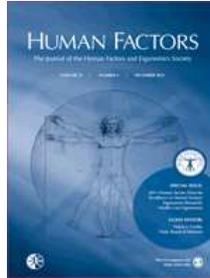


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AGING AND INDIVIDUAL DIFFERENCIES

Julie M. Werner, Mike Carlson, Maryalice Jordan-Marsh, Florence Clark. *Predictors of Computer Use in Community-Dwelling, Ethnically Diverse Older Adults.* S. 431-447.

Objective: In this study, we analyzed self-reported computer use, demographic variables, psychosocial variables, and health and well-being variables collected from 460 ethnically diverse, community-dwelling elders to investigate the relationship computer use has with demographics, well-being, and other key psychosocial variables in older adults. **Background:** Although younger elders with more education, those who employ active coping strategies, or those who are low in anxiety levels are thought to use computers at higher rates than do others, previous research has produced mixed or inconclusive results regarding ethnic, gender, and psychological factors or has concentrated on computer-specific psychological factors only (e.g., computer anxiety). Few such studies have employed large sample sizes or have focused on ethnically diverse populations of community-dwelling elders. **Method:** With a large number of overlapping predictors, zero-order analysis alone is poorly equipped to identify variables that are independently associated with computer use. Accordingly, both zero-order and stepwise logistic regression analyses were conducted to determine the correlates of two types of computer use: e-mail and general computer use. **Results:** Results indicate that younger age, greater level of education, non-Hispanic ethnicity, behaviorally active coping style, general physical health, and role-related emotional health each independently predicted computer usage. **Conclusion:** Study findings highlight differences in computer usage, especially in regard to Hispanic ethnicity and specific health and well-being factors. **Application:** Potential applications of this research include future intervention studies, individualized computer-based activity programming, or customizable software and user interface design for older adults responsive to a variety of personal characteristics and capabilities.

- **Keywords:** aging, ethnicity, psychosocial factors, health, coping, individual differences

ATTENTIONAL PROCESSES

Frédéric Dehais, Mickaël Causse, Sébastien Tremblay. *Mitigation of Conflicts with Automation : Use of Cognitive Countermeasures.* S. 448-460.

Objective: The aim of this study was to empirically assess the efficacy of cognitive countermeasures based on the technique of information removal to enhance human operator attentional disengagement abilities when facing attentional tunneling.

Background: Lessons learned from human factors studies suggest that conflict with automation leads to the degradation of operators' performance by promoting excessive focusing on a single task to the detriment of the supervision of other critical parameters.

Method: An experimental setup composed of a real unmanned ground vehicle and a ground station was developed to test the efficiency of the cognitive countermeasures. The scenario (with and without countermeasure) involved an authority conflict between the participants and the robot induced by a battery failure. The effects of the conflict and, in particular, the impact of cognitive countermeasures on the participants' cognition and arousal were assessed through heart rate measurement and eye tracking techniques.

Results: In the control group (i.e., no countermeasure), 8 out of 12 participants experienced attentional tunneling when facing the conflict, leading them to neglect the visual alarms displayed that would have helped them to understand the evolution of the tactical situation. Participants in the countermeasure group showed lower heart rates and enhanced attentional abilities, and 10 out of 11 participants made appropriate decisions.

Conclusions: The use of cognitive countermeasures appeared to be an efficient means to mitigate excessive focus issues in the unmanned ground vehicle environment.

Applications: The principle of cognitive countermeasures can be applied to a large domain of applications involving human operators interacting with critical systems.

- **Keywords:** assistant system, attentional tunneling, alarm misperception, conflict, automation, eye tracking, psychophysiological measurement, unmanned vehicle

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Wen-Ruey Chang, Chien-Chi Chang, Simon Matz. *The Effect of Transverse Shear Force on the Required Coefficient of Friction for Level Walking*. S. 461-473.

