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Laura Lewis, Harshada Patel, Mirabelle D'Cruz & Sue Cobb. What makes a space invader? Passenger perceptions of personal space invasion in aircraft travel. Pages: 1461-1470.

The invasion of personal space is often a contributory factor to the experience of discomfort in aircraft passengers. This paper presents a questionnaire study which investigated how air travellers are affected by invasions of personal space and how they attempt to adapt to, or counter, these invasions. In support of recent findings on the factors influencing air passenger comfort, the results of this study indicate that the invasion of personal space is not only caused by physical factors (e.g. physical contact with humans or objects), but also other sensory factors such as noise, smells or unwanted eye contact. The findings of this study have implications for the design of shared spaces. **Practitioner Summary:** This paper presents a questionnaire study which investigated personal space in an aircraft environment. The results highlight the factors which affect the perception of personal space invasion in aircraft and can therefore inform the design of aircraft cabin environments to enhance the passenger experience.

- **Keywords:** Proxemics, personal space, interpersonal distance, aviation, comfort

Chia-Fen Chi, Ratna Sari Dewi, Yopie Yutama Surbakti & Dong-Yu Hsieh. The perceived quality of in-vehicle auditory signals: a structural equation modelling approach. Pages: 1471-1484.

The current study applied Structural Equation Modelling to analyse the relationship among pitch, loudness, tempo and timbre and their relationship with perceived sound quality. Twenty-eight auditory signals of horn, indicator, door open warning and parking sensor were collected from 11 car brands. Twenty-one experienced drivers were recruited to evaluate all sound signals with 11 semantic differential scales. The results indicate that for the continuous sounds, pitch, loudness and timbre each had a direct impact on the perceived quality. Besides the direct impacts, pitch also had an impact on loudness perception. For the intermittent sounds, tempo and timbre each had a direct impact on the perceived quality. These results can help to identify the psychoacoustic attributes affecting the consumers' quality perception and help to design preferable sounds for vehicles. In the end, a design guideline is proposed for the development of

auditory signals that adopts the current study's research findings as well as those of other relevant research. **Practitioner Summary:** This study applied Structural Equation Modelling to analyse the relationship among pitch, loudness, tempo and timbre and their relationship with perceived sound quality. The result can help to identify psychoacoustic attributes affecting the consumers' quality perception and help to design preferable sounds for vehicles.

- **Keywords:** Semantic differential scale, loudness, pitch, timbre, tempo

Victoria Lynne Claypoole & James L. Szalma. *Examining social facilitation in vigilance: a hit and a miss.* Pages: 1485-1499.

Vigilance is the ability of an observer to maintain attention for extended periods of time; however, performance tends to decline with time on watch, a pattern referred to as the vigilance decrement. Previous research has focused on factors that attenuate the decrement; however, one factor rarely studied is the effect of social facilitation. The purpose for the present investigation was to determine how different types of social presence affected the performance, workload and stress of vigilance. It was hypothesised that the presence of a supervisory figure would increase overall performance, but may occur at the cost of increased workload and stress. Results indicated that the per cent of false alarm and response times decreased in the presence of a supervisory figure. Using social facilitation in vigilance tasks may thus have positive, as well as, negative effects depending on the dependent measure of interest and the role of the observer.

Practitioner Summary: Social facilitation has rarely been examined in the context of vigilance, even though it may improve performance. Vigilance task performance was examined under social presence. The results of the present study indicated that false alarms and response times decreased in the social presence of a supervisory figure, thus improving performance.

- **Keywords:** Vigilance, social facilitation, human performance, supervisor

Sue Brouwers, Mark W. Wiggins, Barbara Griffin, William S. Helton & David O'Hare. *The role of cue utilisation in reducing the workload in a train control task.* Pages: 1500-1515

Skilled performance has been characterised, in part, by the capacity to accurately identify and respond to patterns as cues in the environment. The outcome is a reduction in cognitive load and a greater residual capacity to undertake concurrent tasks. The present study was designed to examine the relationship between cue utilisation and temporal pattern recognition in the context of a simulated, rail control task. Sixty-one university students undertook an assessment of cue utilisation and engaged in a rail control simulation. The appearance and movement of trains followed a consistent but implicit (undisclosed) pattern. Throughout the second half of the rail task, a secondary task was included. The results indicated that participants with relatively higher cue utilisation were more likely to identify the implicit pattern of rail movements, were more accurate and responded more rapidly under increased workload conditions. The results suggest that a propensity to identify patterns as cues may provide an opportunity to reduce cognitive demands, thereby facilitating performance in a novel task. Implications for selection and system design are discussed. **Practitioner Summary:** This study was designed to explain differences in the way in which people learn, particularly when tasks involve recurring patterns. Using simulated rail control, the results indicated that participants who display behaviour that is indicative of the utilisation of cues also recognise patterns in the movement of simulated trains. This enables them to manage trains more effectively, even while undertaking other tasks.

