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Leon Straker, Rebecca Abbott, Rachel Collins & Amity Campbell.
Evidence-based guidelines for wise use of electronic games by children.
pages 471-489.

Electronic games (e-games) are widely used by children, often for substantial durations, yet to date there are no evidence-based guidelines regarding their use. The aim of this paper is to present guidelines for the wise use of e-games by children based on a narrative review of the research. This paper proposes a model of factors that influence child–e-games interaction. It summarises the evidence on positive and negative effects of use of e-games on physical activity and sedentary behaviour, cardio-metabolic health, musculoskeletal health, motor coordination, vision, cognitive development and psychosocial health. Available guidelines and the role of guidelines are discussed. Finally, this information is compiled into a clear set of evidence-based guidelines, about wise use of e-games by children, targeting children, parents, professionals and the e-game industry. These guidelines provide an accessible synthesis of available knowledge and pragmatic guidelines based on e-game specific evidence and related research.

Practitioner Summary: E-games are an important part of life for many children. Evidence suggests they impact on many aspects of children's behaviour, health and development, though many issues lack convincing evidence. These evidence-based guidelines provide an accessible synthesis of available knowledge and pragmatic guidelines based on e-game specific evidence and related research.

- **Keywords:** Video games, computer games, physical activity, health, adolescents

Amy Z.Q. Chung, Ann Williamson & Steven T. Shorrock. ***What do human factors and ergonomics professionals value in research publications? Re-examining the research-practice gap.*** **pages 490-502.**

The research-practice gap is of concern in human factors/ergonomics (HF/E) as there is a belief that HF/E research may not be making an impact on practice in the 'real world'. A potential issue is what researchers and practitioners perceive as important in HF/E journal articles as a primary means of conveying research findings to practitioners. This study examined the characteristics that make scientific journal articles appeal to HF/E researchers and practitioners using a web-based survey. HF/E researchers and practitioners were more similar than expected in judgements of important attributes and the selection of articles. Both practitioners and researchers considered practical

significance to be more important than theoretical significance, in direct contrast to professionals from a related discipline – psychology. Well-written articles were appreciated across disciplines. The results signal a strong interest in practical applications in HF/E, but a relative lack of focus on development of theories that should be the basis for practical applications. **Practitioner Summary:** HF/E researchers and practitioners make similar choices of journal articles and view presentation quality and practical significance as high but theory as low in determining the impact of articles, indicating a smaller than expected research-practice gap and that HF/E should encourage stronger focus on theory to ensure its continuing development.

- **Keywords:** human factors, ergonomics, research-practice gap, research publications

Karyn Pravossoudovitch, Francois Cury, Steve G. Young & Andrew J. Elliot. *Is red the colour of danger? : testing an implicit red-danger association.* pages 503-510.

Research using participant's self-reports has documented a link between red and danger. In this research, we used two different variants of a Stroop word evaluation task to test for the possibility of an implicit red–danger association using carefully controlled colour stimuli (equated on lightness and chroma). Experiment 1, using words as stimuli, yielded strong evidence of a link between red and danger, and weaker evidence of a green–safety association. Experiment 2, using symbols as stimuli, again yielded strong evidence of a link between red and danger; no green effects were observed. The findings were discussed in terms of the power and promise of red in signal communication. **Practitioner Summary:** This research documents an implicit association between red and danger. Our findings confirm the wisdom of using red to communicate danger in systematic signal systems, and suggest that red may be used more broadly in other communication contexts to efficiently convey danger-relevant information.

- **Keywords:** red, danger, implicit association, signal communication, green

Elisângela Vilar, Francisco Rebelo, Paulo Noriega, Emília Duarte & Christopher B. Mayhorn. *Effects of competing environmental variables and signage on route-choices in simulated everyday and emergency wayfinding situations.* pages 511-524.

This study examined the relative influence of environmental variables (corridor width and brightness) and signage (directional and exit signs), when presented in competition, on participants' route-choices in two situational variables (everyday vs. emergency), during indoor wayfinding in virtual environments. A virtual reality-based methodology was used. Thus, participants attempted to find a room (everyday situation) in a virtual hotel, followed by a fire-related emergency egress (emergency situation). Different behaviours were observed. In the everyday situation, for no-signs condition, participants choose mostly the wider and brighter corridors, suggesting a heavy reliance on the environmental affordances. Conversely, for signs condition, participants mostly complied with signage, suggesting a greater reliance on the signs rather than on the environmental cues. During emergency, without signage, reliance on environmental affordances seems to be affected by the intersection type. In the sign condition, the reliance on environmental affordances that started strong decreases along the egress route. **Practitioner Summary:** Virtual reality was used to study relative influence of environmental variables and signage, when in competition, on participants' route-choices in everyday and emergency situations. For everyday no-signs condition, findings suggested a reliance on environmental variables. For emergency sign condition, higher reliance on environmental variables was found for first three intersections.