Objective: An enhanced methodology to extract the required coefficient of friction (RCOF) value was used to investigate the effects of the transverse shear component of the ground reaction force (GRF) on the RCOF. **Background:** The RCOF is an important indicator for slip incidents. However, the extraction of the RCOF from GRF is not standardized. The transverse shear force is usually ignored in calculating the RCOF value. **Method:** For this study, 40 participants performed four walking conditions. The RCOF values both with (RCOF2) and without (RCOF1) the transverse shear force were identified from each strike by the use of an enhanced method and were compared. **Results:** A total of 24,851 strikes were collected. The transverse component increased the RCOF value by more than 10% in 7.2% of the strikes. In 10.4% of the strikes, the RCOF2 occurred at least 20 ms earlier and the RCOF value was on average 8.9% larger than RCOF1. **Conclusion:** With this method, we were able to successfully identify the RCOF in a significantly large number of strikes across 40 participants. In a portion of the strikes, the transverse shear force increased the RCOF significantly. In a significant portion of the strikes, the RCOF2 occurred much earlier than RCOF1. **Application:** Better estimates of the RCOF magnitude and instant of occurrence could potentially improve risk assessment and identification of critical instants in gait.

- **Keywords:** required coefficient of friction, transverse shear force, human locomotion, friction demand

Kyle A. Saginus, Richard W. Marklin, Patricia Seeley, Guy G. Simoneau, Stephen Freier. *Biomechanical Effects of Mobile Computer Location in a Vehicle Cab*. S. 474-488.

Objective: The objective of this research is to determine the best location to place a conventional mobile computer supported by a commercially available mount in a light truck cab. **Background:** U.S. and Canadian electric utility companies are in the process of integrating mobile computers into their fleet vehicle cabs. There are no publications on the effect of mobile computer location in a vehicle cab on biomechanical loading, performance, and subjective assessment. **Method:** The authors tested four locations of mobile computers in a light truck cab in a laboratory study to determine how location affected muscle activity of the lower back and shoulders; joint angles of the shoulders, elbows, and wrist; user performance; and subjective assessment. A total of 22 participants were tested in this study. **Results:** Placing the mobile computer closer to the steering wheel reduced low back and shoulder muscle activity. Joint angles of the shoulders, elbows, and wrists were also closer to neutral angle. Biomechanical modeling revealed substantially less spinal compression and trunk muscle force. In general, there were no practical differences in performance between the locations. Subjective assessment indicated that users preferred the mobile computer to be as close as possible to the steering wheel. **Conclusion:** Locating the mobile computer close to the steering wheel reduces risk of injuries, such as low back pain and shoulder tendonitis. **Application:** Results from the study can guide electric utility companies in the installation of mobile computers into vehicle cabs. Results may also be generalized to other industries that use trucklike vehicles, such as construction.

- **Keywords:** biomechanics, spine and low backupper extremities, vehicle, utility fleet vehicles, mobile computers, MDT (mobile display terminal)

COGNITIVE PROCESSES

Ilanit Hochmiz, Nirit Yuviler-Gavish. *Physical Fidelity Versus Cognitive Fidelity Training in Procedural Skills Acquisition*. S. 489-501.

Objective: The current study examined whether training simulators for the acquisition of procedural skills should emphasize physical fidelity or cognitive fidelity of the task. **Background:** Simulation-based training for acquiring and practicing procedural skills is becoming widely established. Generally speaking, these simulators offer technological sophistication but disregard theory-based design, leaving unanswered the question of what task features should be represented in the simulators. The authors compared real-world training and two alternative virtual trainers, one emphasizing physical fidelity and the other cognitive fidelity of the task. **Method:** Participants were randomly assigned to one of four training groups in a LEGO® assembly task: virtual-physical fidelity, cognitive fidelity, real world, and control. A posttraining test to assess the development of procedural skills was conducted. **Results:** Both the virtual-physical fidelity and cognitive fidelity training methods produced better performance time than no training at all, as did the real-world training. The cognitive fidelity training was inferior in terms of test time compared to the real-world training, whereas the virtual-physical fidelity training was not. In contrast, only the real-world and the cognitive fidelity groups, and not the virtual-physical fidelity group, required significantly less time than the control group for error correction. **Conclusion:** The two training methods have complementary advantages. **Application:** Combining physical fidelity and cognitive training methods can enhance procedural skills acquisition when real-world training is not practicable.

