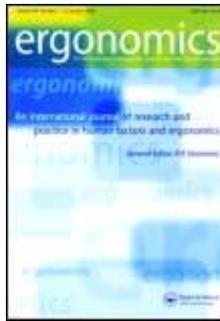


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Samuel M. Waldron; John Patrick; Geoffrey B. Duggan; Simon Banbury; Andrew Howes. *Designing information fusion for the encoding of visual-spatial information*. S. 775 – 797.

In a simulated aircraft navigation task, a fusion technique known as triangulation was used to improve the accuracy and onscreen availability of location information from two separate radars. Three experiments investigated whether the reduced cognitive processing required to extract information from the fused environment led to impoverished retention of visual-spatial information. Experienced pilots and students completed various simulated flight missions and were required to make a number of location estimates. Following a retention interval, memory for locations was assessed. Experiment 1 demonstrated, in an applied setting, that the retention of fused information was problematic and Experiment 2 replicated this finding under laboratory conditions. Experiment 3 successfully improved the retention of fused information by limiting its availability within the interface, which it is argued, shifted participants' strategies from over-reliance on the display as an external memory source to more memory-dependent interaction. These results are discussed within the context of intelligent interface design and effective human-machine interaction.

- **Keywords:** human-machine interaction; information fusion; adaptive memory; transfer-appropriate processing

D. P. Jenkins; N. A. Stanton; P. M. Salmon; G. H. Walker; M. S. Young. *Using cognitive work analysis to explore activity allocation within military domains*. S. 798 – 815.

Cognitive work analysis (CWA) is frequently advocated as an approach for the analysis of complex socio-technical systems. Much of the current CWA literature within the military domain pays particular attention to its initial phases; work domain analysis and contextual task analysis. Comparably, the analysis of the social and organisational constraints receives much less attention. Through the study of a helicopter mission planning system software tool, this paper describes an approach for investigating the constraints affecting the distribution of work. The paper uses this model to evaluate the potential benefits of the social and organisational analysis phase within a military context. The analysis shows that, through its focus on constraints, the approach provides a unique description of the factors influencing the social organisation within a complex domain. This approach appears to be compatible with existing approaches and serves as a validation of more established social analysis techniques. As part of the ergonomic

design of mission planning systems, the social organisation and cooperation analysis phase of CWA provides a constraint-based description informing allocation of function between key actor groups. This approach is useful because it poses questions related to the transfer of information and optimum working practices.

- **Keywords:** activity allocation; aviation; planning; military; CWA

S. A. Birrell; R. A. Haslam. *The influence of rifle carriage on the kinetics of human gait.* S . 816 – 826.

The influence that rifle carriage has on human gait has received little attention in the published literature. Rifle carriage has two main effects, to add load to the anterior of the body and to restrict natural arm swing patterns. Kinetic data were collected from 15 male participants, with 10 trials in each of four experimental conditions. The conditions were: walking without a load (used as a control condition); carrying a lightweight rifle simulator, which restricted arm movements but applied no additional load; wearing a 4.4 kg diving belt, which allowed arms to move freely; carrying a weighted (4.4 kg) replica SA80 rifle. Walking speed was fixed at 1.5 m/s ($\pm 5\%$) and data were sampled at 400 Hz. Results showed that rifle carriage significantly alters the ground reaction forces produced during walking, the most important effects being an increase in the impact peak and mediolateral forces. This study suggests that these effects are due to the increased range of motion of the body's centre of mass caused by the impeding of natural arm swing patterns. The subsequent effect on the potential development of injuries in rifle carriers is unknown.

- **Keywords:** load carriage; gait analysis; military; rifle carriage

K. K. Finnis; D. Walton. *Field observations to determine the influence of population size, location and individual factors on pedestrian walking speeds.* S. 827 – 842.

This study measures pedestrian walking speeds in New Zealand to estimate the influences on mean walking speeds as these concern urban planning and pedestrian facility design. Research was conducted using field observations of walking speeds under different conditions: gradient and urban/rural townships. The data show complex interrelationships between environment, personal characteristics of pedestrian and physical factors. Mean walking speeds between 80-95 m/min are observed. These results do not support the idea that walking speeds are indicative of pace of life. Rather, walking speeds are proposed as being an indicator of the environment's 'walkability', as a walking speed that closely reflects that of the mean population is a key indicator of the successful design of pedestrian facilities.

- **Keywords:** pedestrian; walking speed; pace of life; factors affecting pedestrians

Jer-Hao Chang; Kun-Yueh Ho; Fong-Chin Su. *Kinetic analysis of the thumb in jar-opening activity among female adults.* S. 843 – 857.