- **Keywords:** Cue utilisation, rail control, workload, cognitive load, learning

Maryam Zahabi, Wenjuan Zhang, Carl Pankok, Mei Ying Lau, James Shirley & David Kaber. *Effect of physical workload and modality of information presentation on pattern recognition and navigation task performance by high-fit young males.* Pages: 1516-1527.

Many occupations require both physical exertion and cognitive task performance. Knowledge of any interaction between physical demands and modalities of cognitive task information presentation can provide a basis for optimising performance. This study examined the effect of physical exertion and modality of information presentation on pattern recognition and navigation-related information processing. Results indicated males of equivalent high fitness, between the ages of 18 and 34, rely more on visual cues vs auditory or haptic for pattern recognition when exertion level is high. We found that navigation response time was shorter under low and medium exertion levels as compared to high intensity. Navigation accuracy was lower under high level exertion compared to medium and low levels. In general, findings indicated that use of the haptic modality for cognitive task cueing decreased accuracy in pattern recognition responses.

Practitioner Summary: An examination was conducted on the effect of physical exertion and information presentation modality in pattern recognition and navigation. In occupations requiring information presentation to workers, who are simultaneously performing a physical task, the visual modality appears most effective under high level exertion while haptic cueing degrades performance.

- **Keywords:** Physical exertion, sensory modalities, cognitive task performance, pattern recognition, navigation

Heejin Jeong & Yili Liu. *Effects of touchscreen gesture's type and direction on finger-touch input performance and subjective ratings.* Pages: 1528-1539.

This study examined how finger-touch input performance (i.e. task completion time, failure status, and error rate) and subjective ratings (i.e. performance and physical demand) are influenced by touchscreen gestures' type and direction. Twenty participants performed one-touch (i.e. drag and swipe) and two-touch (i.e. pinch and spread) gesture tasks on a tablet, using several major directions (i.e. eight directions for one-touch and four directions for two-touch gestures). The results showed that swipe was approximately 4.5 times faster than drag, but pinch and spread showed no significant difference in task completion time. Dragging and pinching showed more failures or higher error rates compared to swiping and spreading, respectively. One-touch gestures in the horizontal directions were rated to have higher performance and lower physical demand than those in the vertical and diagonal directions. Two-touch gestures in the horizontal directions took the shortest time but caused more failures and higher error rates. **Practitioner Summary:** This study provides evidence for the effects of touchscreen gestures' type and direction on human performance and subjective ratings, which varied depending on the number of fingers used. Designers should arrange related touchscreen components accordingly, to improve touch-finger input performance and reduce user workload.

- **Keywords:** Touchscreen gesture, gesture direction, tablet usability, touchscreen interface design

Wen-Ruey Chang, Yueng-Hsiang Huang, Christopher Brunette & Jin Lee. *Use of portable ladders: field observations and self-reported safety performance in the cable TV industry.* Pages: 1540-1550.

Portable ladders incidents remain a major cause of falls from heights. This study reported field observations of environments, work conditions and safety behaviour involving portable ladders and their correlations with self-reported safety performance. Seventy-

five professional installers of a company in the cable and other pay TV industry were observed for 320 ladder usages at their worksites. The participants also filled out a questionnaire to measure self-reported safety performance. Proper setup on slippery surfaces, correct method for ladder inclination setup and ladder secured at the bottom had the lowest compliance with best practices and training guidelines. The observation compliance score was found to have significant correlation with straight ladder inclined angle (Pearson's $r = 0.23$, $p < 0.0002$) and employees' self-reported safety participation ($r = 0.29$, $p < 0.01$). The results provide a broad perspective on employees' safety compliance and identify areas for improving safety behaviours. **Practitioner Summary:** A checklist was used while observing professional installers of a cable company for portable ladder usage at their worksites. Items that had the lowest compliance with best practices and training guidelines were identified. The results provide a broad perspective on employees' safety compliance and identify areas for improving safety behaviours.

- **Keywords:** Ladder setup, field study, extension ladder, step ladder, user behaviour, self-reported safety performance

Mohsen Zare, Sophie Biau, Rene Brunet & Yves Roquelaure. Comparison of three methods for evaluation of work postures in a truck assembly plant. Pages: 1551-1563.

