Jin-Sup Eom and Jin-Hun Sohn. *Physiological mechanism underlying the improvement in visuospatial performance due to 30% oxygen inhalation.* .Pages 166-170.**

This study investigated the effect of 30% oxygen inhalation on visuospatial cognitive performance, blood oxygen saturation, and heart rate. Six male (25.8(mean) $\pm$ 1.0(SD) years) and six female (23.8 $\pm$ 1.9 years) college students participated in this experiment. Two psychological tests were developed to measure the performance level of visuospatial cognition. The experiment consisted of two runs: one was a visuospatial cognition task under normal air (21% oxygen) condition and the other under hyperoxic air (30% oxygen) condition. The experimental sequence in each run consisted of four phases, that were Rest1 (1 min), Control (1 min), Task (4 min), and Rest2 (4 min). Blood oxygen saturation and heart rate were measured throughout the course of four phases. The analysis of behavioral performance with 30% oxygen administration when compared to 21% oxygen revealed that the mean performance was improved. When supplied 30% oxygen in the air, the blood oxygen saturation was increased while the heart rate was decreased compared to those under 21% oxygen condition. We conclude that 30% oxygen inhalation enhanced visuospatial performance by the increased the oxygen saturation in the blood.

- **Keywords:** Visuospatial performance; Oxygen saturation in the blood; Heart rate; 30% oxygen administration
- **Summary:**

**Venerina Johnston, Tina Souvlis, Nerina L. Jimmieson and Gwendolen Jull. *Associations between individual and workplace risk factors for self-reported neck pain and disability among female office workers.* Pages 171-182.**

A cross-sectional survey of female office workers (n=333) was undertaken to determine the level of neck pain and disability (Neck Disability Index—NDI) and to explore the relationship between individual and workplace risk factors with the NDI score and the presence of pain. Workers reported nil (32%), mild (53%), moderate (14%) and severe (1%) neck pain. There were more risk factors associated with the NDI score than the presence of neck pain. The presence of neck pain was associated with a history of neck trauma (OR: 4.8), using a graduated lens (OR: 4.6), and negative affectivity (OR: 2.7) in the multiple regression model. Factors associated with higher NDI score were using the computer mouse for more than 6 h per day, higher negative affectivity, older age and an uncomfortable workstation. These results suggest that measuring the level of neck pain and disability rather than just the presence of neck pain provides more specific directives for the prevention and management of this disorder.

- **Keywords:** Neck pain; Risk factors; Office work
- **Summary:**

**Kaj Bo Veiersted, Kristian Schulerud Gould, Nina Osteras and Gert-Ake Hansson. *Effect of an intervention addressing working technique on the biomechanical load of the neck and shoulders among hairdressers.* Pages 183-190.**

The purpose of this study was to describe, and analyse the effect of an intervention on, the biomechanical workload in the neck and shoulder region of female hairdressers. Arm elevation was measured by inclinometers and muscular load of m. trapezius by

electromyography. The intervention comprised working technique recommendations, e.g. to work with less elevated arms and more relaxed muscles. The subjects were randomised between two different intensity levels of the intervention, one with written information only and the other with additional personal follow-up. The effect of the intervention was evaluated after 1–2 months. The hairdressers worked with their arms elevated 60° or more for approximately 13% of the total working time and 16% during the specific hairdressing tasks. The intervention group including personal follow-up instructions had a reduction in workload from 4.0% to 2.5% of hairdressing time with highly elevated right upper arm, i.e. above 90°. No effect was detected on muscular load or neck and shoulder symptoms after the intervention.

- **Keywords:** Biomechanical workload; Intervention; Hairdressers
- **Summary:**

**Yong-Ku Kong, Brian D. Lowe, Soo-Jin Lee and Edward F. Krieg. *Evaluation of handle shapes for screwdriving*. Pages 191-198.**

This study investigated the effects of screwdriver handle shape, surface, and workpiece orientation on subjective discomfort, number of screw-tightening rotations, screw-insertion time, axial screwdriving force, and finger contact forces in a screwdriving task. Handles with three longitudinal cross-sectional shapes (circular, hexagonal, triangular), four lateral shapes (cylindrical, double frustum, reversed double frustum, cone), and two surface materials (plastic, rubber coated) were tested. Individual phalangeal segment force distributions indicated how fingers and phalangeal segments were involved in the creation of total finger force (15.0%, 34.6%, 34.5%, and 15.9% for the index, middle, ring, and little fingers; and 45.7%, 22.4%, 12.9%, and 19.0% for the distal, middle, proximal, and metacarpal phalanges, respectively). From this finding, the index and little fingers appeared to contribute mainly in the guiding and balancing of the screwdriver handles, whereas middle and ring fingers played a more prominent role in gripping and turning. Participants preferred circular and hexagonal longitudinal-shaped and double frustum and cone lateral-shaped handles over the triangular longitudinal-shaped handles, and cylindrical and reversed double frustum lateral-shaped handles. Circular, cylindrical, and double frustum handles exhibited the least total finger force associated with screw insertion. In terms of combinations of longitudinal and lateral shapes, circular with double frustum handles were associated with less discomfort and total finger force.

