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Dina Burkolter & Annette Kluge. *Process control and risky decision-making: moderation by general mental ability and need for cognition.* Pages 1285-1297.

Human factors and ergonomics research could benefit from focusing more strongly on individual differences – especially trait variables. The present study suggests the analysis of moderator effects as a promising way to enhance understanding of trait variables and process control performance. Process control performance was studied by analysing moderator effects of general mental ability (GMA) and need for cognition (NC) on risky decision-making (RDM) and performance. Fifty engineering students were trained on a process control task using a computer-based simulation for three hours and tested twice thereafter. Risky decision-making was measured using a computerised gambling task while GMA and NC were assessed with questionnaires. Risky decision-making in interaction with each GMA and NC explained variance in performance over and above variance explained by the single effects. In conclusion, the analysis of moderator effects between individual difference variables and process control performance seems promising.

Practitioner Summary: Individual difference variables affect learning and performance, but have often not been studied to any great extent in human factors research. This article suggests a promising approach to studying individual differences – moderator analyses – and illustrates how such differences can lead to a better understanding of what determines process control performance.

- **Keywords:** decision-making, process control performance, individual differences, interaction effects

Tom Wellings, Matthew J. Pitts & Mark A. Williams. *Characterising the experience of interaction: an evaluation of automotive rotary dials.* Pages 1298-1315.

Optimising sensory product qualities is a priority for automotive manufacturers when developing human-machine interfaces, as user experience frameworks consider sensory aesthetics to be a main influencing factor of the overall judgement of product appeal. This empirical study examines whether users' overall judgements of product appeal can be predicted from measures of non-visual aesthetic qualities. Ninety-one UK owners of Supermini segment cars assessed five examples of rotary temperature dials. Factor

analysis gave four clear factors common across all samples, of which 'unrefined loudness' and 'positivity/precision' predicted up to 26% variance in the hedonic score; both factors were similarly important in the regression models. Significant differences in appeal were observed between the samples; however, there were no effects due to age or gender.

Practitioner Summary: The research shows that the overall appeal of automotive rotary dials is partially predicted by their non-visual aesthetics. These findings are applicable to the design of any products where improving the user experience is a goal, as it demonstrates that user experience models are applicable to product domains other than computing and information technology.

- **Keywords:** automotive HMI, user experience, perceived quality, sensory interaction, rotary dials

Alan H.S. Chan & Annie W.Y. Ng. *Effects of display factors on Chinese proofreading performance and preferences.* Pages 1316-1330.

This experiment investigated the influence of four display factors, viz. typeface (Ming Liu and Jheng Hei), font size (10-point and 14-point), text direction (horizontal and vertical) and copy placement (left-right and top-bottom) on Chinese proofreading performance and subjective preferences. Proofreading performance was measured in terms of time and accuracy, and preferences were examined in terms of comfort, ease and fatigue. It was found that the horizontal text direction resulted in faster proofreading than the vertical one, but the other three factors were non significant. The faster proofreading using the horizontal text direction was valid for both the left-right and the top-bottom arrangements. There was an interaction between typeface and font size such that, for the smaller character size (10-point), the Ming Liu style produced a faster performance than the Jheng Hei style. However, for the larger character size (14-point), the Jheng Hei style produced a faster performance than the Ming Liu style. Regarding proofreading accuracy, the number of non-detected missing words and related false alarm in left-right copy placement setting was significantly larger than that in top-down setting. Greater accuracy was obtained in proofreading at the cost of a speed-accuracy trade-off – the higher the accuracy in the proofreading task, the longer the proofreading time. Font size and text direction had significant effects on proofreading preferences, but typeface and copy placement did not.

Practitioner Summary: This study examined four display factors on Chinese proofreading performance and subjective preferences. The findings of this experiment provide information and recommendations that should prove useful for the design of proofreading interfaces to improve proofreading time and accuracy, and to satisfy proofreaders' preference.