This study compared the results of three risk assessment tools (self-reported questionnaire, observational tool, direct measurement method) for the upper limbs and back in a truck assembly plant at two cycle times (11 and 8 min). The weighted Kappa factor showed fair agreement between the observational and direct measurement method for the arm (0.39) and back (0.47). The weighted Kappa factor for these methods was poor for the neck (0) and wrist (0) but the observed proportional agreement (P_o) was 0.78 for the neck and 0.83 for the wrist. The weighted Kappa factor between questionnaire and direct measurement showed poor or slight agreement (0) for different body segments in both cycle times. The results revealed moderate agreement between the observational tool and the direct measurement method, and poor agreement between the self-reported questionnaire and direct measurement. **Practitioner Summary:** This study provides risk exposure measurement by different common ergonomic methods in the field. The results help to develop valid measurements and improve exposure evaluation. Hence, the ergonomist/practitioners should apply the methods with caution, or at least knowing what the issues/errors are.

- **Keywords:** Observational method, self-reported questionnaire, direct measurement method, truck assembly plant

Nastaran Raffler, Jörg Rissler, Rolf Ellegast, Christian Schikowsky, Thomas Kraus & Elke Ochsmann. Combined exposures of whole-body vibration and awkward posture: a cross sectional investigation among occupational drivers by means of simultaneous field measurements. Pages: 1564-1575.

Objective: Multifactorial workloads such as whole-body vibration (WBV), awkward posture and heavy lifting are potential predictors for low back pain (LBP). In this study, we investigate the association between LBP and these exposures among 102 professional drivers. Methods: The combined exposures of WBV and posture are measured at different workplaces. Health and personal data as well as information about lifting tasks are collected by a questionnaire. Results: The daily vibration exposure value (odds ratio 1.69) and an index for awkward posture (odds ratio 1.63) show significant association with the occurrence of LBP. Awkward posture and heavy lifting appear to be more strongly associated with sick leave than WBV exposure. Furthermore, a combination of the measurement results of WBV and awkward posture into one quantity also shows

significant correlation to LBP. Conclusion: The combined exposure of WBV and awkward posture can be described in terms of the daily vibration exposure and the index for awkward posture. This facilitates work place assessments and future research in this area. **Practitioner Summary:** For the first time, quantitative measures combining whole-body vibration and awkward posture exposures have shown to correlate with the occurrence of low back pain significantly. This validates the proposed quantities and measurement methods, which facilitate workplace assessments and assist in the design of further studies which are necessary to establish a causal exposure-response relationship.

- **Keywords:** Whole-body vibration, awkward posture, field measurements, low-back pain, combined exposures

Celeste E. Coltman, Julie R. Steele & Deirdre E. McGhee. *Breast volume is affected by body mass index but not age.* Pages: 1576-1585.

Background: This study aimed to establish normative breast volume data for women of varying ages, body masses and breast sizes, and to determine the effect of age and body mass index (BMI) on breast volume. **Methods:** The breast volume of 356 women (age range: 18.1–83.7 years; BMI range: 18.4–54.5 kg/m²) was measured using three-dimensional scanning in a prone position. **Results:** Breast volumes ranged from 48 to 3100 mL. Although breast volume was not significantly affected by age, it was significantly affected by BMI, with the breast volume of overweight and obese women being two-to-three times greater than women with normal BMI's. **Conclusion:** It is recommended that bra cups must be designed to support the wide range and increasing magnitude of breast volumes exhibited by women. **Practitioner summary:** This original research provides evidence for bra designers and manufacturers on the range of breast volumes of women and the significant effect of BMI on breast volume. Bra cups need to be designed to support the wide range and increasing magnitude of breast volumes exhibited by women.

- **Keywords:** Breast volume, body mass index, age, breast support, bra design, bra cup

Jung Yong Kim, Jae Woo You & Mi Sook Kim. *South Korean anthropometric data and survey methodology: 'Size Korea' project.* Pages: 1586-1596.

Considering the many emerging markets in East Asia, access to contemporary anthropometric data for this region is important for designers and manufacturers seeking to produce the best fitting products and living environments for consumers. The purpose of this paper is to describe Korean anthropometric data collection and survey techniques for those who are interested in ethnic characteristics, conducting surveys, and formulating ergonomic product designs for South Korean and, more broadly, East Asian populations. The Size Korea survey was conducted in 2003–2004 and 2010. A total of 14,200 civilians aged 0–90 years participated in the survey, with 119 body and weight dimensions measured in 2004. Twenty new dimensions from Inbody measurement were added in 2010 and the data were continuously updated. We referred to ISO 7250, 8559 and 15535 to ensure validity and reliability. Fifty major body dimensions, including weight, are summarised in this paper, and 34 of these dimensions can be compared with 11 multinational data already reported in other publications. **Practitioner Summary:** This paper presents the up-to-date anthropometric database of East Asian physical characteristics and survey methodology. These data satisfy the ISO standards and comprise 50 physical dimensions including weight. Thirty-four dimensions of these can be directly compared with available multinational data.

- **Keywords:** Size Korea, anthropometry, survey methodology, multinational comparison