

Ergonomics– rok 2014, ročník 57

Číslo 9



Richard Pak, Anne Collins McLaughlin & Brock Bass. *A multi-level analysis of the effects of age and gender stereotypes on trust in anthropomorphic technology by younger and older adults.* pages 1277-1289.

Previous research has shown that gender stereotypes, elicited by the appearance of the anthropomorphic technology, can alter perceptions of system reliability. The current study examined whether stereotypes about the perceived age and gender of anthropomorphic technology interacted with reliability to affect trust in such technology. Participants included a cross-section of younger and older adults. Through a factorial survey, participants responded to health-related vignettes containing anthropomorphic technology with a specific age, gender, and level of past reliability by rating their trust in the system. Trust in the technology was affected by the age and gender of the user as well as its appearance and reliability. Perceptions of anthropomorphic technology can be affected by pre-existing stereotypes about the capability of a specific age or gender. **Practitioner Summary:** The perceived age and gender of automation can alter perceptions of the anthropomorphic technology such as trust. Thus, designers of automation should design anthropomorphic interfaces with an awareness that the perceived age and gender will interact with the user's age and gender.

- **Keywords:** automation, trust, aging, stereotypes, mobile, health

Marion Verneau, John van der Kamp, Geert J.P. Savelsbergh & Michiel P. de Looze. *Optimising assembly learning in older adults through the manipulation of instruction.* pages 1290-1299.

The present investigation assessed the putative benefits of reducing instructions for older adults' learning of an assembly task. Young and older adults had to build a product by assembling six components. Two groups practiced following instruction methods that differed in the degree of explicit information they conveyed about the correct assembly order. After practice, retention, consolidation of performance (tested immediately after practice and on a separate day, respectively) and stability of performance (tested by introducing a concurrent second task) were assessed. Younger adults showed similar performance levels for both instruction methods. Older adults, however, showed similar retention but clearly weaker consolidation and stability of performance following less encompassing instructions. Contrary to expectations, enhancing the involvement of

explicit processes allowed older adults to gain a more permanent and stable performance improvements. The findings are discussed relative to the characteristics of the assembly task. **Practitioner Summary:** We addressed how performance and learning of older adults in an assembly task can be optimised through different types of instruction. The findings suggest that increasing awareness of task characteristics enhance not only long-term performance, but also resilience against distraction. Future work must evaluate if these findings generalise to more complex tasks.

- **Keywords:** aging, explicit instruction, sequential learning, resilience, chain industry work

Rui-feng Yu & Lin-dong Yang. *Age-related changes in visual lobe shape characteristics and their relationship to visual search performance.* pages 1300-1314.

Visual lobe shape plays an important role in visual search performance, but little is known about the age-related changes in visual lobe shape. The age-related changes in visual lobe shape characteristics and their relationships to visual search performance were investigated in this study. A total of 96 participants aged 15–64 years participated in this study. Their visual lobes were mapped on a uniform 2-D test field composed of 24 regularly spaced meridians passing through the centre of the visual field, and their search performances were also measured. The results showed that in general, age significantly affected visual lobe size, visual lobe shape and search time. As age increased, the visual lobe size decreased; in addition, the roundness, boundary smoothness, symmetry and regularity of the visual lobe deteriorated, and the search time increased. Moreover, significant correlations between visual lobe shape, search time and age were found. Regression analyses indicated that age was important in determining visual lobe shape and search time, suggesting that age differences should be considered when predicting search time and when designing tasks and products that involve visual search in our daily lives and work. **Practitioner Summary:** Age-related changes in visual lobe shape characteristics and their relationships to visual search performance were investigated in this study. The results help to explain how tasks and products involving visual search in our daily lives and work should be designed for target audiences of different ages.

- **Keywords:** visual search, visual lobe, age differences, performance

J.L. Szalma, T.N. Schmidt, G.W.L. Teo & P.A. Hancock. *Vigilance on the move: video game-based measurement of sustained attention.* pages 1315-1336.

