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Oronzo Parlangeli, Paul M. Liston, Enrica Marchigiani, Margherita Bracci, Alessandra Giani. *Perceptions and Use of Computed Tomography in a Hospital Emergency Department: Technicians' Perspectives*. pp. 5–19.

Objective: This study traces the evolution of perceptions and use of computed tomography (CT) by radiology technicians in the emergency department (ED) of a hospital in Italy across a 7-year period. **Background:** The sociotechnical context of the CT room of an ED has been neglected by scientific research—potentially impacting safety.**Method:** Two studies were performed, one in 2011 and one in 2018. Six CT technicians were involved in each. Structured interviews were performed to gather information on perceptions related to the evolution of the use of CT according to nine different factors—e.g. the level of complexity, and mental workload. Observations were performed on duration of exams, the flow of people, conversations, and any critical issues. **Results:** The CT technology is appreciated, used effectively and with confidence by CT technicians. From 2011-2018, the execution times of the exams have decreased but not the proportion of time dedicated to the patient. Expectations for future improvements are limited by issues concerning the design of both the user interface and the social context of the ED workplace. **Conclusions:** The safety and efficiency of the system as a whole are greatly dependent on the competence of the CT technicians. CT manufacturers rely on this competence to help compensate for the deficiencies created by suboptimal user interfaces and the lack of fit of the technology with the social context of the workplace. **Application:** Training programs aimed at improving the management of relationships and communications between staff could improve performance and efficiency. CT manufacturers should try to better understand the cognitive and operational context of the workplaces where CT technicians work—and to design better diagnostic technology which accounts for these operational realities.

Claudia Bellini, Roberto Guerranti, Francesca Cinci Eva Milletti, Carlo Scapellato. *Defining and Managing the Preanalytical Phase With FMECA: Automation and/or "Human" Control*. pp. 20–36.

Objective: Our scope is to provide methodological elements on how to manage effectively the preanalytical phase in the laboratory testing process, by objectively measuring the risk connected to the phases handled by man with respect to those managed by machines. **Background:** Preanalytical errors account for most of the mistakes related to laboratory testing and can affect patient care. Hence, it is necessary to manage the risk connected to the preanalytical phase, as required by certification and accreditation bodies. The risk assessment discloses the steps at greater risk and gives indications to make decisions. **Method:** We have reviewed the state of art in the automation of the preanalytical phase, addressing needs and problems. We have used the proactive risk assessment methodology FMECA (Failure Mode, Effects, and Criticality Analysis) to identify the most critical phases in our preanalytical process and have calculated the risk associated. **Results:** The most critical phases were the human controlled ones. In particular, the highest risk indexes were associated to manual acceptance of test orders, identification of the patients, tube labeling, and sample collection. **Conclusion:** Automation in the preanalytical phase is fundamental to replace, support, or extend the human contribution. Nevertheless each organization is different about workloads and competencies, so the most suitable management must be tailor-made in each context. **Application:** We present a method by which each organization is able to find its best balance between automation and human contribution in the control of the preanalytical phase.

Fabien Bernard Mohsen Zare, Jean-Claude Sagot Raphael Paquin. *Using Digital and Physical Simulation to Focus on Human Factors and Ergonomics in Aviation Maintainability*. pp. 37–54.

Objective: This research aimed to evaluate the differences in the assessments made by three simulation tools used in a maintainability design office to perform human factor/ergonomics (HFE) analysis: digital human modeling (DHM), virtual reality (VR), and physical mock-up (PMU). **Background:** Maintainability engineers use digital/physical simulation tools in the early design phase to analyze whether the design is well adapted for maintenance operators. Knowing the potential of these simulation tools would encourage maintainability stakeholders to integrate HFE in the design process more efficiently. **Method:** Eleven maintenance tasks were analyzed from the participation of six maintenance operators. Various HFE indicators including physical, cognitive, and organizational indicators were assessed. Each operator repeated 11 maintenance tasks on VR and PMU. Based on the anthropometric parameters, six manikins were created to analyze 11 maintenance tasks on DHM. **Results:** A significant difference was found for the organizational indicators between VR and PMU, whereas the physical and cognitive indicators are similar. DHM, VR, and PMU are compared with the common HFE indicators for the physical dimension and present a significant difference for individual tasks. **Conclusion:** To reduce the gap between simulation tools, a better physical representation is requested on the VR platform, improving the perception of work sequences in the virtual world. Concerning DHM, a new paradigm is proposed to study a few tasks per work area instead of studying each task independently. **Application:** This study will help develop a new methodology and tools specifically for non-HFE experts in the maintainability department.