- **Keywords:** wayfinding, route-choice, virtual reality, emergency egress, affordances

Joachim Vogt & Katia R.A. Nunes. *Recycling behaviour in healthcare: waste handling at work.* pages 525-535.

This article reviews the motivational factors for environmental behaviour in general, presenting a case study on recycling disposable plastics in hospitals. Results show that 90% of over 600 employees from six analysed hospitals in Germany reported that the recycling of disposable plastics on the wards makes sense from an environmental and economic point of view. The case study reports an assessment of recycling attitudes and problems of hospital staff, mainly nurses. Employees in eco-certified hospitals were much more satisfied and reported fewer problems with the recycling system. The gender effect was significant only for saving energy, while age correlated with nearly all reported pro-environmental behaviour at home. At work, the mere introduction of a recycling system was insufficient to achieve good recycling results. Based on the study findings, recommendations are given aimed at improving the safety and sustainability of the recycling system. **Practitioner Summary:** This study examines the factors influencing recycling behaviour in hospitals, using a case study of recycling disposable plastics in six German hospitals. The main findings revealed that personal factors do relate to recycling, however, the greatest potential for improvement was identified in organisational issues, mainly concerning information, feedback and logistics.

- **Keywords:** ecological awareness, hospital, recycling, sustainability, work safety

Peter Le, Joseph Rose, Gregory Knapik & William S. Marras. *Objective classification of vehicle seat discomfort.* pages 536-544.

The objective of this study was to identify how physiological measures relate to self-reported vehicle seating discomfort. Twelve subjects of varied anthropometric characteristics were enrolled in the study. Subjects sat in two seats over a 2-h period and were evaluated via three physiological measures (near-infrared spectroscopy, electromyography and pressure mapping) yielding six testing sessions. Subjective discomfort surveys were recorded before and after each session for nine regions of the body. Conditional classification discomfort models were developed through dichotomised physiological responses and anthropometry to predict subjective discomfort in specific body locations. Models revealed that subjects taller than 171 cm with reduced blood oxygenation in the biceps femoris or constant, low-level muscle activity in the trapezius tended to report discomfort in the lower extremities or neck, respectively. Subjects weighing less than 58 kg with reduced blood oxygenation in the biceps femoris or unevenly distributed pressure patterns tended to report discomfort in the buttocks. The sensitivities and specificities of cross-validated models ranged between 0.69 and 1.00.

Practitioner Summary: Discomfort has been studied extensively in order to enhance the seating design process. However, biomechanical and physiological responses relative to subjective discomfort have been largely ignored in the literature. Considering these responses along with anthropometry may provide insight into why a specific individual reports a seat as uncomfortable.

- **Keywords:** seating, sitting, car, physiological discomfort

Sjan-Mari van Niekerk, Quinette Abigail Louw & Karen Grimmer-Somers. *Frequency of postural changes during sitting whilst using a desktop computer : exploring an analytical methodology.* pages 545-554.

Background: Dynamic movement whilst sitting is advocated as a way to reduce musculoskeletal symptoms from seated activities. Conventionally, in ergonomics research, only a 'snapshot' of static sitting posture is captured, which does not provide

information on the number or type of movements over a period of time. A novel approach to analyse the number of postural changes whilst sitting was employed in order to describe the sitting behaviour of adolescents whilst undertaking computing activities. **Methods:** A repeated-measures observational study was conducted. A total of 12 high school students were randomly selected from a conveniently selected school. Fifteen minutes of 3D posture measurements were recorded to determine the number of postural changes whilst using computers. **Results:** Data of 11 students were able to be analysed. Large intra-subject variation of the median and IQR was observed, indicating frequent postural changes whilst sitting. **Conclusion:** Better understanding of usual dynamic postural movements whilst sitting will provide new insights into causes of musculoskeletal symptoms experienced by computer users. **Practitioner Summary:** Dynamic movement whilst sitting and operating a computer may prevent musculoskeletal pain. A new method was used to analyse usual sitting posture at a desktop computer to determine the number of postural changes whilst sitting. Better understanding of the dynamics of sitting could unlock the association with musculoskeletal symptoms experienced by many keyboard operators.