Jar opening is commonly viewed as a challenging task for female adults in daily living. The thumb plays a particular role in grasping the jar lid and leading the turning activity through opposition to the other digits. This study measured and compared the force, torque and torque contribution of the thumb in the activity under ordinary grasp patterns and jar-holding positions. A steel jar-like cylinder was custom made to measure the force and torque generated simultaneously by thumb and wrist. Sixteen young females without a history of hand injury were recruited as subjects. The force and torque of the thumb were found to be influenced significantly only by the grasp pattern but its torque contribution was significantly affected only by the jar-holding position. However, overall torque was influenced by both the grasp pattern and the jar-holding position. The torque

contribution of the thumb under the four different grasp patterns and jar-holding positions was found to range from 17.4% to 23.9%. The contribution ratios suggest that the thumb may offer a force equivalent to the other digits rather than just a counter force in this activity.

- **Keywords:** jar-opening; thumb kinetics; torque contribution

Angela DiDomenico; Maury A. Nussbaum. *Estimation of forces exerted by the fingers using standardised surface electromyography from the forearm. S. 858 – 871.*

Determination and integration of human force capabilities and requirements is an essential component of ergonomic evaluation. With regard to hand-intensive tasks, direct force measurements can be cumbersome and intrusive. Here, the use of surface electromyography (EMG) was evaluated. EMG was obtained from three standardised electrode sites on the forearms of 30 individuals. Linear regression models were generated to estimate finger force levels from normalised electromyographic measures, while forces were generated in several finger couplings. The results suggest that standardised procedures for obtaining electromyographic data and simple linear models can be used to accurately estimate finger forces during a variety of finger exertions in fixed postures, although the level of accuracy depends on the type of model. Such models begin to overcome the limitations of direct finger strength measurements of individuals.

- **Keywords:** finger strength; pinches; electromyography; prediction

Janet M. Blackstone; Catherine Karr; Janice Camp; Peter W. Johnson. *Physical exposure differences between children and adults when using standard and small computer input devices. S. 872 – 889.*

By the age of five years, 75% of the children in the USA are using computers and at this age they are only one-half to two-thirds the size of and about one-fifth as strong as their adult counterparts. Fourteen children between five and eight years of age and their same-gender biological parents (giving a total of 28 subjects) were evaluated using both a standard and a smaller, child-proportional input device during standardised mouse and keyboard tasks. Typing and computer mouse performance were measured with tracking software, wrist posture was measured with an electrogoniometer and electromyography was used to measure finger flexor and extensor muscle activity in the right arm. With the small mouse, both children and adults performed the mouse task significantly faster and made significantly fewer errors. When using the standard-sized mouse and keyboard, children worked with significantly greater ulnar deviation and significantly less extension than their adult counterparts. When children used the smaller mouse, finger flexor muscle activity, finger extensor muscle activity and ulnar deviation significantly decreased, with little change in wrist extension compared to the standard mouse. No significant differences were observed between the standard and small keyboards for children or their parents. Compared to their adult counterparts, children had to apply twice the relative force, as a percentage of their maximum capacity, to activate the buttons and keys on the input devices. These measured differences may have application in the design of computer input devices for children.

- **Keywords:** children; anthropometry; muscle activity; wrist posture; upper extremity; computers; ergonomics

M. H. Kim; C. H. Yi; O. Y. Kwon; S. H. Cho; W. G. Yoo. *Changes in neck muscle electromyography and forward head posture of children when carrying schoolbags. S. 890 – 901.*

This study tested the effects of three alternative types of backpack on head posture and neck muscle electromyography (EMG) in children. Four loading conditions were tested: no pack; a backpack; a double pack; a modified double pack (designed with a backpack and a front pack weighing 10% and 5% of body weight, respectively). Dependent variables were neck muscle activity, forward head angle and forward head distance (the perpendicular distance from C7 to a vertical line through the tragus of the ear). Fifteen children were asked to walk at a speed of 0.8 m/s on a treadmill. The EMG activity of upper trapezius, sternocleidomastoid and midcervical paraspinals muscles and the forward head angle and forward head distance were all significantly higher when carrying a backpack than for the other conditions. When carrying a double pack, there was a backward head posture characterised by an increased negative forward head angle, decreased forward head distance, increased sternocleidomastoid EMG signal and decreased midcervical paraspinals EMG signal, compared to carrying no pack. When carrying a modified double pack, the forward head angle and forward head distance decreased when compared to carrying a backpack. These findings indicate that the modified double pack minimises postural deviation.