- **Keywords:** Screwdriver handle; Handle surface; Finger/phalange force; Screwdriving
- **Summary:**

**Chad A. Sutherland, Wayne J. Albert, Allan T. Wrigley and Jack P. Callaghan. *A validation of a posture matching approach for the determination of 3D cumulative back loads*. Pages 199-208.**

The purpose of this project was to investigate the amount of error in calculating cumulative lumbar spine kinetics using a posture matching approach (3DMatch) compared to a 3D coordinate electromagnetic tracking approach (FASTRAK™). Six subjects were required to perform five repeats each of two symmetrical and two asymmetrical lifts while being simultaneously recorded from 4 camera views at viewing angles of 0°, 45°, 60° and 90° to the sagittal plane while wearing eight FASTRAK™ sensors to define an 8 segment rigid link model (RLM) of the head, arms, and trunk. Four hundred and eighty lifts (6 subjects × 20 lifts × 4 camera views) were analyzed using the 3DMatch posture-matching program to calculate the following cumulative loads at the L4/L5 joint: compression, anterior shear, posterior shear, reaction shear and extension moment. The errors in cumulative load calculation were determined as the difference

between the values calculated for the same lifts using a 3D RLM that used electromagnetic motion tracking sensors (FASTRAK™) positioned at the segment center of masses as model inputs. No significant difference ( $p < 0.05$ ) in the relative error for any of the cumulative loading variables between the four camera views and the 3D RLM approach was found. Furthermore the relative errors for cumulative compression, joint anterior shear, reaction anterior shear and extension moment were all below 12%. These results suggest that posture matching by trained users can provide reasonable 3D data to calculate cumulative low back loads with a biomechanical model.

- **Keywords:** Cumulative spinal loading; Posture matching; 3Dmatch
- **Summary:**

**Chieh-Hsin Tang, Ching-Yuan Lin and Yu-Min Hsu. *Exploratory research on reading cognition and escape-route planning using building evacuation plan diagrams. Pages 209-217.***

The purpose of evacuation plan diagrams is for readers to comprehend and then plan an evacuation route. However, comprehending such diagrams involves complex issues that have yet to be addressed by research. This study aims to investigate how Taiwanese people interpret evacuation plan diagrams in their buildings. Issues of interest include the amount of time that it takes for a member of the general public to read a diagram and the time that they spend planning their escape route. Correlated and influencing factors are analyzed. The floor plan of an actual department store was used as the diagram for cognitive testing. A method of stimulated measurement was conducted over the Internet. The results of the experiment showed that the time it takes to plan an escape route is about 1.1 to 2 times longer than its reading time. This indicates that there is a significant time difference between diagram interpretation and stimulated planning. It was found that the longer it takes to read a diagram, the longer it takes to plan an escape route. In addition, to understand the difference between interpretations by the general public versus those with an architectural background, an analysis showed that the general public takes two to three times longer than architectural professionals to read a diagram and plan an escape route. Consequently, improvements in reading diagrams could help in the planning of a more efficient escape route. Furthermore, through our analysis, we found that the design of diagram symbols must satisfy conventional use and also that diagrams must avoid the use of metaphorical and abstract symbols. Diagrams that follow our guidelines will generally result in more effective and efficient conveyance of the intended message, thereby assisting in an emergency.

- **Keywords:** Evacuation plan diagram; Reading cognition; Escaping disaster
- **Summary:**

**Linda Törnström, Joakim Amprazis, Marita Christmansson and Jörgen Eklund. *A corporate workplace model for ergonomic assessments and improvements. Pages 219-228.***

Several companies have developed their own company-specific models for ergonomic improvements. This study aims to describe and identify factors supporting and hindering the implementation and application of one such corporate model for ergonomic assessment and improvement. The model has been developed by Volvo Car Corporation and implemented at an assembly plant in Göteborg, Sweden. The model is unique as it is intended to be used by production engineers and safety representatives in cooperation. The process for assessment of musculoskeletal risks is standardised and participatory, which also supports identification of solutions. Interviews, questionnaires, observation and document studies were used to evaluate the use of the model. The model was found to improve participation and collaboration among stakeholders; provide a more effective

ergonomic improvement process; visually represent the ergonomics situation in the company; and give legitimacy to and awareness of ergonomics. However, the model was found to be rather resource demanding and dependent on support from management and unions. In particular, a substantial training programme and regular use of the model are needed.