- **Keywords:** trainers, virtual reality, human factors, transfer of training

HEALTH AND MEDICAL SYSTEMS

Enid Montague, Jie Xu, Ping-yu Chen, Onur Asan, Bruce P. Barrett, Betty Chewing. *Modeling Eye Gaze Patterns in Clinician–Patient Interaction With Lag Sequential Analysis*. S. 502-516.

Objective: The aim of this study was to examine whether lag sequential analysis could be used to describe eye gaze orientation between clinicians and patients in the medical encounter. This topic is particularly important as new technologies are implemented into multiuser health care settings in which trust is critical and nonverbal cues are integral to achieving trust. This analysis method could lead to design guidelines for technologies and more effective assessments of interventions. **Background:** Nonverbal communication patterns are important aspects of clinician–patient interactions and may affect patient outcomes. **Method:** The eye gaze behaviors of clinicians and patients in 110 videotaped medical encounters were analyzed using the lag sequential method to identify significant behavior sequences. Lag sequential analysis included both event-based lag and time-based lag. **Results:** Results from event-based lag analysis showed that the patient’s gaze followed that of the clinician, whereas the clinician’s gaze did not follow the patient’s. Time-based sequential analysis showed that responses from the patient usually occurred within 2 s after the initial behavior of the clinician. **Conclusion:** Our data suggest that the clinician’s gaze significantly affects the medical encounter but that the converse is not true. **Application:** Findings from this research have implications for the design of clinical work systems and modeling interactions. Similar research methods could be used to identify different behavior patterns in clinical settings (physical layout, technology, etc.) to facilitate and evaluate clinical work system designs.

- **Keywords:** nonverbal communication, medical encounter, health care system

MACROERGONOMICS AND THE ENVIRONMENT

Peter A. Hancock, Deborah R. Billings, Kristin E. Schaefer, Jessie Y. C. Chen, Ewart J. de Visser, Raja Parasuraman. *A Meta-Analysis of Factors Affecting Trust in Human-Robot Interaction*. S. 517-527.

Objective: We evaluate and quantify the effects of human, robot, and environmental factors on perceived trust in human-robot interaction (HRI). **Background:** To date, reviews of trust in HRI have been qualitative or descriptive. Our quantitative review provides a fundamental empirical foundation to advance both theory and practice. **Method:** Meta-analytic methods were applied to the available literature on trust and HRI. A total of 29 empirical studies were collected, of which 10 met the selection criteria for correlational analysis and 11 for experimental analysis. These studies provided 69 correlational and 47 experimental effect sizes. **Results:** The overall correlational effect

size for trust was $r = +0.26$, with an experimental effect size of $d = +0.71$. The effects of

human, robot, and environmental characteristics were examined with an especial evaluation of the robot dimensions of performance and attribute-based factors. The robot performance and attributes were the largest contributors to the development of trust in HRI. Environmental factors played only a moderate role. **Conclusion:** Factors related to the robot itself, specifically, its performance, had the greatest current association with trust, and environmental factors were moderately associated. There was little evidence for effects of human-related factors. **Application:** The findings provide quantitative estimates of human, robot, and environmental factors influencing HRI trust. Specifically, the current summary provides effect size estimates that are useful in establishing design and training guidelines with reference to robot-related factors of HRI trust. Furthermore, results indicate that improper trust calibration may be mitigated by the manipulation of robot design. However, many future research needs are identified.

- **Keywords:** trust, trust development, robotics, human-robot team

Masumi R. Izawa, Michael D. French, Alan Hedge. *Shining New Light on the Hawthorne Illumination Experiments*. S. 528-547.

