
The Cognitive Failures Questionnaire (CFQ) is used in ergonomics research to measure behavioural problems associated with attentiveness and memory in everyday life. CFQ scores have been related to constructs such as accident proneness and outcomes such as human error and psychological strain. The two-year test-retest reliability of the CFQ is reported together with the findings of factor analyses of CFQ data from 535 respondents. Evidence for the predictive and criterion validity and internal reliability of the CFQ is provided. Psychological strain was measured concurrently with CFQ on both testing occasions, two years apart. The test-retest reliability of the summated CFQ score was found to be 0.71, while for the General Health Questionnaire (GHQ-12) strain measure it was 0.32. The relative variance stability was five times greater for the CFQ than the GHQ, indicating that scores on these questionnaires are not covariates. The use of the CFQ as a measure of cognitive control capacity is also discussed.

**Practitioner Summary:** Ergonomists have long been interested in human error and the role of high work demands due to poor equipment design and excessive workload. The CFQ measures attentiveness in daily life and is shown to have excellent psychometric properties that make it suitable for use in both laboratory and field studies as a trait measure of attentiveness in daily life.

- **Keywords:** individual differences, cognitive impairment, human performance modelling, attention and vigilance


In this study, principles of Cognitive Systems Engineering are used to better understand the human–machine interaction manifesting in the use of anaesthesia alarms. The hypothesis is that the design of the machine incorporates built-in assumptions of the user that are discrepant with the anaesthesiologist's self-assessment, creating ‘user image mismatch’. Mismatch was interpreted by focusing on the ‘user image’ as described from the perspectives of both machine and user. The machine-embedded image was interpreted through document analysis. The user-described image was interpreted through user (anaesthesiologist) interviews. Finally, an analysis was conducted in which
the machine-embedded and user-described images were contrasted to identify user image mismatch. It is concluded that analysing user image mismatch expands the focus of attention towards macro-elements in the interaction between man and machine. User image mismatch is interpreted to arise from complexity of algorithm design and incongruity between alarm design and tenets of anaesthesia practice.

Practitioner Summary: Cognitive system engineering principles are applied to enhance the understanding of the interaction between anaesthesiologist and alarm. The ‘user image’ is interpreted and contrasted from the perspectives of machine as well as the user. Apparent machine–user mismatch is explored pertaining to specific design features.

- **Keywords:** anesthesia alarms, cognitive systems engineering, user image, man–machine interaction, alarms and warnings


A field study was conducted to evaluate the illumination levels, to examine the effect of lighting conditions (including lighting characteristics and disturbances) on employee satisfaction, job performance, safety and health, and to compare the employees' perception of lighting level with actual illuminance levels in a hospital setting using both questionnaire and physical illuminance measurements. The illumination levels varied across different locations within the hospital and were lower than standards for 52.2% of the workplaces surveyed. Most respondents indicated that at least one of the four lighting characteristics (i.e. light level, type of light sources, light colour and use of daylight) was inappropriate, and that at least one of the three lighting disturbances (i.e. flickering lights, glare and unwanted shadows) was a major disturbance to them. The employees' perceptions of illuminance generally reflected the actual illuminance levels. The more appropriate maintenance or installation of lighting fixtures was rated as the most appropriate for improving lighting. The findings suggest that environmental ergonomics should be given a more prominent role in hospital building and workplace design to support safer healthcare facilities (for staff and potentially for patients).

Practitioner Summary: Good lighting is essential to improve employee performance, health and safety. The findings suggest that quantitative physical measurements should be supplemented by qualitative subjective assessments to provide a more holistic approach where specific details about the lighting condition in each working environment are incorporated from the workers' perspective.

- **Keywords:** light level, illuminance, healthcare, field study, environmental ergonomics


The present study examined whether children and adolescents can correctly report dry eyes and blurred distance vision, two visual problems associated with computer vision syndrome. Participants are 913 children and adolescents aged 6–17. They were asked to report their visual problems, including dry eyes and blurred distance vision, and received an eye examination, including tear film break-up time (TFBUT) and visual acuity (VA). Inconsistency was found between participants' reports of dry eyes and TFBUT results among all 913 participants as well as for all of four subgroups. In contrast, consistency was found between participants' reports of blurred distance vision and VA results among
873 participants who had never worn glasses as well as for the four subgroups. It was concluded that children and adolescents are unable to report dry eyes correctly; however, they are able to report blurred distance vision correctly. Three practical implications of the findings were discussed.

