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Arne Nieuwenhuys; Simone R. Caljouw; Maaïke R. Leijssen; Bart A. J. Schmeits; Raoul R. D. Oudejans. *Quantifying police officers' arrest and self-defence skills : does performance decrease under pressure?* Pages 1460 – 1468.

This study investigated police officers' performance on five selected arrest and self-defence skills that are regularly used in the line of duty. In Experiment 1 a 5-point scale to measure skill performance was developed and tested with 14 police instructors. Results showed that the new scale has satisfactory inter-rater reliability and good intra-rater reliability. In Experiment 2, the external and concurrent validity of the scale was tested by measuring the performances of 19 police officers executing the same skills in a high- and a low-pressure environment and comparing the results obtained with the new 5-point scale with results obtained with a currently used binary scale (i.e. sufficient/insufficient). While the scale proved to have good external and concurrent validity, it appeared that the police officers' performance really suffered under pressure. Given the criticality of successful police performance, it is suggested that incorporating psychological factors (e.g. pressure) in training procedures may enhance performance.

- **Keywords:** anxiety; choking; measurement scale; practical skills execution

Kristian S. Gould; Kati Hirvonen; Vilhelm F. Koefoed; Bjarte K. Røed; Mikael Sallinen; Anu Holm; Robert S. Bridger; Bente E. Moen. *Effects of 60 hours of total sleep deprivation on two methods of high-speed ship navigation.* Pages 1469 – 1486.

This study investigated how workload and performance in high-speed ship navigation was affected by sleep deprivation using methods based on either paper charts or electronic chart display and information systems (ECDIS). In two separate weeks, five navigators sailed 10 routes in high-fidelity simulators while undergoing progressive sleep deprivation for up to 60 h. Results showed that navigation performance was better using ECDIS, but was largely unaffected by sleep deprivation in both. There was significant interaction between speed, sleep deprivation and navigation method, indicating that navigators using ECDIS reduced their speed more while sleepy. Secondary task performance was reduced by sleep deprivation, but was equally affected in both conditions. Workload was higher in the ECDIS condition, as indicated by subjective ratings and heart rate variability. No significant differences in sleepiness were found, but electroencephalographic recordings indicated more frequent microsleep episodes in the

ECDIS condition. This may be influenced by lower overall arousal while navigating with ECDIS.

- **Keywords:** fast patrol boat; ECDIS; navigation; workload; sleep deprivation

Ola Lindroos. *Relationships between observed and perceived deviations from normative work procedures.* Pages 1487 – 1500.

Deviations from anticipated courses of events are often associated with accidents, while the effects of deviations that decrease productivity but do not obviously lead to human injury are less clear. A systemic approach to production and safety is introduced, and it is proposed that production deviations have effects that may lead to safety violations and personal injury. In addition, the relationship between observed and perceived production deviations from 12 senior (60-79 years old) males' routine work using three firewood processing machines is analysed. For simple machine work, perceived deviations were positively related to observed deviations per work cycle and inversely correlated to the perception of work efficiency. For more complex machine work it was more difficult to match observers' and operators' perceptions of deviations. Despite challenges in the production deviation concept, this approach offers a holistic understanding of the performance of human-machine-environment systems and complements assessments of deviations from safe working practice.

- **Keywords:** production deviations; perception; human error; equipment safety; firewood

Fion C. H. Lee; Alan H. S. Chan. *Effects of learning for linear and differential video magnifiers.* Pages 1501 – 1513.

This study sought to determine the learning effects of repeated practice with the traditional linear and the novel differential linear and differential non-linear magnification methods on visual inspection performance. Performance feedback of speed and accuracy and process feedback of scan paths and coverage of search area were given to subjects in order to facilitate the learning process. Objective performance in terms of speed and accuracy and subjective evaluation using the NASA Task Load Index paradigm were captured and analysed. The results showed that there were positive learning effects for the three magnification methods and the learning effects for the two differential magnification methods were greater than that for the traditional linear method. Three exponential learning curves were established for the three search tasks, which showed that search performance with the differential linear and differential non-linear magnifications would surpass the traditional linear method after four and 10 sessions of repeated practice, respectively.

