

# Ergonomics– rok 2012, ročník 55

## Číslo 1



**Yuichiro Kato, Hiroshi Endo, Tatsu Kobayakawa, Kazuhiro Kato & Satoshi Kitazaki. *Effects of intermittent odours on cognitive-motor performance and brain functioning during mental fatigue.* Pages 1-11.**

Effects of intermittent presentation of odours on cognitive-motor performance and brain activity during mental fatigue were examined using event-related brain potentials. Participants performed a Go/NoGo task for 60 min, in both odour and air control conditions. The time-on-task reaction time increase was significantly smaller in the odour condition than in the air control condition. Go- and NoGo-P3 amplitudes were larger in the presence of odours than during the air control, during mental fatigue. There were no effects of odours on error negativity (Ne)/error-related negativity (ERN) amplitude and latency. These results suggest that the presence of intermittent odours improves attentional/effortful control of response selection, and that this effect mitigates the deterioration of cognitive-motor performance during mental fatigue.

**Practitioner Summary:** The present study provides evidence for a potentially effective strategy, the use of odours, to mitigate deficits in cognitive-motor performance during time-on-task. The results show that the presence of intermittent odours is an efficient tool for maintenance of attention and reaction time during a prolonged task.

- **Keywords:** intermittent odours, mental fatigue, cognitive-motor performance, reaction time, event-related brain potentials

**Marjolein D. van der Zwaag, Chris Dijksterhuis, Dick de Waard, Ben L.J.M. Mulder, Joyce H.D.M. Westerink & Karel A. Brookhuis. *The influence of music on mood and performance while driving.* Pages 12-22.**

Mood can influence our everyday behaviour and people often seek to reinforce, or to alter their mood, for example by turning on music. Music listening while driving is a popular activity. However, little is known about the impact of music listening while driving on physiological state and driving performance. In the present experiment, it was investigated whether individually selected music can induce mood and maintain moods during a simulated drive. In addition, effects of positive, negative, and no music on driving behaviour and physiological measures were assessed for normal and high cognitive demanding rides. Subjective mood ratings indicated that music successfully maintained mood while driving. Narrow lane width drives increased task demand as shown in effort ratings and increased swerving. Furthermore, respiration rate was lower during music listening compared to rides without music, while no effects of music were

found on heart rate. Overall, the current study demonstrates that music listening in car influences the experienced mood while driving, which in turn can impact driving behaviour.

**Practitioners Summary:** Even though it is a popular activity, little is known about the impact of music while driving on physiological state and performance. We examined whether music can induce moods during high and low simulated drives. The current study demonstrates that in car music listening influences mood which in turn can impact driving behaviour. The current study shows that listening to music can positively impact mood while driving, which can be used to affect state and safe behaviour. Additionally, driving performance in high demand situations is not negatively affected by music.

- **Keywords:** music mood induction, demand, simulated drive, respiration rate, heart rate, driving behaviour

**Ulf J.J. Hahnel & Heiko Hecht. *The impact of rear-view mirror distance and curvature on judgements relevant to road safety.* Pages 23-36.**

We report two experiments that investigate the impact of rear-view mirror distance and curvature on distance, spacing, and time-to-contact (TTC) judgements. The variation in mirror distance had a significant effect on TTC judgements, but only marginally influenced distance and spacing estimations. As mirror distance increased, TTC was overestimated, which is potentially dangerous. Control conditions with identical visual angles across different mirror distances revealed that effects were not solely caused by variation in visual angle. The impact of mirror curvature moderated the effect. While observers were unable to compensate for the mirror distance effect, they could do so for the distortions generated by non-planar mirrors, at least up to a certain degree of distortion. Implications for vehicle design and national guidelines are discussed.

**Practitioner Summary:** Regulations regarding rear-view mirrors are vastly different between countries. For instance EU regulations encourage convex driver-side mirrors, whereas US regulations allow them merely on the passenger's side. The use of a dynamic TTC paradigm puts the human factors designer in a position to evaluate the existing regulations and to design safer mirrors.