Vigilance represents the capacity to sustain attention to any environmental source of information over prolonged periods on watch. Most stimuli used in vigilance research over the previous six decades have been relatively simple and often purport to represent important aspects of detection and discrimination tasks in real-world settings. Such displays are most frequently composed of single stimulus presentations in discrete trials against a uniform, often uncluttered background. The present experiment establishes a dynamic, first-person perspective vigilance task in motion using a video-game environment. 'Vigilance on the move' is thus a new paradigm for the study of sustained attention. We conclude that the stress of vigilance extends to the new paradigm, but whether the performance decrement emerges depends upon specific task parameters. The development of the task, the issues to be resolved and the pattern of performance, perceived workload and stress associated with performing such dynamic vigilance are reported. **Practitioner Summary:** The present experiment establishes a dynamic, first-person perspective movement-based vigilance task using a video-game environment. 'Vigilance on the move' is thus a new paradigm for the evaluation of sustained attention

in operational environments in which individuals move as they monitor their environment. Issues addressed in task development are described.

- **Keywords:** vigilance, sustained attention, video games, monitoring, workload
Related articles

Ray F. Lin & Chih-Hsiang Hsu. *Measuring individual corrective reaction time using the intermittent illumination model.* pages 1337-1352.

The corrective reaction time (t_{cr}) is an essential motor property when modelling hand control movements. Many studies designed experiments to estimate t_{cr} , but reported only group means with inconsistent definitions. This study proposes an alternative methodology using Drury's (1994) intermittent illumination model. A total of 24 participants performed circular tracking movements under five levels of visual information delay using a modified monitor in a darkened room. Measured movement speeds and the manipulated delays were used with the model to estimate t_{cr} of individuals and test effects of gender and path width. The results showed excellent model fits and demonstrated individual differences of t_{cr} , which was 273 ms on average and ranged from 87 to 441 ms. The wide range of t_{cr} values was due to significant effects of gender and path width. Male participants required shorter t_{cr} compared to female participants, especially for narrow path widths. **Practitioner Summary:** This study reports the corrective reaction time (t_{cr}) of individuals using a novel methodology. The estimated t_{cr} ranged from 87 to 441 ms, helping model hand control movements, such as aiming and tracking. The methodology can be continuously applied to study t_{cr} under conditions with various performers and movements.

- **Keywords:** corrective reaction time, visual processing time, hand control movement, intermittent correction servo, ballistic movement

Brad Nicholson & David O'Hare. *The effects of individual differences, prior experience and cognitive load on the transfer of dynamic decision-making performance.* pages 1353-1365.

Situational awareness is recognised as an important factor in the performance of individuals and teams in dynamic decision-making (DDM) environments (Salmon et al. 2014, **36**. Salmon, P. M., N. A. Stanton, G. H. Walker, D. Jenkins, D. Ladva, L. Rafferty, and M. Young. 2014. "Measuring SA in Complex Systems: Comparison of Measurement Study." *International Journal of Industrial Ergonomics* 39: 490–500.). The present study was designed to investigate whether the scores on the WOMBAT™ *Situational Awareness and Stress Tolerance Test* (Roscoe and North 1980 **33**. Roscoe, S. N., and R. North. 1980. "Prediction of Pilot Performance." In *Aviation Psychology*, edited by S. N. Roscoe, 123–127. Ames: The Iowa State University Press) would predict the transfer of DDM performance from training under different levels of cognitive load to a novel situation. Participants practised a simulated firefighting task under either low or high conditions of cognitive load and then performed a (transfer) test in an alternative firefighting environment under an intermediate level of cognitive load. WOMBAT™ test scores were a better predictor of DDM performance than scores on the Raven Matrices. Participants with high WOMBAT™ scores performed better regardless of their training condition. Participants with recent gaming experience who practised under low cognitive load showed better practice phase performance but worse transfer performance than those who practised under high cognitive load. **Practitioner Summary:** The relationship between task experience, situational awareness ability, cognitive load and the transfer of dynamic decision-making (DDM) performance was investigated. Results showed that the WOMBAT™ test predicted transfer of DDM performance regardless of task cognitive load. The effects of cognitive load on performance varied according to previous task-relevant experience.