- **Keywords:** magnification interface design; learning curve; differential magnification methods; video magnifier

Zoë Mack; Sarah Sharples. *The importance of usability in product choice : a mobile phone case study.* Pages 1514 – 1528.

Usability has become established as an important aspect of product design. This paper describes an investigation that was carried out to identify the importance of usability in product choice related to other product attributes. Interviews were initially carried out to identify possible attributes that contribute to product choice. Experiments were then undertaken using the methods of active information search, structured preference elicitation, ranking and interviews in order to find out what attributes were important to people when choosing an example product - mobile phones. It was found that usability is indeed important in product choice but perhaps not as much as users themselves believe. Other attributes that were found to be more important were features, aesthetics and

cost. The process of product choice was found to be complex and it may be the case that people have come to expect usability in their products. Further research is needed to understand more fully the changing role of usability in product choice and to further improve the quality of the user-product relationship.

- **Keywords:** usability; product choice; mobile phone; evaluation

Hugh E. McLoone; Melissa Jacobson; Peter Clark; Ryan Opina; Chau Hegg; Peter Johnson. *Design and evaluation of a curved computer keyboard. Pages 1529 – 1539.*

Conventional, straight keyboards remain the most popular design among keyboards sold and used with personal computers despite the biomechanical benefits offered by alternative keyboard designs. Some typists indicate that the daunting medical device-like appearance of these alternative 'ergonomic' keyboards is the reason for not purchasing an alternative keyboard design. The purpose of this research was to create a new computer keyboard that promoted more neutral postures in the wrist while maintaining the approachability and typing performance of a straight keyboard. The design process created a curved alphanumeric keyboard, designed to reduce ulnar deviation, and a built-in, padded wrist-rest to reduce wrist extension. Typing performance, wrist postures and perceptions of fatigue when using the new curved keyboard were compared to those when using a straight keyboard design. The curved keyboard reduced ulnar deviation by $2.2^\circ \pm 0.7$ ($p < 0.01$). Relative to the straight keyboard without a built-in wrist-rest, the prototype curved keyboard with the built-in padded wrist-rest reduced wrist extension by $6.3^\circ \pm 1.2$ ($p < 0.01$). There were no differences in typing speed or accuracy between keyboards. Perceived fatigue ratings were significantly lower in the hands, forearms and shoulders with the curved keyboard. The new curved keyboard achieved its design goal of reducing discomfort and promoting more neutral wrist postures while not compromising users' preferences and typing performance.

- **Keywords:** wrist posture; ergonomics; performance; comfort; productivity

J. M. Richter; S. E. Mathiassen; H. P. Slijper; E. A. B. Over; M. A. Frens. *Differences in muscle load between computer and non-computer work among office workers. Pages 1540 – 1555.*

Introduction of more non-computer tasks has been suggested to increase exposure variation and thus reduce musculoskeletal complaints (MSC) in computer-intensive office work. This study investigated whether muscle activity did, indeed, differ between computer and non-computer activities. Whole-day logs of input device use in 30 office workers were used to identify computer and non-computer work, using a range of classification thresholds (non-computer thresholds (NCTs)). Exposure during these activities was assessed by bilateral electromyography recordings from the upper trapezius and lower arm. Contrasts in muscle activity between computer and non-computer work were distinct but small, even at the individualised, optimal NCT. Using an average group-based NCT resulted in less contrast, even in smaller subgroups defined by job function or MSC. Thus, computer activity logs should be used cautiously as proxies of biomechanical exposure. Conventional non-computer tasks may have a limited potential to increase variation in muscle activity during computer-intensive office work.