- **Keywords:** posture measurement, sitting biomechanics, dynamism

Kaitlin M. Gallagher, Troy Campbell & Jack P. Callaghan. *The influence of a seated break on prolonged standing induced low back pain development. pages 555-562.*

With the recent attention to 'sitting disease', health practitioners and scientists are promoting standing in the workplace to decrease sedentary time, despite a high prevalence of low back pain (LBP) development during prolonged standing. The purpose of this study was to assess how a seated break inserted between bouts of prolonged standing would influence LBP development, posture and movement. A total of 20 participants stood for 45 minutes, sat for 15 minutes and repeated this sequence while lumbar and thoracic angles were measured, and LBP visual analogue scale reports were taken. Of the sample, 55% participants reported LBP in standing. A stand to sit ratio of 3:1 did not provide lasting recovery of LBP from standing and pain developers utilised a limited range of their lumbar spine angle and increased thoracic extension, resulting in static postures that caused tissue aggravation that was not resolved after 15 minutes of sitting. Prolonged standing in the workplace has the potential to result in LBP for some workers and alternate ways to reduce sedentary time should be investigated.

Practitioner Summary: Recommending standing to replace sitting should be undertaken with caution. A ratio of 3:1 (stand to sit) did not mitigate standing induced LBP. Practitioners should consider the interplay between standing and seated work and provide a variety of activities to reduce sedentary time tailored to work, preference and tolerance for an activity.

- **Keywords:** office ergonomics, occupational standing, sit-stand desks, work-rest ratios, working posture

Lauren J. Morgan & Neil J. Mansfield. *A survey of expert opinion on the effects of occupational exposures to trunk rotation and whole-body vibration. pages 563-574.*

We present a review of current expert opinion on the effects of combined exposures to trunk rotation and whole-body vibration (WBV), commonly experienced by operators of agricultural machinery. We evaluate the level of agreement between academic experts in the field of ergonomics, human response to WBV and agricultural operators, on the effects of exposure to WBV and trunk rotation. A total of 83 individuals responded to the paper-based questionnaire, which included questions on risk levels from individual and combined exposures, discomfort development, exposure duration limits and tasks within agriculture. The results showed that all groups considered exposure to WBV and trunk

rotation as risk factors for the development of back pain. The experts were not in consensus regarding acceptable exposure durations, areas of discomfort experienced or recommendations for cab developments. **Practitioner Summary:** Trunk rotation combined with WBV is the suggested cause for low back pain in exposed populations. Expert opinion on possible interactions is explored through risk assessment and practice recommendations. Designers should consider the operators' feedback on the machines they use, as this may include valuable insight on future developments.

- **Keywords:** agriculture, vibration, driving, trunk rotation, low back pain

Jay P. Mehta, Steven A. Lavender & Richard J. Jagacinski. *Physiological and biomechanical responses to a prolonged repetitive asymmetric lifting activity. pages 575-588.*

This study investigated the effects of a prolonged repetitive asymmetric lifting task on behavioural adaptations during repetitive lifting activity, measures of tissue oxygenation and spine kinematics. Seventeen volunteers repeatedly lifted a box, normalised to 15% of the participant's maximum lifting strength, at the rate of 10 lifts/min for a period of 60 min. The lifts originated in front of the participants at ankle level and terminated on their left side at waist level. Overall, perceived workload increased during the repetitive lifting task. Erector spinae oxygenation levels, assessed using near-infrared spectroscopy, decreased significantly over time. Behavioural changes observed during the repetitive lifting task included increases in the amount of forward bending, the extension velocity and the lateral bending velocity, and a reduced lateral bending moment on the spine. These changes, with the exception of the reduced lateral bending moment, are associated with increased risk of low back disorder. **Practitioner Summary:** Repetitive lifting is known to affect low back injury risk; however, the biomechanical mechanisms linking physical fatigue and back injury risk are not well understood. This study showed that behavioural adaptations made by people performing asymmetric repetitive lifting activity may increase risk through increased dynamic loading of the tissues.

- **Keywords:** repetitive lifting, manual handling, musculoskeletal disorders, biomechanics, near-infrared spectroscopy

Aoife Finneran & Leonard O'Sullivan. *Self-selected duty cycle times for grip force, wrist flexion postures and three grip types. pages 589-601.*

Performance and health issues are common in industry. On-the-job productivity gains related to good design, which could help justify ergonomics intervention, are often not considered. More quantitative data are needed to model the discomfort/productivity relationship for upper limb activity in simulated repetitive assembly type work. Eighteen participants completed an experiment, simulating a repetitive upper limb task with force, posture and grip type recorded as independent variables. Duty cycle time and discomfort were recorded as dependent variables. Participants performed 18 experiment combinations (block designed around force); each treatment lasted 35 min, including breaks. Analysis indicated a significant two-way interaction between posture and grip type. Results from this experiment were used to model the effect of these variables on operator discomfort and performance. **Practitioner Summary:** Grip type, wrist posture and exertion level can alter the effect of performance and discomfort in repetitive tasks. Careful consideration needs to be given to the choice of grip type in task design and its effects in conjunction with other risk factors such as level of force and awkward posture.