- **Keywords:** proofreading, typeface, font size, text direction, copy placement

M. Menozzi, E. Baumer-Bergande & B. Seiffert. *Working towards a test for screening visual skills in a complex visual environment.* Pages 1331-1339.

We developed a test for screening visual skills under similar conditions as at workplace. The test was administered to 207 participants, recruited in the working population. Six-digit numbers were super-imposed on a video of a drive and presented for 300 ms in the central visual field and in the periphery. Participants reported whether or not the integer '3' was included in the numbers. Normative data for the test were computed using 150 data sets of participants reporting not to take drugs and with an age ranging between 15 y and 67 y. Participants performed better in the central visual field than in periphery. The

test could successfully be completed by participants of all ages without the need of adjustment of settings. Comparison of 46 data sets recorded in participants taking drugs (30 y – 68 y) with age matched participants not taking drugs demonstrates an additional potential application of the test.

Practitioner Summary: Developed test delivers comparative estimates of visual skills within short time and appears as valuable and cheap complementation to current testing procedures in industrial practice. The test can be used in a preventive and in educative manner to monitor effects of factors like fatigue, sleep deprivation or drug consumption.

- **Keywords:** visual skills, screening, detectability, complex visual environment

Kosuke Kaida, Yuji Takeda & Kazuyo Tsuzuki. *Can a short nap and bright light function as implicit learning and visual search enhancers?* Pages 1340-1349.

The present study examined effects of a short nap (20 min) and/or bright light (2000 lux) on visual search and implicit learning in a contextual cueing task. Fifteen participants performed a contextual cueing task twice a day (1200–1330 h and 1430–1600 h) and scored subjective sleepiness before and after a short afternoon nap or a break period. Participants served a total of four experimental conditions (control, short nap, bright light and short nap with bright light). During the second task, bright light treatment (BLT) was applied in the two of the four conditions. Participants performed both tasks in a dimly lit environment except during the light treatment. Results showed that a short nap reduced subjective sleepiness and improved visual search time, but it did not affect implicit learning. Bright light reduced subjective sleepiness. A short nap in the afternoon could be a countermeasure against sleepiness and an enhancer for visual search.

Practitioner Summary: The study examined effects of a short afternoon nap (20 min) and/or bright light (2000 lux) on visual search and implicit learning. A short nap is a powerful countermeasure against sleepiness compared to bright light exposure in the afternoon.

- **Keywords:** sleep, nap, bright light, implicit learning, visual search

Carolyn M. Sommerich, Steven A. Lavender, Radin Zaid Radin Umar, Peter Le, Jay Mehta, Pei-Ling Ko, Rafael Farfan, Mohini Dutt & SangHyun Park. *A biomechanical and subjective assessment and comparison of three ambulance cot design configurations.* Pages 1350-1361.

Effects of ambulance cot design features (handle design and leg folding mechanism) were evaluated. Experienced ambulance workers performed tasks simulating loading and unloading a cot to and from an ambulance, and a cot raising task. Muscle activity, ratings of perceived exertion, and performance style were significantly affected by cot condition ($p < 0.05$). Erector Spinae activity was significantly less when using Cot-2's stretcher-style handles. Shoulder muscle activity was significantly less when using Cot-2's loop handle. During loading and unloading, operators allowed the cot to support its own weight most often with Cot-2's stretcher-style handles. Preference for Cot-2 (either handles) over Cot-1 (with loop handle) was consistent across tasks. Handle effects were influenced by operator stature; taller participants received more benefit from Cot-2's stretcher-style handles; shoulder muscles' demands were greater for shorter participants due to handle location. Providing handle options and automatic leg folding/unfolding operation can reduce cot operator's effort and physical strain.

Practitioner Summary: Paramedics frequently incur musculoskeletal injuries associated with patient-handling tasks. A controlled experiment was conducted to assess effects of ambulance cot design features on physical stress of operators, as seen through muscle activity and operator's perceptions. Differences between cots were found, signalling that intentional design can reduce operator's physical stress.