**Practitioner Summary:** Little is known about children’s ability to report their visual problems, an issue critical to diagnosis and treatment of children’s computer vision syndrome. This study compared children’s self-reports and clinic examination results and found children can correctly report blurred distance vision but not dry eyes.

- **Keywords:** computer vision syndrome, computer ergonomics, paediatric optometry


Smoke diving is physically demanding, and firefighters must therefore meet certain minimum physical requirements. The aim of this study was to compare the physiological demands of two fire fitness tests: a test of 8-min treadmill walking approved by the Norwegian Labour Inspection Authority (NLIA) (a laboratory test) and a Canadian test consisting of 10 firefighting specific tasks carried out in sequence (an applied field test). If the Canadian field test is as physically demanding as the NLIA-approved laboratory test, it may be suitable for testing Norwegian firefighters. Twenty-two male professional firefighters were tested on separate days. In both tests, the subjects wore a complete firefighting outfit including a breathing apparatus. The test durations were 8 min (NLIA test) versus approximately 6 min (Canadian test). Neither the peak O₂ uptake (VO₂) of approximately 45 ml kg⁻¹ min⁻¹ nor the blood lactate concentration (BLC) at test termination (≈ 9 mmol L⁻¹) differed between the two tests. Rating of perceived exertion (RPECR-10) was lower for the Canadian test than for the Norwegian test (5.2 ± 1.5 vs. 7.0 ± 2.0, respectively), and the exercise time at a high VO₂ was also shorter. In conclusion, the Canadian test appeared to be almost as physically demanding as the NLIA-approved test, having equal peak VO₂ and BLC, but shorter time at a high VO₂ and shorter duration. It might thus be a suitable alternative to the NLIA test with some modifications. The advantage of the Canadian field test is the inclusion of specific firefighting-like tasks that are not part of the NLIA test.

**Practitioner summary:** The physiological load from two firefighter fitness tests was compared. The demands were found to be similar, but the field test was of a shorter duration. With some modifications, the field test may be sufficiently demanding to be used as a fire fitness test for smoke divers in Norway.

- **Keywords:** firefighting, blood lactate concentration, lung/pulmonary ventilation (VE), oxygen uptake, ratings of perceived exertion, testing


Sudden unexpected loading has been identified as a risk factor of work-related low back pain (LBP). This study investigated the effects of different foot placements and load-releasing locations on trunk biomechanics under an unexpected sudden loading event. Fifteen subjects experienced sudden release of a 6.8-kg external load from symmetric or asymmetric directions while maintaining four different foot placements. The results showed that subjects experienced on average 4.1° less trunk flexion, 6.6 Nm less L5/S1 joint moment and 32.0 N less shear force with staggered stance with the right foot forward (the most preferred placement) compared with wide stance (the least preferred placement). Asymmetric load-releasing positions consistently resulted in smaller impacts
on trunk biomechanics than symmetric positions. The findings suggest that staggered stance and asymmetric load-holding position can be used as a protective load-handling posture against LBP caused by sudden loading.

**Practitioner Summary:** In a work environment, unexpected sudden loading may cause low back pain (LBP). In this study, we used empirical data to demonstrate how different foot placements and load-releasing locations can be used to mitigate the impact of sudden loading on the spine and to reduce the risk of LBP.

- **Keywords:** low back pain, sudden loading, foot placement, protective strategy

**Justyna Drzał-Grabiec, Sławomir Snela, Maciej Rachwał, Justyna Rykała & Justyna Podgórska. Effects of carrying a backpack in a symmetrical manner on the shape of the feet. Pages 1577-1583.**

The aim of this study was to assess changes in the shape of the feet while carrying a backpack constituting 10% of a child's weight. It was an observational, cross-sectional study involving 118 primary school children aged 11–13 years. Selected parameters of foot shape were assessed in both a normal position and with a backpack using podoscopy and a CQ-ST examination device. The study revealed significant differences in the length and width of the right and left feet between assessments. Moreover, the longitudinal arch of the foot was significantly lowered and deformity of the great toe was reported. Carrying a backpack constituting 10% of a child's weight results in lowering of the longitudinal and traverse arches of the feet and advanced toe deformities.

**Practitioner Summary:** We performed an observational, cross-sectional study examining the effect of carrying a backpack constituting 10% of a child's weight on parameters of foot shape and observed significant lowering of the longitudinal and traverse arches of the feet and advanced toe deformities.