- **Keywords:** grip type, performance, discomfort, repetitive tasks, task design

Iman Dianat & Arezou Salimi. Working conditions of Iranian hand-sewn shoe workers and associations with musculoskeletal symptoms. pages 602-611.

The working conditions and the prevalence of self-reported musculoskeletal symptoms among 180 Iranian hand-sewn shoe workers were evaluated in this cross-sectional study. Data were collected using both questionnaire (for assessing musculoskeletal symptoms and associated risk factors) and direct observations of posture (by the Rapid Upper Limb Assessment [RULA] method). The prevalence and severity of symptoms was very high among the study population. The mean RULA grand score of 6.2 indicates that in most cases the workers' postures at their workstations need to be investigated and some changes are required immediately. Multiple logistic regression models indicated that the job experience, daily working hours, duration of continuous work without breaks, feeling pressure due to work and working postures were significantly associated with musculoskeletal symptoms of different body regions. The results are discussed in terms of their implications for hand-sewing tasks. These findings can help to better understand the working conditions of those jobs involving hand-sewing operation and highlight the potential for ergonomic interventions to reduce musculoskeletal symptoms among these working groups. **Practitioner Summary:** Working conditions of hand-sewn shoe workers and their musculoskeletal symptoms were investigated. The prevalence and severity of musculoskeletal symptoms was very high among the study population. Poor working postures, feeling pressure due to work, long duration of work without breaks and prolonged daily working hours were positively associated with musculoskeletal symptoms.

- **Keywords:** hand-sewing, shoemaking, RULA, posture, Iran

Anthony Walker, Matthew Driller, Christos Argus, Julie Cooke & Ben Rattray. The ageing Australian firefighter : an argument for age-based recruitment and fitness standards for urban fire services. pages 612-621.

Currently, there is no enforcement of physical standards within Australian fire services post-recruitment, possibly leading to inappropriate fitness and body composition. This study evaluated the impacts of ageing on physical standards of Australian firefighters. Seventy-three firefighters from three different 10-year age groups [25–34 years ($n = 27$), 35–44 years ($n = 27$), 45–54 years ($n = 19$)] volunteered for physical testing using dual-energy X-ray analysis and existing fitness tests used for recruitment by an Australian fire service. Older (45–54 years) participants demonstrated significantly poorer physical standards compared with younger participants including cardiovascular fitness ($p < 0.05$), strength ($p = 0.001$) and simulated operational power testing tasks ($p < 0.001$). Age-related body composition changes were also observed independent of body mass index. Minimum recruitment standards and fitness programs need to account for age-related declines in physical capabilities to ensure that the minimum standard is maintained regardless of age. **Practitioner Summary:** Using dual-energy X-ray analysis and established fitness testing protocols, this study aimed to gain an appreciation of the current standards of body composition and fitness of Australian firefighters and the effects of ageing on their physical abilities post-recruitment. The study demonstrated a significant decline in physical standards due to age.

- **Keywords:** firefighter, ageing, fitness, body composition, recruitment

B. Bonnechère, B. Jansen, P. Salvia, H. Bouzahouene, V. Sholukha, J. Cornelis, M. Rooze & S. Van Sint Jan. Determination of the precision and accuracy of morphological measurements using the Kinect™ sensor: comparison with standard stereophotogrammetry. pages 622-631.

The recent availability of the Kinect™ sensor, a low-cost Markerless Motion Capture (MMC) system, could give new and interesting insights into ergonomics (e.g. the creation of a morphological database). Extensive validation of this system is still missing. The aim of the study was to determine if the Kinect™ sensor can be used as an easy, cheap and fast tool to conduct morphology estimation. A total of 48 subjects were analysed using MMC. Results were compared with measurements obtained from a high-resolution stereophotogrammetric system, a marker-based system (MBS). Differences between MMC and MBS were found; however, these differences were systematically correlated and enabled regression equations to be obtained to correct MMC results. After correction, final results were in agreement with MBS data ($p = 0.99$). Results show that measurements were reproducible and precise after applying regression equations. Kinect™ sensors-based systems therefore seem to be suitable for use as fast and reliable tools to estimate morphology. **Practitioner Summary:** The Kinect™ sensor could eventually be used for fast morphology estimation as a body scanner. This paper presents an extensive validation of this device for anthropometric measurements in comparison to manual measurements and stereophotogrammetric devices. The accuracy is dependent on the segment studied but the reproducibility is excellent.

- **Keywords:** ergonomics instrumentation, anthropometry, ergonomics tools and methods, general ergonomics