- **Keywords:** musculoskeletal injury, EMS, paramedic, occupational injury, engineering control, patient handling

Monica R. Weiler, Steven A. Lavender, J. Mac Crawford, Paul A. Reichelt, Karen M. Conrad & Michael W. Browne. *Identification of factors that affect the adoption of an ergonomic intervention among Emergency Medical Service workers. Pages 1362-1372.*

This study explored factors contributing to intervention adoption decisions among Emergency Medical Service (EMS) workers. Emergency Medical Service workers ($n = 190$), from six different organisations, participated in a two-month longitudinal study following the introduction of a patient transfer-board (also known as slide-board) designed to ease lateral transfers of patients to and from ambulance cots. Surveys administered at baseline, after one month and after two months sampled factors potentially influencing the EMS providers' decision process. 'Ergonomics Advantage' and 'Patient Advantage' entered into a stepwise regression model predicting 'intention to use' at the end of month one ($R^2 = 0.78$). After the second month, the stepwise regression indicated only two factors were predictive of intention to use: 'Ergonomics Advantage,' and 'Endorsed by Champions' ($R^2 = 0.58$). Actual use was predicted by: 'Ergonomics Advantage' and 'Previous Tool Experience.' These results relate to key concepts identified in the diffusion of innovation literature and have the potential to further ergonomics intervention adoption efforts.

Practitioner Summary. This study explored factors that potentially facilitate the adoption of voluntarily used ergonomics interventions. EMS workers were provided with foldable transfer-boards (slideboards) designed to reduce the physical demands when laterally transferring patients. Factors predictive of adoption measures included perceived ergonomics advantage, the endorsement by champions, and prior tool experience.

- **Keywords:** intervention adoption, ergonomics intervention, injury prevention, EMS, firefighter

Pieter Coenen, Idsart Kingma, Cécile R.L. Boot, Marjolein Douwes, Paulien M. Bongers & Jaap H. van Dieën. *Work-site musculoskeletal pain risk estimates by trained observers – a prospective cohort study. Pages 1373-1381.*

Work-related musculoskeletal pain (MSP) risk assessments by trained observers are often used in ergonomic practice; however, the validity may be questionable. We investigated the predictive value of work-site MSP risk estimates in a prospective cohort study of 1745 workers. Trained observers estimated the risk of MSP (neck, shoulder or low-back pain) using a three-point scale (high, moderate and low risk) after observing a video of randomly selected workers representing a task group. Associations of the estimated risk of pain and reported pain during a three-year follow-up were assessed using logistic regression. Estimated risk of neck and shoulder pain did (odds ratio, OR: 1.45 (95% confidence interval, CI: 1.01–2.08); 1.64 (95% CI: 1.05–2.55)), however, estimated risk of low-back pain did not significantly predict pain (OR: 1.27 (95% CI: 0.91–1.79)). The results show that observers were able to estimate the risk of shoulder and neck pain, whereas they found it difficult to estimate the risk of low-back pain.

Practitioner Summary: Work-related musculoskeletal pain risk assessments by observers are often used in ergonomic practice. We showed that observers were able to estimate shoulder and neck pain risk, but had difficulties to estimate the risk of low-back pain. Therefore, observers' risk estimates might provide a useful method for musculoskeletal pain risk assessments.