- **Keyword:** feet, backpack, deformity, shape

**Danuta Roman-Liu, Anna Groborz & Tomasz Tokarski. Comparison of risk assessment procedures used in OCRA and ULRA methods. Pages 1584-1598.**

The aim of this study was to analyse the convergence of two methods by comparing exposure and the assessed risk of developing musculoskeletal disorders at 18 repetitive task workstations. The already established occupational repetitive actions (OCRA) and the recently developed upper limb risk assessment (ULRA) produce correlated results ($R = 0.84, p = 0.0001$). A discussion of the factors that influence the values of the OCRA index and ULRA's repetitive task indicator shows that both similarities and differences in the results produced by the two methods can arise from the concepts that underlie them. The assessment procedure and mathematical calculations that the basic parameters are subjected to are crucial to the results of risk assessment. The way the basic parameters are defined influences the assessment of exposure and risk assessment to a lesser degree. The analysis also proved that not always do great differences in load indicator values result in differences in risk zones.

**Practitioner Summary:** We focused on comparing methods that, even though based on different concepts, serve the same purpose. The results proved that different methods with different assumptions can produce similar assessment of upper limb load; sharp criteria in risk assessment are not the best solution.

- **Keyword:** upper limbs, ULRA, OCRA
Kathleen Denbeigh, Tegan R. Slot & Geneviève A. Dumas. Wrist postures and forces in tree planters during three tree unloading conditions. Pages 1599-1607.

The aims of this study were to investigate wrist postures and forces while operating the shovel during tree planting and to determine if different tree unloading techniques result in variations in wrist postures and forces. Experienced tree planters performed the planting task in a laboratory environment for three conditions: (1) symmetric tree unloading, and asymmetric unloading resulting in (2) right-loaded planting bags and (3) left-loaded planting bags. An optoelectric system and a shovel instrumented with strain gauges captured wrist posture and forces at the wrist, respectively. Wrist extension of up to 45° was observed, and this posture, in combination with varying degrees of wrist deviation, may be a primary risk factor for musculoskeletal pain. Average resultant forces at the wrist were moderately high (>30 N) for each unloading condition, indicating increased risk for the development of repetitive strain injuries such as carpal tunnel syndrome. No significant differences in wrist posture or forces existed between unloading conditions.

Practitioner Summary: Wrist pain is a major musculoskeletal complaint among tree planters. This study measured wrist postures and forces at the wrist while operating the shovel during tree planting. The wrist extension observed, in combination with deviation, may be a key risk factor for musculoskeletal pain. Forces at the wrist indicate increased risk for repetitive strain injuries.

- **Keyword:** tree planting, wrist posture, wrist forces, injury, biomechanics


Research on the effects of the spatial correlation between signal and response key has shown a clear relationship between signal/response spatial correlation and reaction time (RT) for signals and response keys that are in a linear relationship (Morin and Grant 1955; Hoffmann 2010). By means of a reanalysis of previous data of Chan and Chan (2009a, 2009b, 2011a, 2011b, 2010), the equivalent relationships for two-dimensional (2D) and three-dimensional (3D) display/control relationships are established. In a 2D array of signals with a corresponding 2D array of response keys, RT is dependent on spatial correlation, with arrangements having transverse compatibility reacting faster than those with longitudinal compatibility. 3D arrangements show a similar effect, with up/down compatibility being a major factor in determination of RT and with similar effects of transverse compatibility. The results indicate the best arrangements of signal/key arrangements where complex designs are necessary.

Practitioner Summary: Design of complex display/control arrangements requires high compatibility in order to minimise reaction times. This work extends previous research to cases where displays and controls are in two-dimensional and three-dimensional arrangements, and indicates how reaction time is affected by these more complex arrangements.

- **Keyword:** display/control relationships, response time, stimulus–response correlation
Worringham and Beringer (1989, 1998) developed a very important principle relating compatibility of movement of horizontally moving translational controls to display movements when the operator’s view of the display is in a plane different to that of the control. On the basis of past data of the current authors, it is shown that the visual field principle also applies to the operation of vertically moving translational controls and to rotary controls. These additions make the Worringham and Beringer principle the most powerful design principle available for situations where the operator is viewing a display that is not in the same plane as the control.

**Practitioner Summary:** High compatibility between control input and display output is of great importance in machine design. This paper demonstrates that, for cases where the display is not in the same plane as the control, the visual field principle is operational for vertically moving translational controls and rotary controls as well as for horizontally moving translational controls.

- **Keyword:** rotary controls, visual field principle, display/control orientation