- **Keywords:** electromyography; forward head posture; schoolbag; children

Giulia Earle-Richardson; Paul L. Jenkins; David Strogatz; Erin M. Bell; Andris Freivalds; Julie A. Sorensen; John J. May. *Electromyographic assessment of apple bucket intervention designed to reduce back strain.* S. 902 – 919.

The authors previously developed an apple bucket that was modified by use of a hip belt to reduce muscle fatigue. The intervention of belt use was accepted by workers and shown not to interfere with productivity. However, use of this intervention did not appear to reduce muscle fatigue when measured by tests of voluntary muscle strength. The purpose of the present study was to evaluate the intervention's effect on muscle fatigue employing surface electromyographic (EMG) amplitude. Amplitude measurements on 15 muscles were taken from 10 laboratory volunteers who were carrying a full bucket of apples, once while wearing the intervention belt and once without the intervention. These measurements were taken for seven different postures (four angles of trunk flexion (0°, 20°, 45°, 90°) and three raised-arm positions (both up, dominant up, non-dominant up)) common to apple harvest work. Participants were measured in these conditions both with the bucket carried in front and with the bucket carried to the side. Significant reductions in amplitude favouring the intervention were seen for 11 of the 15 muscles in models considering the four body flexion angles. Ten of these were of the middle and lower back. These control/intervention differences were seen with both bucket-carrying positions (front vs. side) and tended to increase with increasing flexion angle. In contrast, no significant intervention effects were observed in models considering treatment by arm-raised position. One significant main effect (upper trapezius, side bucket) showed an amplitude reduction in the treatment condition. Another main effect showing increased amplitude in the intervention condition use was observed in the dominant levator scapulae (side bucket). Thus, the use of the intervention belt reduces EMG amplitude among a number of mid- and lower-back muscles. This is suggestive of a protective effect against back strain.

- **Keywords:** agricultural ergonomics; migrant farm workers; musculoskeletal strain; muscle fatigue; EMG; agriculture

Myriam Bikah; M. Susan Hallbeck; John H. Flowers. *Supracutaneous vibrotactile perception threshold at various non-glabrous body loci.* S. 920 – 934.

Researchers at the University of Nebraska-Lincoln are currently designing a wearable/portable neutron detector. As an alerting mechanism, the device will transmit

vibration to the wearer's skin in the presence of hazardous levels of neutron radiation. The present study was designed to help in the ergonomically correct body placement of the neutron detection device while providing numerical values for vibratory thresholds at the surface of various non-glabrous body loci. The aim of the study was to investigate the underlying effects of locus stimulated, amount of subcutaneous fat around a specific body site and gender on low frequency vibration thresholds. Thirty-six participants, who were categorised by both dichotomous body fat group (high or low) and gender, were tested at 24 loci orthogonally located around six body sites: head; neck; upper arm; wrist; waist; ankle. The results indicated that frequency threshold depends significantly on the locus stimulated ($p=0.001$). The nape of the neck had the greatest sensitivity to low frequency stimulations, while the loci around the waist were least sensitive. Also, body fat significantly affected ability to perceive vibratory stimuli ($p=0.048$), with the mean frequency threshold of the low body fat group lower than that of the high body fat group. There was no statistical difference in thresholds with gender.

- **Keywords:** vibrotactile perception threshold; vibrotactile device; cutaneous perception

Victoria L. Richmond; Mark P. Rayson; David M. Wilkinson; James M. Carter; Sam D. Blacker; Alan Nevill; Jill Du Ross; Steve Moore. *Development of an operational fitness test for the Royal Air Force. S. 935 – 946.*

Since 2002, the Royal Air Force (RAF) has been working towards developing role-related physical tests for use as an operational fitness test (OFT). The purpose of this study was to establish reliability of the OFT (comprising four tests), investigate gym-based tests as predictors of performance and establish performance standards. Fifty-eight RAF personnel performed the OFT on three occasions. A separate cohort carried out fitness and anthropometric tests before performing the OFT, by way of establishing performance predictors. Documented evidence and views of an expert panel were used to determine OFT standards. Reliability ranged from moderate to good for three tests, with one test (Dig) showing poor reliability. The 95% limits of agreement for the prediction models ranged from good to poor (6.7-34.2%). The prediction models were not sufficiently accurate to estimate confidently OFT performance, but could be used as a guide to quantify likely outcome and training needs.

- **Keywords:** operational fitness test; Royal Air Force; reliability; gym test; performance predictor