- **Keywords:** musculoskeletal pain, longitudinal studies, prospective studies, risk estimates

Cristiane Shinohara Moriguchi, Letícia Carnaz, Luiz Carlos Miranda Júnior, Richard William Marklin & Helenice Jane Cote Gil Coury. *Are posture data from simulated tasks representative of field conditions? Case study for overhead electric utility workers. Pages 1382-1394.*

Many ergonomics studies are conducted in laboratory-simulated work environments to assess risks for the development of musculoskeletal disorders under more controlled conditions. However, the simulated conditions could be of questionable validity with respect to reproduction of field conditions involving risk factors. The objective of this study was to verify whether the postures recorded for neck extension/flexion and upper arm elevation of overhead electric utility workers in a simulated environment were similar to those recorded in a field environment. Of the three frequently performed tasks analysed, two presented similar exposure in both conditions. However, differences were identified for a more complex task (relay replacement). These results suggest that simulated tasks may be more representative for more standardised tasks. This may indicate that researchers investigating risks should avoid simplifying complex tasks when reproducing field posture exposure in laboratories, since omitting extra subtasks may lead to an inaccurate reproduction of field exposure.

Practitioner Summary: Studies comparing results from field and simulated environments are necessary to evaluate to what degree postural exposure reproduced in laboratory is representative of the exposure occurring in real work situations. This is particularly relevant for tasks involving training in simulated environment due to safety constraints.

- **Keywords:** work-related musculoskeletal disorders, laboratory simulation studies, postural exposure, inclinometers

Jeong Ho Kim & Peter W. Johnson. *Viability of using digital signals from the keyboard to capture typing force exposures. Pages 1395-1403.*

Although previous studies have shown that systematic temporal changes in keystroke durations may be used as surrogate measures of muscle fatigue, software-based keystroke duration may be adversely affected by different keyswitch force-displacement characteristics. Therefore, this study used a force platform to measure the keystroke durations and compared them to software-based measures in order to determine whether the software-based keystroke duration is a robust surrogate measure for the force-derived durations (independent of keyswitch designs). A total of 13 subjects typed for 15 minutes each on three keyboards with different force-displacement characteristics. The results showed that the software-based keystroke durations closely mirrored and approximated the true force-derived keystroke durations, regardless of the force-displacement characteristics. Furthermore, the subject-dependent correlations indicated that the software-based keystroke durations approximated the true force-derived keystroke durations. Therefore, the software-based keystroke durations could be used as a surrogate non-invasive, cost-effective measure to identify muscle fatigue during computer use for large-scale epidemiological studies.

Practitioner Summary: Developing non-invasive, cost-effective computer exposure assessment tools can help researchers develop a better understanding on the underlying mechanisms of computer-related musculoskeletal disorders. This study demonstrates how software measured keystroke duration can be used as a non-invasive, cost-effective exposure assessment measure during computer use.

- Keywords: computer use, musculoskeletal disorders, exposure assessment, keystroke duration, office ergonomics

Tsun-Shun Huang, Wei-Cheng Cheng & Jiu-Jenq Lin. *Relationship between trapezius muscle activity and typing speed: taping effect.* Pages 1404-1411.

Clinically, over-activation of upper trapezius (UT) muscular activity is a common cause of symptoms in computer users. The purpose of this study was to investigate the correlation between trapezius muscular activity and typing speed with and without taping. Twelve participants performed a typing task for 15 min with and without taping on the UT muscle. Electromyography (EMG) of the muscular activity of UT and lower trapezius (LT) was recorded. With or without taping, there was a significantly positive correlation ($r = 0.40$, $p = 0.04$) between typing speed and UT/LT. Additionally, UT and UT/LT ratios were lower with taping than without taping (difference = 5.2% and 26.9%). The LT ratio was higher with taping than without taping (difference = 5.8%). Taping can alter the muscular activity of the trapezius during typing and may have the potential to be applied in computer users to prevent over-activation of UT muscular activity.

Practitioner Summary: The effect of taping was tested on typing speed and trapezius muscular activity. With or without taping, typing speed was correlated with trapezius activity. The muscle activity of the trapezius, however, was lower with taping than without taping. Thus, taping has the potential to prevent over-activation of UT muscular activity during typing.

- Keywords: trapezius, muscular activity, typing, taping

Xinhui Zhu & Gwanseob Shin. *Shoulder and neck muscle activities during typing with articulating forearm support at different heights.* Pages 1412-1419.