- **Keywords:** dynamic decision-making, situational awareness, individual differences, simulation

Nicky Nibbeling, Raoul R.D. Oudejans, Emiel M. Ubink & Hein A.M. Daanen. *The effects of anxiety and exercise-induced fatigue on shooting accuracy and cognitive performance in infantry soldiers.* pages 1366-1379.

Operational performance in military settings involves physical and mental skills that are generally investigated separately in lab settings, leading to reduced ecological validity. Therefore, we investigated the effects of anxiety and exercise-induced fatigue, separately and in combination, on cognitive and shooting performance of 22 soldiers in a real-world setting. Findings indicated that soldiers' shooting accuracy and decision-making and mathematical skills decreased significantly under anxiety. Whether exercise-induced fatigue was beneficial or detrimental to task performance depended on the task at hand. The increased arousal levels through exercise prevented shooting accuracy from deteriorating in the decision task. In contrast, cognitive performance suffered from the increased arousal: participants more often failed to shoot when being fired at by an opponent and also math performance seemed to decrease. We conclude that anxiety can deteriorate soldier performance and that exercise-induced fatigue may improve or deteriorate performance in combination with anxiety depending on the nature of the task. **Practitioner Summary:** Soldiers encounter anxiety and exercise-induced fatigue. We investigated to what degree these factors influence soldiers' shooting and cognitive performance. Experimental manipulation of anxiety and exercise during a representative field course indicated decreased performance under anxiety. Exercise prevented shooting accuracy from deteriorating under anxiety, although cognitive performance was negatively affected after exercise.

- **Keywords:** anxiety, cognitive performance, exercise-induced fatigue, shooting accuracy, soldiers

Hugo Loeches De La Fuente, Guillaume Rao, Jean-Christophe Sarrazin, Eric Berton & Laure Fernandez. *A multi-level approach to investigate the control of an input device: application to a realistic pointing task.* pages 1380-1396.

This study investigates the subjects' performance during realistic conditions of control of a joystick. An adapted reciprocal aiming task consisting in driving a virtual vehicle along a slalom course as fast as possible was performed while accuracy constraints were manipulated. Realistic dynamical Interface Screen Relationship between the joystick displacements and the displacements of the vehicle was simulated. Vehicle displacements and motor activity (muscle activity and joint kinematics) were recorded. The results highlighted the applicability of the Fitts' law to more realistic conditions where the use of an input device is performed in an intensive control situation. Besides, biomechanical results suggested that neuromuscular responses were different regarding the direction of movement, whereas the performance at a behavioural level were not affected. Thus, this study demonstrates the interest in considering two different aspects of the user's performance (behavioural and biomechanical ones) to make a better agreement between the device design and users' needs. **Practitioner Summary:** This study considered two different aspects of the subject's performance in a realistic situation of speed-accuracy trade-off: the behavioural and motor activity. The necessity for the design of the future ergonomics pointing devices to meet the expectations of the neuromuscular system in order to facilitate their uses is highlighted.

- **Keywords:** input device, user performance, motor control, biomechanics, multi-level analysis

Hwayeong Kang & Gwanseob Shin. *Hand usage pattern and upper body discomfort of desktop touchscreen users.* pages 1397-1404.

A laboratory study was conducted to determine how users of different handedness interact with desktop touchscreen displays and how the hand usage pattern influences their body discomfort development. Twenty-one participants in three different handedness groups conducted simple web-browsing for 30 minutes using a 23" touchscreen display while their subjective body discomfort, frequency of use of each hand and touch area preference were periodically quantified. Participants reported a gradual increase in body discomfort during web-browsing, and the increments in body discomfort varied between handedness groups for some body parts. Results also show that right-handed participants had stronger laterality than the left-handed, and ambidextrous participants used both hands more evenly than other participants, suggesting associations between the hand usage pattern and body discomfort development. Findings of the current study suggest that body discomfort of desktop touchscreen display users could be moderated by user-interface improvements and user training. **Practitioner Summary:** Body discomfort development of desktop touchscreen users may be influenced by their hand usage pattern. Findings of this laboratory study suggest that user discomfort may be moderated by placing menu items in the lower area within the display or training users to alternate hands when conducting touch gestures.