Sai Praveen Velagapudi, Gaur Gopal Ray. *The Influence of Static Factors on Seating Comfort of Motorcycles: An Initial Investigation*. pp. 55–63.

Objective: The aim of the current study is to examine the influence of static factors on overall seating comfort in motorcycles and validate the use of static lab-based setups for

evaluating seating comfort in motorcycles. **Background:** Seating comfort in automobiles has two factors, static and dynamic. Research on seating comfort of passenger cars has shown that when the magnitude of vibration reaching the seat is low, comfort is largely determined by static factors. Studies have also validated the use of static lab-based setups for research on seating comfort in passenger cars. Static lab-based setups are easy to develop, provide a controlled environment, and efficient for experimental research. The riding posture, mass distribution, and dynamics of a motorcycle differ from a passenger car and warrant further investigation to extend the results from the research on passenger cars. **Method:** The study compares subjective rating of seating comfort and objective measurement of seat interface pressure in two test conditions: a static lab-based setup and actual driving on a flat test track where the magnitude of vibration reaching the seat is low. The vibration at the seat is measured for the driving trial. A group of 18 male volunteers from TVS Motor Company participated in the study, and two motorcycles from the economy/executive segment of India are used in the study. The subjective ratings are analyzed statistically using analysis of variance (ANOVA) and Pearson's correlation. The vibration data are analyzed as per ISO 2631-1 to calculate the frequency-weighted acceleration, aw. **Results:** The results show that there is no significant difference between the two test conditions either in the objective measurements or in the subjective rating of comfort. There is also a statistically significant correlation between the subjective ratings of seating comfort in static lab-based setup and actual riding ($r = .77$, $p < .01$, $n = 36$). The mean aw at the seat while driving in the test track used in this study is 0.2 m/s2. **Conclusion:** Static factors have a significant influence on seating comfort in motorcycles. When the vibration reaching the seat is low (aw ≤ 0.2 m/s2), seating comfort is largely determined by the static factors. The use of static lab-based setups for evaluating static factors of seating comfort in motorcycles is validated. **Application:** The results of this study enable further research to understand the human criterion for seating comfort in motorcycles using static lab-based setups which are easier to develop and provide controlled environment that is essential for any research.

Margherita Micheletti Cremasco, Federica Caffaro, Ambra Giustetto, Lucia Vigoroso Giuseppe Paletto, Eugenio Cavallo. *Tractor Rollover Protection: Is the Incorrect Use of Foldable Rollover Protective Structures Due to Human or to Technical Issues?* pp. 64–76.

Objective: To identify the critical behaviors that may hinder the correct use of foldable rollover protective structures (FROPS) on tractors and to explore the influence of user factors and FROPS technical characteristics. **Background:** FROPS are effective in preventing fatal injuries in rollover accidents if they are in the upright position. However, many farmers leave FROPS folded down. **Method:** Twenty farmers and sixteen models of tractors were involved in the study. Operators were observed while raising the FROPS, and the observed behaviors were correlated with user factors and FROPS technical features. **Results:** In the initial rotation of the FROPS, higher lowered roll-bar to ground distance and FROPS pivot-pin to ground distance required more awkward and unbalanced postures ($p = .02$ and $p = .01$, respectively). When rotating the FROPS in upright position, smaller stature of the participants and higher FROPS pivot-pin to ground distance were significantly correlated with using the tractor's rear 3-point lower links as a supporting surface ($p = .01$ and $p = .02$, respectively). **Conclusion:** FROPS might be revised considering users' comfort in use and anthropometric variability, to improve reachability, avoid risky behaviors, and enhance FROPS operation. **Application:** Technical solutions to enhance FROPS accessibility may be developed, particularly by providing safe surfaces to support operators and highlighting the grasping points. Further best practices and information on correct gestures to handle the FROPS should be included in the tractor manual.

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Aleksandra R. Budarick, Uma Lad, Steven L. Fischer*. Can the Use of Turn-Assist Surfaces Reduce the Physical Burden on Caregivers When Performing Patient Turning?* pp. 77–92.