- **Keywords:** Musculoskeletal risks; Work design; Participation
- **Summary:**

**C.E. Siemieniuch and M.A. Sinclair. *Using corporate governance to enhance 'long-term situation awareness' and assist in the avoidance of organisation-induced disasters. Pages 229-240.***

This paper considers the issue of how corporate governance can and should deal with the long-term understanding of systems health—what we may call 'long-term situation awareness' (i.e. which evolves and is coherent over time) for organisational systems (and their component sub systems) in the engineering domain. Many characteristics affect long-term situation awareness—the rate of change to processes, pressures for greater efficiency from existing resources, changes in personnel, cultural changes and changes to the operational environment of the organisational systems. Many disasters (e.g. Chernobyl, Flixborough, Piper Alpha) have a causal path that indicates a loss of group situation awareness, over a long period of time. The problem of the gradual, slow drift over many years towards unsafe conduct of company operations is discussed and examples of possible consequences provided. A 'parable' from the world of manufacturing is used to exemplify the problem. The paper goes on to discuss some ways by which this problem could be addressed and longer-term system situational awareness increased; essentially by good corporate governance, knowledge management and ownership of processes. Links are made to the literature on these topics, and a route map to help organisations to gain the benefits is offered.

- **Summary:**

**Hélène Eyrolle, Jacques Virbel and Julie Lemarié. *Impact of incomplete correspondence between document titles and texts on users' representations : a cognitive and linguistic analysis based on 25 technical documents. Pages 241-246.***

Based on previous research in the field of cognitive psychology, highlighting the facilitatory effects of titles on several text-related activities, this paper looks at the extent to which titles reflect text content. An exploratory study of real-life technical documents investigated the content of their Subject lines, which linguistic analyses had led us to regard as titles. The study showed that most of the titles supplied by the writers failed to represent the documents' contents and that most users failed to detect this lack of validity.

- **Keywords:** Technical documents; Titles; Information selection; Linguistics
- **Summary:**

**Bert H. Jacobson, Tia J. Wallace, Doug B. Smith and Tanner Kolb. *Grouped comparisons of sleep quality for new and personal bedding systems. Pages 247-254.***

The purpose of this study was to compare sleep comfort and quality between personal and new bedding systems. A convenience sample (women, n=33; men, n=29) with no

clinical history of disturbed sleep participated in the study. Subjects recorded back and shoulder pain, sleep quality, comfort, and efficiency for 28 days each in their personal beds (pre) and in new medium-firm bedding systems (post). Repeated measures ANOVAs revealed significant improvement between pre- and post-test means for all dependent variables. Furthermore, reduction of pain and stiffness and improvement of sleep comfort and quality became more prominent over time. No significant differences were found for the groupings of age, weight, height, or body mass index. It was found that for the cheapest category of beds, lower back pain was significantly ( $p < 0.01$ ) more prominent than for the medium and higher priced beds. Average bed age was 9.5 yrs. It was concluded that new bedding systems can significantly improve selected sleep variables and that continuous sleep quality may be dependent on timely replacement of bedding systems.

- **Keywords:** Mattress; Back pain; Sleep quality
- **Summary:**

**Inger Arvidsson, Gert-Ake Hansson, Svend Erik Mathiassen and Staffan Skerfving. *Neck postures in air traffic controllers with and without neck/shoulder disorders. Pages 255-260.***

Prolonged computer work with an extended neck is commonly believed to be associated with an increased risk of neck–shoulder disorders. The aim of this study was to compare neck postures during computer work between female cases with neck–shoulder disorders, and healthy referents. Based on physical examinations, 13 cases and 11 referents were selected among 70 female air traffic controllers with the same computer-based work tasks and identical workstations. Postures and movements were measured by inclinometers, placed on the forehead and upper back (C7/Th1) during authentic air traffic control. A recently developed method was applied to assess flexion/extension in the neck, calculated as the difference between head and upper back flexion/extension. Results: cases and referents did not differ significantly in neck posture (median neck flexion/extension:  $-10^\circ$  vs.  $-9^\circ$ ;  $p=0.9$ ). Hence, the belief that neck extension posture is associated with neck–shoulder disorders in computer work is not supported by the present data.

- **Keywords:** Case-referent; Computer work; Inclinometry
- **Summary:**

**Ling-Ling Tsai and Hau-Min Liu. *Effects of bedding systems selected by manual muscle testing on sleep and sleep-related respiratory disturbances. Pages 261-270.***

In this study, we investigated the feasibility of applying manual muscle testing (MMT) for bedding selection and examined the bedding effect on sleep. Four lay testers with limited training in MMT performed muscle tests for the selection of the bedding systems from five different mattresses and eight different pillows for 14 participants with mild sleep-related respiratory disturbances. For each participant individually, two bedding systems—one inducing stronger muscle forces and the other inducing weaker forces—were selected. The tester-participant pairs showed 85% and 100% agreement, respectively, for the selection of mattresses and pillows that induced the strongest muscle forces. The firmness of the mattress and the height of the pillow were significantly correlated with the body weight and body mass index of the participants for the selected strong bedding system but not for the weak bedding system. Finally, differences were observed between the strong and the weak bedding systems with regard to sleep-related respiratory disturbances and the percentage of slow-wave sleep. It was concluded that MMT can be performed by inexperienced testers for the selection of bedding systems.

- **Keywords:** Sleep-disordered breathing; Mattress; Pillow
- **Summary:**