- **Keywords:** touchscreen, touch interface, handedness, hand preference, body discomfort

Jimmy Tat, Michael W.R. Holmes & Peter J. Keir. *Cycle to cycle variability in a repetitive upper extremity task.* pages 1405-1415.

The purpose of this study was to examine the variability in muscle activity at rest and work during a repetitive task. A total of 20 participants performed a bimanual push task using three frequencies (4, 8, 16 pushes/min), three loads (1 kg, 2 kg, 4 kg) and two grip conditions (no grip, 30% maximum). The coefficient of variation (CoV) of muscle activity was determined for the anterior deltoid, biceps brachii, extensor digitorum and flexor digitorum superficialis. Faster push frequencies and heavier loads had lower work-rest ratio CoV and higher mean muscle activity ($p < 0.01$). Sixteen pushes per minute produced the lowest CoV for the anterior deltoid ($p < 0.01$), while the 1-kg load produced the lowest CoV for the extensor digitorum and flexor digitorum superficialis ($p < 0.01$). Changes were driven by the rest phase rather than by the work phase, except for grip decreasing forearm muscle CoV. These findings underscore the importance of variability at rest and indicate that low variability of muscle activity is associated with ergonomic risk factors. **Practitioner Summary:** Decreased motor variability has been associated with pain and injury. A cyclical push task, evaluated in terms of work and rest phases, found that greater workloads increased variability primarily due to changes in the rest phase. Muscle variability, especially for the rest phase, may provide insight into injury risk.

- **Keywords:** electromyography, work-rest ratio, rest, upper extremity, motor variability

Xuguang Wang, Nancy Black, Sonia Duprey & Christophe Roybin. *An experimental investigation on push force and its perception during a flexible hose insertion task encountered in a truck assembly line.* pages 1416-1426.

The push force and its perception when inserting a flexible hose laterally into a connector were investigated. Effects of hose diameter, glove, target position and obstacle condition were studied. Maximum voluntary insertion forces (MVs) under similar working

conditions were also measured. The larger the diameter, the higher the force required. The peak axial forces for the hoses of 6, 12 and 16 mm in diameter were on average respectively 94, 122 and 184 N, representing 45%, 61% and 93% of MVF. Glove condition, target position and obstacle did not significantly affect the axial insertion force and moment, but they did affect effort perception. Lower effort was perceived with gloves and high and near position. High intra- and inter-individual variability in insertion force for a given hose may suggest that feedback of successful insertion was insufficient. The recognition of a successful insertion must be ensured to avoid unnecessary extra force exertion. **Practitioner summary:** The effects of glove, hose diameter, target location and obstacle on push force and its perception were studied when inserting a flexible hose. Solutions for improving the recognition of a successful insertion and the hose/connector system design must be found to reduce force exertion to safe levels.

- **Keywords:** hose insertion, force, effort perception, maximum voluntary exertion

Brooke R. Collier, Laura Holland, Deirdre McGhee, John A. Sampson, Alison Bell, Paul J. Stapley & Herbert Groeller. *Precision markedly attenuates repetitive lift capacity.* pages 1427-1439.

This study investigated the effect of precision on time to task failure in a repetitive whole-body manual handling task. Twelve participants were required to repetitively lift a box weighing 65% of their single repetition maximum to shoulder height using either precise or unconstrained box placement. Muscle activity, forces exerted at the ground, 2D body kinematics, box acceleration and psychophysical measures of performance were recorded until task failure was reached. With precision, time to task failure for repetitive lifting was reduced by 72%, whereas the duration taken to complete a single lift and anterior deltoid muscle activation increased by 39% and 25%, respectively. Yet, no significant difference was observed in ratings of perceived exertion or heart rate at task failure. In conclusion, our results suggest that when accuracy is a characteristic of a repetitive manual handling task, physical work capacity will decline markedly. **Practitioner Summary:** The capacity to lift repetitively to shoulder height was reduced by 72% when increased accuracy was required to place a box upon a shelf. Lifting strategy and muscle activity were also modified, confirming practitioners should take into consideration movement precision when evaluating the demands of repetitive manual handling tasks.

- **Keywords:** strength, precision, maximal lift capacity, occupation, performance, fatigue