Objective: To quantify differences in physical workload afforded by turn-assist surfaces relative to manual patient turns, and between nursing caregivers (turn-away vs. turn-toward) while performing partnered patient turning. **Background:** Nurse caregivers experience an increased risk of musculoskeletal injuries at the back or shoulders when performing patient-handling activities. Use of turn-assist surfaces can reduce the physical burden and risk on caregivers. **Method:** Whole-body motion capture and hand force measures were collected from 25 caregivers (17 female) while performing partnered manual and technology-facilitated turns. Shoulder and low back angles and L4/L5 joint contact forces were calculated at the instant of peak hand force application for both caregivers. **Results:** Hand force requirements for the turn-away caregiver were 93% of the estimated maximum acceptable force when performing a manual turn. Use of a turn-assist surface eliminated hand forces required to initiate the patient turn for the turn-away caregiver, where their role was reduced to inserting appropriate wedging behind the patient once the facilitated turn was complete. This reduced shoulder moments by 21.3 Nm for the turn-away caregiver, a reduction in exposure from 70% of maximum shoulder strength capacity to 15%. Spine compression exposures were reduced by 302.1 N for the turn-toward caregiver when using a turn-assist surface. **Conclusion:** Use of a turn-assist surface reduced peak hand force and shoulder-related exposures for turning away and reduced spine-related exposures for turning toward. **Application:** Turn-assist devices should be recommended to decrease the risk of musculoskeletal disorder hazards for both caregivers when performing a partnered patient turn.

COGNITION

Kristy Martin, Julien Périard, Ben Rattray, David B. Pyne. *Physiological Factors Which Influence Cognitive Performance in Military Personnel*. pp. 93–123.

Objective: To identify and detail physiological factors that influence cognition in military personnel. **Background:** Maintenance of cognitive and task performance is important under several scenarios, none more so than in a military context. Personnel are prepared for and trained to tolerate many of the stressors they encounter; however, consideration of stressors typically extends only as far as the physical, psychological, and environmental requirements of a given task. While considering these factors certainly characterizes the broader picture, several physiological states and traits can influence cognition and thus, should also be considered. **Method:** A systematic review of the electronic databases Medline (PubMed), EMBASE (Scopus), PsycINFO, and Web of Science was conducted from inception up to January 2019. Eligibility criteria included current military personnel, an outcome of cognition, and the assessment of a physiological factor. **Results:** The search returned 60,564 records, of which 60 were included in the review. Eleven studies examined the impact of demographic factors on cognition, 16 examined fatigue, 10 investigated nutrition, and 24 the impact of biological factors on cognitive performance. **Conclusion:** Factors identified as having a positive impact on cognition include aerobic fitness, nutritional supplementation, and visual acuity. In contrast, factors identified as having a negative impact include fatigue arising from sustained operations, dehydration, undernutrition, and an exaggerated physiological stress response to a cognitive task or a stressor. A further subset of these factors was considered modifiable. **Application:** The modifiable factors identified provide avenues for training and preparation to enhance cognition in ways previously unconsidered.

HEALTH CARE/HEALTH SYSTEMS

Renae Collett, Isaac Salisbury, Robert G. Loeb, Penelope M. Sanderson. *Smooth or Stepped? Laboratory Comparison of Enhanced Sonifications for Monitoring Patient Oxygen Saturation*. pp. 124–137.

Background: The pulse oximeter (PO) provides anesthesiologists with continuous visual and auditory information about a patient's oxygen saturation (SpO2). However, anesthesiologists' attention is often diverted from visual displays, and clinicians may inaccurately judge SpO2 values when relying on conventional PO auditory tones. We tested whether participants could identify SpO2 value (e.g., "97%") better with acoustic enhancements that identified three discrete clinical ranges by either changing abruptly at two threshold values (stepped-effects) or changing incrementally with each percentage value of SpO2 (smooth-effects). **Method:** In all, 79 nonclinicians participated in a between-subjects experiment that compared performance of participants using the stepped-effects display with those who used the smooth-effects display. In both conditions, participants heard sequences of 72 tones whose pitch directly correlated to SpO2 value, and whose value could change incrementally. Primary outcome was percentage of responses that correctly identified the absolute SpO2 percentage, ±1, of the last pulse tone in each sequence. **Results:** Participants using the stepped-effects auditory tones identified absolute SpO2 percentage more accurately (M = 53.7%) than participants using the smooth-effects tones (M = 47.9%, $p = .038$). Identification of range and detection of transitions between ranges showed even stronger advantages for the stepped-effects display ($p < .005$). **Conclusion:** The stepped-effects display has more pronounced auditory cues at SpO2 range transitions, from which participants can better infer absolute SpO2 values. Further development of a smooth-effects display for this purpose is not necessary.