- **Keywords:** rear-view mirror, mirror distance, mirror curvature, time-to-contact, visual angle

**Nora Balfe, John R. Wilson, Sarah Sharples & Theresa Clarke. *Development of design principles for automated systems in transport control.* Pages 37-54.**

This article reports the results of a qualitative study investigating attitudes towards and opinions of an advanced automation system currently used in UK rail signalling. In-depth interviews were held with 10 users, key issues associated with automation were identified and the automation's impact on the signalling task investigated. The interview data highlighted the importance of the signallers' understanding of the automation and their (in)ability to predict its outputs. The interviews also covered the methods used by signallers to interact with and control the automation, and the perceived effects on their workload. The results indicate that despite a generally low level of understanding and ability to predict the actions of the automation system, signallers have developed largely successful coping mechanisms that enable them to use the technology effectively. These findings, along with parallel work identifying desirable attributes of automation from the literature in the area, were used to develop 12 principles of automation which can be used to help design new systems which better facilitate cooperative working.

**Practitioner Summary:** The work reported in this article was completed with the active involvement of operational rail staff who regularly use automated systems in rail signalling. The outcomes are currently being used to inform decisions on the extent and type of automation and user interfaces in future generations of rail control systems.

- **Keywords:** automation, rail, signalling, ergonomics design principles, control centres

**M. Riethmüller, E. Fernandez Castelao, I. Eberhardt, A. Timmermann & M. Boos. *Adaptive coordination development in student anaesthesia teams: a longitudinal study.* Pages 55-68.**

Although adaptive coordination has been highlighted by several studies, research dealing with how adaptive coordination develops is still rare. Thus, the aim of this study was to investigate the development of coordination mechanisms and their task-related adaptation in a longitudinal observation of medical simulation-based training of final year students. We recorded six anaesthesia teams during a sequence of four task scenarios, and each scenario comprised of a routine and a complication phase. After trained observers rated sub-tasks within each scenario for explicit and implicit coordination, statistical analysis revealed a statistically significant effect of previous scenarios on coordination development in the routine phases. While the amount of explicit coordination decreased, implicit coordination increased, revealing adaptive coordination as a skill developed through repeated group interaction. We conclude that anaesthesia training should consider cost- and patient safety-benefits of implicit and explicit coordination and focus on adaptive coordination.

**Practitioner Summary:** Group coordination is crucial to anaesthesia team performance. Results of this longitudinal observation of six anaesthesia teams during four medical simulation-based training scenarios document that teams develop adaptive patterns of coordination. This study also demonstrates that adaptive coordination is a trainable skill within crisis resource management training.

- **Keywords:** explicit and implicit coordination, anaesthesia teams, coordination development, adaptive coordination, high-fidelity simulation

**Julien Jacquier-Bret, Philippe Gorce & Nasser Rezzoug. *The manipulability: a new index for quantifying movement capacities of upper extremity.* Pages 69-77.**

In this work, it is proposed to evaluate the upper-limb movements through a global index of performance borrowed from the field of robotics: the manipulability. For a given posture, this index quantifies the set of velocities that can be achieved at the wrist in all the Cartesian directions. The manipulability can be represented by an ellipsoid from which the volume and shape related parameters can be derived. During a reach to grasp movement, the ellipsoid obtained from experiment presented a flattened shape along the forearm longitudinal axis and an increased volume as the arm was extended. From this study, it is concluded that: (1) the ellipsoid volume reflects well the ability to generate speed at the wrist which is effectively maximal for an extended posture; (2) if maximal velocity is an important parameter it might be advisable to primarily move the hand perpendicularly to the forearm longitudinal axis.

**Practitioner Summary:** The interest of manipulability indices is that they evaluate globally a posture of the upper-limb in relation to a given task. This original parameter could help to design environments or devices in order that the adopted postures maximise one particular aspect of the performance, i.e. the velocity of the hand.

- **Keywords:** upper limb, biomechanics, manipulability, reach-to-grasp

**A.B. Oliveira, L.C.C.B. Silva, E.S.L. Pálincás, R.S. Padula & H.J.C.G. Coury.**  
***How is a box handled when all surfaces can be freely held? Pages 78-86.***

In this study, we investigated how experienced and inexperienced subjects handle a box when it could be approached from any of its sides. Subjects moved a box (11 kg) either to a high (HS) or a low surface (LS). Wrist movements and grip force were synchronised and recorded, respectively, by electrogoniometers and an instrumented box. All subjects adopted a lateral-and-bottom grip, with parts of the hands simultaneously placed on the side and bottom of the box. This grip allowed the 50th percentile of wrist movements to be within safe limits, particularly in the sagittal plane. Low force was associated with lowering the box to LS and equally distributed but greater force when lifting to HS. Larger ulnar deviation was recorded when the box was lifted to HS. Only peak of wrist extension differentiated experienced from inexperienced subjects, with experienced presenting larger wrist extension. Alternative box designs are suggested to improve handling in real settings.