Objective: This study provides an historical and statistical analysis of archival data from the Hawthorne illumination experiments. **Background:** Previous accounts of the illumination experiments are fraught with inconsistencies because they have been based on secondary sources. The general consensus has been that variations in light levels had no effect on worker productivity at Hawthorne. All reports and data were thought to have been destroyed, but an archive at Cornell University was found to contain copies of the original documentation and much of the data from all three illumination experiments. Conclusions were originally drawn from visual comparisons of productivity graphs, and the data have never been properly statistically analyzed. **Method:** Archival reports, notes, photographs, and letters on the experiments were consulted. Productivity data were extracted from the tables and graphs in the reports and statistically analyzed for each experiment. **Results:** Previously unpublished details of the illumination experiments emerged. An effect of lighting on productivity was found in the first treatment sequence for the first experiment, but this finding was not confirmed in the second sequence or in the second and third experiments. **Conclusion:** Experimental results provided inconsistent evidence of an association between light levels and productivity. All three experiments were found to be seriously flawed. **Application:** This study challenges popular accounts of the "Hawthorne effect," and the shortcomings of these experiments also have implications for the design of field studies.

- **Keywords:** lighting, illumination, productivity, Hawthorne effect

PSYCHOLOGICAL STATES AND NEUROERGONOMICS

Michael R. Baumann, Carol L. Gohm, Bryan L. Bonner. *Phased Training for High-Reliability Occupations : Live-Fire Exercises for Civilian Firefighters*. S. 548-557.

Objective: The aim of this study was to assess whether the stress reduction effects of phased training culminating in repeated exposure to a stressful scenario generalize to new scenarios. **Background:** High-reliability occupations require personnel to operate in stressful situations involving complex environments, high degrees of uncertainty and time pressure, and severe consequences for mistakes. One method of training for such environments culminates in practice in high-fidelity, highly stressful simulations. For some domains, realism necessitates large-scale, difficult-to-modify physical simulations. This necessity often results in repeated exposure to one or very few scenarios. The literature gives reason to question whether the stress reduction effects of such exposure transfer to new scenarios. **Method:** Anxiety and cognitive difficulties were measured among firefighter trainees during three live-fire drills. For each trainee, two drills involved the same scenario, and the other involved a new scenario that was structurally similar to the repeated scenario. **Results:** As predicted, anxiety and cognitive difficulties decreased across repetitions of the same scenario. However, the reduction did not generalize to a new scenario, and a nontrivial portion of the sample showed signs of negative transfer. **Conclusion:** Repeated exposure to the same stressful scenario as the final phase of training has limited practical value for stress reduction. Methods for expanding the range of scenarios to which trainees are exposed or for increasing the value of the exposure are recommended. **Application:** The findings could help improve design of training programs for high-reliability occupations.

- **Keywords:** extreme environments, acute stress, transfer of training, affective outcomes

TRAINING, EDUCATION, INSTRUCTIONAL SYSTEMS

Richard T. Stone, Kristopher P. Watts, Peihan Zhong, Chen-Shuang Wei.
Physical and Cognitive Effects of Virtual Reality Integrated Training. S. 558-572.

Objective: The objective of this study was to evaluate the cognitive and physical impact of virtual reality (VR) integrated training versus traditional training methods in the domain of weld training. **Background:** Weld training is very important in various industries and represents a complex skill set appropriate for advanced training intervention. As such, there has been a long search for the most successful and most cost-effective method for training new welders. **Method:** Participants in this study were randomly assigned to one of two separate training courses taught by sanctioned American Welding Society certified welding instructors; the duration of each course was 2 weeks. After completing the training for a specific weld type, participants were given the opportunity to test for the corresponding certification. Participants were evaluated in terms of their cognitive and physical parameters, total training time exposure, and welding certification awards earned. Each of the four weld types taught in this study represented distinct levels of difficulty and required the development of specialized knowledge and skills. **Results:** This study demonstrated that participants in the VR integrated training group (VR50) performed as well as, and in some cases, significantly outperformed, the traditional welding (TW) training group. The VR50 group was found to have a 41.6% increase in overall certifications earned compared with the TW group. **Conclusion:** VR technology is a valuable tool for the production of skilled welders in a shorter time and often with more highly developed skills than their traditionally trained counterparts. **Application:** These findings strongly support the use of VR integrated training in the welding industry.

- **Keywords:** training, virtual reality, welding, EMGK, cognitive development