SIMULATION AND VIRTUAL REALITY

Yannick Daviaux, Emilien Bonhomme, Hans Ivers, Étienne de Sevin, Jean-Arthur Micoulaud-Franchi, Stéphanie Bioulac, Charles M. Morin, Pierre Philip, Ellemarije Altena. *Event-Related Electrodermal Response to Stress: Results From a Realistic Driving Simulator Scenario*. pp. 138–151.

Objective: The study goal was to test whether induced stress during driving could be measured at the event level through electrodermal activity responses. **Background:** Stress measured in simulation scenarios could thus far show an overall change in the stress state, but not be well attributed to acute stressful events. Driving simulator scenarios that induce stress measurable at the event level in realistic situations are thus warranted. As such, acute stress reactions can be measured in the context of changing situational factors such as fatigue, substance abuse, or medical conditions. **Method:** Twelve healthy female participants drove the same route numerous times in a driving simulator, each time with different random traffic events occurring throughout. During one of the scenarios, unknown to the participants, 10 programmed neutral traffic events occurred, whereas in another scenario, at the same location, 10 stressful events occurred. **Results:** Electrodermal response results showed both effects of scenario type and of events. The amplitude of the electrodermal response was significantly correlated with subjective stress experience. **Conclusion:** We conclude that our developed ecological driving simulation scenarios can be used to induce and measure stress at the event level. **Application:** The developed simulator scenarios enable us to measure stress reactions in driving situations at the time when the event actually happens. With these scenarios, we can measure how situational factors, such as fatigue or substance abuse, can change immediate stress reactions when driving. We can further measure more specifically how induced driving stress can affect physical and mental functioning afterward.

TRAINING, EDUCATION, INSTRUCTIONAL SYSTEMS

Adam M. Braly, Patricia R. DeLucia. *Can Stroboscopic Training Improve Judgments of Time-to-Collision?* pp. 152–165.

Objective: The aim of this study was to determine whether training with stroboscopic viewing could improve time-to-collision (TTC) judgments, which have importance in real-world tasks such as driving. **Background:** Prior research demonstrated that training with stroboscopic vision can improve motion coherence thresholds, improve anticipatory timing performance for laterally moving objects, and can protect against performance degradation over time. **Method:** Participants viewed computer simulations of an object that moved and then disappeared. In two separate experiments, the object approached the observer or moved laterally toward a target, representing different optical flow patterns. Participants judged TTC by pressing a button when they thought the object would hit them (approach), or the target (lateral). Performance was measured during four sessions—pretest, intervention, immediately after intervention, and 10 min after intervention. **Results:** Both stroboscopic training and repeated practice improved performance over time for approach motion (decrease in constant error) and stroboscopic training protected against performance degradation for lateral motion (no decrement in variable error), but only when TTC was 3.0 s. There was no difference between training and repeated practice. **Conclusion:** Under certain conditions, stroboscopic training may improve TTC judgments. However, effects of stroboscopic training depend on the nature of the optical flow pattern. **Application:** It is important to determine the conditions under which training can improve TTC judgments which have importance in real-world tasks such as driving. If individuals can be trained to judge TTC more accurately, they may benefit from driver training programs.

Ashley M. Hughes, Stephanie Zajac, Amanda L. Woods, Eduardo Salas. *The Role of Work Environment in Training Sustainment: A Meta-Analysis*. pp. 166–183.

Objective: The purpose of this meta-analytic review is to examine the role of three work environment support variables (i.e., peer, supervisor, and organizational support) in training transfer and sustainment or long-term use of learned knowledge, skills, and attitudes (KSAs). **Background:** Estimates demonstrate that little training is transferred to the job, wasting billions in organizational spending each year and resulting in significant loss to safety and individual and team performance. Prior research shows the importance of a supportive work environment to facilitating transfer; however, we know little of the relative importance of specific support variables. This study seeks to examine the unique roles of distinct support variables in training transfer. **Method:** A meta-analysis was conducted with multiple regressions to answer three primary research questions. **Results:** All work environment support variables demonstrate moderate and positive correlations with transfer of training. Furthermore, multiple regressions demonstrate that each factor of the work environment explains unique variance as a predictor, with the model accounting for 32% of transfer and peer support accounting for most of R2. Motivation to transfer mediates the relationship between all three work environment support variables and transfer. Furthermore, three support variables are positively related to sustainment, with peer and supervisor support showing the strongest relationships. **Conclusion:** Findings illuminate the relative contribution of peer, supervisor, and organizational support to transfer and sustainment of training. As transfer continues to be an important yet understudied measure of the effectiveness of workplace training, these findings hold implications for both research and practice.