**Practitioner Summary**

Understanding worker preferences for box lifting behaviour can contribute to the development of new designs that facilitate the adoption of more efficient postures while reducing the risk of upper-limb musculoskeletal disorders and promoting safer manual material handling.

- **Keywords:** manual handling, upper limb disorders, hand tools and interfaces, industrial ergonomics

**André Plamondon, Christian Larivière, Alain Delisle, Denys Denis & Denis Gagnon.**  
***Relative importance of expertise, lifting height and weight lifted on posture and lumbar external loading during a transfer task in manual material handling. Pages 87-102.***

The objective of this study was to measure the effect size of three important factors in manual material handling, namely expertise, lifting height and weight lifted. The effect of expertise was evaluated by contrasting 15 expert and 15 novice handlers, the effect of the weight lifted with a 15-kg box and a 23-kg box and the effect of lifting height with two different box heights: ground level and a 32 cm height. The task consisted of transferring a series of boxes from a conveyor to a hand trolley. Lifting height and weight lifted had more effect size than expertise on external back loading variables (moments) while expertise had low impact. On the other hand, expertise showed a significant effect of posture variables on the lumbar spine and knees. All three factors are important, but for a reduction of external back loading, the focus should be on the lifting height and weight lifted.

**Practitioner Summary**

The objective was to measure the effect size of three important factors in a transfer of boxes from a conveyor to a hand trolley. Lifting height and weight lifted had more effect size than expertise on external back loading variables but expertise was a major determinant in back posture.

- **Keywords:** manual material handling, lifting, expert, low back load, ergonomic intervention, training programs

**Dingding Lin, Maury A. Nussbaum & Michael L. Madigan. *Efficacy of three interventions at mitigating the adverse effects of muscle fatigue on postural control.* Pages 103-113.**

This study evaluated the efficacy of three interventions at reducing the adverse effects of muscle fatigue on postural control. The first provided rest breaks according to perceived decrements in postural stability, while the other two involved auditory stimulations (static pure tone and moving conversation). Sixteen participants performed repetitive box handling (lifting + lowering) over 1.5 h to induce muscle fatigue mainly in the lumbar extensors. Trials of quiet upright stance were completed at 10-min intervals, during which the interventions (or a control condition) were applied. Postural control was assessed using perceived stability (PS) and several measures derived from centre-of-pressure (COP) time series. Allowance of rest breaks did not significantly affect any of the objective measures, though a trend indicated an offset to fatigue-induced decreases in PS. Both the static pure tone and moving conversation led to significant changes in the dependent measures indicating a mitigation of fatigue-induced postural instability.

**Practitioner Summary:** We examined the effects of three control strategies on postural control in the presence of muscle fatigue induced by a simulated occupational task. The findings can facilitate the development of future strategies or practical interventions to reduce falling risk and prevent falls.

- **Keywords:** postural control, muscle fatigue, intervention, auditory stimulation, falls, quiet stance

**G.S. Paddan, S.R. Holmes, N.J. Mansfield, H. Hutchinson, C.I. Arrowsmith, S.K. King, R.J.M. Jones & A.N. Rimell. *The influence of seat backrest angle on human performance during whole-body vibration.* Pages 114-128.**

This study investigated the effects of reclined backrest angles on cognitive and psychomotor tasks during exposure to vertical whole-body vibration. Twenty participants were each exposed to three test stimuli of vertical vibration: 2–8 Hz; 8–14 Hz and 14–20 Hz, plus a stationary control condition whilst seated on a vibration platform at five backrest angles: 0° (recumbent, supine) to 90° (upright). The vibration magnitude was 2.0 ms<sup>-2</sup> root-mean-square. The participants were seated at one of the backrest angles and exposed to each of the three vibration stimuli while performing a tracking and choice reaction time tasks; then they completed the NASA-TLX workload scales. Apart from 22.5° seat backrest angle for the tracking task, backrest angle did not adversely affect the performance during vibration. However, participants required increased effort to maintain performance during vibration relative to the stationary condition. These results suggest that undertaking tasks in an environment with vibration could increase workload and risk earlier onset of fatigue.

**Practitioner Summary**

Current vibration standards provide guidance for assessing exposures for seated, standing and recumbent positions, but not for semi-recumbent postures. This paper reports new experimental data systematically investigating the effect of backrest angle on human performance. It demonstrates how workload is elevated with whole-body vibration, without getting affected by backrest angle.

- **Keywords:** whole-body vibration, human performance, backrest angle, tracking, reaction time