- **Keywords:** office ergonomics; computer use; exposure assessment; EMG

Tove Østensvik; Kaj Bo Veiersted; Petter Nilsen. *Association between numbers of long periods with sustained low-level trapezius muscle activity and neck pain. Pages 1556 – 1567.*

The purpose of this prospective cohort study was to evaluate relationships between sustained low-level muscle activity (SULMA) in the neck and pain after 1 year among machine operators of forest harvesters (n = 19), forwarders (n = 20) and forest researchers (n = 20). Surface electromyography of the right upper trapezius muscle was measured during one working day. Continuous muscle activity (SULMA periods) were analysed in predetermined time intervals. Neck pain was assessed by the Borg's category-ratio scale and the Standardized Nordic Questionnaire (dichotomised into pain duration ≤ 30 or > 30 d). Harvesters reported significantly more pain than researchers. A higher number of long SULMA periods > 8 min duration increased the risk of neck pain > 30 d during the successive year (odds ratio 3.0, 95% CI 1.2-7.8). Perceived personal economy above average was associated with less pain, while other potential confounders or intermediate variables were not significant. Low-level trapezius muscle activity in periods longer than 8 min may constitute a risk for neck pain.

- **Keywords:** Surface electromyography; control levers; forest vehicles; musculoskeletal disorders; epidemiology; cohort

Na Jin Seo; Thomas J. Armstrong. *Biomechanical analysis for handle stability during maximum push and pull exertions.* Pages 1568 – 1575.

This study investigated the effect of handle stability on maximum push/pull force. It was hypothesised that people apply force in directions deviated from the pure push/pull direction to generate a moment that assists producing greater push/pull force when the handle position is fixed (stable) compared to when it is not fixed (unstable). Eight healthy subjects performed maximum push and pull exertions on a stable and an unstable handle in a seated posture, while maximum push/pull force, vertical force and lateral force were recorded. For the unstable handle, vertical and lateral forces were not different from zero during push and pull. For the stable handle, subjects intuitively applied significant downward force during push and significant upward force during pull exertions. As predicted from biomechanical analysis, this downward and upward force was found to be significantly associated with increased push and pull force, respectively, for the stable handle compared to the unstable handle.

- **Keywords:** stability; handle; push; pull; grip

Diane E. Gregory; Carla Laughton; Allan Carman; Stephan Milosavljevic; Jack P. Callaghan. *Trunk postures and peak and cumulative low back kinetics during upright posture sheep shearing.* Pages 1576 – 1583.

Sheep shearing is the most demanding occupation in the wool harvesting industry and is known to have a high prevalence of low back pain. While use of a commercially available trunk harness reduces load on the low back, the extreme trunk flexion associated with shearing still remains. A novel, upright posture shearing technique has been designed to allow a more neutral spine posture. This study assessed this upright technique and found significant reductions in both trunk flexion and cumulative low back loading when compared to either the traditional method or the use of the trunk harness. Moments about the shoulder tended to be higher while using the upright shearing technique and further investigation of shoulder kinetics will be required to assess whether this creates injury risk to the upper extremity. Despite increased shoulder moments, the reduction in flexion and cumulative loading with the use of the upright technique has the potential to reduce risk of low back pain among shearers.

- **Keywords:** agricultural ergonomics; biomechanics; low back injury; trunk posture; shearing station design

David Rempel; Demetra Star; Alan Barr; Billy Gibbons; Ira Janowitz. A new method for overhead drilling. Pages 1584 – 1589.

In the construction sector, overhead drilling into concrete or metal ceilings is a strenuous task associated with shoulder, neck and back musculoskeletal disorders due to the large applied forces and awkward arm postures. Two intervention devices, an inverted drill press and a foot lever design, were developed then compared to the usual method by construction workers performing their normal overhead drilling activities (n = 14). While the intervention devices were rated as less fatiguing than the usual method, their ratings on usability measures were worse than the usual method. The study demonstrates that the intervention devices can reduce fatigue; however, additional modifications are necessary in order to improve usability and productivity. Devices designed to improve workplace safety may need to undergo several rounds of field testing and modification prior to implementation.

- **Keywords:** design; construction; shoulder; musculoskeletal disorders; fall protection