Use of forearm support is known to reduce physical stress of computer users, but research about how to properly position the forearm support is insufficient. This study was aimed to determine whether the height of forearm support influences muscular loads during typing. Twenty four subjects performed a typing task with a pair of articulating forearm support at three different heights as well as without any support, while shoulder, neck and forearm muscle activities and posture data were recorded. Typing with the support at resting elbow height produced significantly ($p < 0.05$) lower shoulder and neck muscle activities than that of no support condition. Typing with the support at heights higher than the resting elbow height produced significantly greater shoulder and neck muscle activities compared to the no support condition. Results suggest that forearm support can help computer users lessen physical stress in typing, but only when the supports are positioned at resting elbow height.

Practitioner Summary: Use of forearm support is known to alleviate physical stress of PC users in computer works such as typing. This experimental study addressed the importance of proper positioning of forearm support by comparing neck and upper extremity muscle activities between conditions with varying heights of forearm support in keyboard typing.

- **Keywords:** forearm support, armrest, computer workstation, office ergonomics, VDT

Yueh-Ching Chou, Chi-Liang Chen & Tzu-Hua Wu. *Medical device on pharmacists' work-related musculoskeletal complaints and burnouts.* Pages 1420-1428.

This study analysed the total number of consumed vials of chemotherapy drugs during the year 2007 to determine workloads, and investigated the effects of using the Spike medical device in contrast to the use of traditional needles on oncology pharmacists' dispensing time, muscle soreness, work-related burnout and fatigue symptoms. Work-related burnout and physiological symptoms were measured using the Copenhagen Burnout Inventory (CBI) and a visual analogue pain scale. The Spike device significantly reduced the time spent in drawing up fluorouracil (39.46 ± 9.43 s vs. 57.13 ± 13.47 s) or cisplatin (29.65 ± 11.22 s vs. 60.93 ± 20.54 s) compared with traditional needles ($P < 0.001$). The CBI burnout score improved significantly with the Spike device (53.21 ± 8.58 vs. 73.21 ± 5.42 ; $P = 0.007$) because finger and palm muscle soreness complaints and subjective fatigue symptoms for eye tiredness and shoulder-wrist pain were significantly reduced ($P < 0.05$).

Practitioner Summary

The pharmacist needs to exert hand strength to counter the vial back-suction pressure to draw out the medical liquid, and confirm the volume during the drawing antineoplastic drug procedure. This study aimed to determine the effects of using a medical device, instead of a needle, on pharmacists' work-related musculoskeletal complaints and burnouts.

- **Keywords:** medical device, time spent, Copenhagen Burnout Inventory, fatigue score

Iman Dianat, Christine M. Haslegrave & Alex W. Stedmon. *Methodology for evaluating gloves in relation to the effects on hand performance capabilities: a literature review.* Pages 1429-1451.

The present study was conducted to review the literature on the methods that have been considered appropriate for evaluation of the effects of gloves on different aspects of hand performance, to make recommendations for the testing and assessment of gloves, and to identify where further research is needed to improve the evaluation protocols. Eighty-five papers meeting the criteria for inclusion were reviewed. Many studies show that gloves may have negative effects on manual dexterity, tactile sensitivity, handgrip strength, muscle activity and fatigue and comfort, while further research is needed to determine glove effects on pinch strength, forearm torque strength and range of finger and wrist movements. The review also highlights several methodological issues (including consideration of both task type and duration of glove use by workers, guidance on the selection and allocation of suitable glove(s) for particular tasks/jobs, and glove design features) that need to be considered in future research.

Practitioner Summary: The relevant literature on the effects of protective gloves on different aspects of hand performance was reviewed to make recommendations for the testing and assessment of gloves, and to improve evaluation protocols. The review highlights research areas and methodological issues that need to be considered in future research.

- **Keywords:** glove, strength, dexterity, tactile sensitivity, wrist posture, muscle activity and fatigue