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ACCIDENTS, HUMAN ERROR

Kristen Pammer, Stephanie Sabadas, Stephanie Lentern. *Allocating Attention to Detect Motorcycles: The Role of Inattentional Blindness*. pp. 5–19.

Objective: To determine whether inattentional blindness (IB) can be used to understand the psychological mechanisms around looked-but-failed-to-see (LBFTS) crashes involving motorcycles. **Background:** IB occurs when an observer looks directly at an object yet fails to see it, thus LBFTS crashes may be a real-world example of IB. The study tests a perceptual cycle model in which motorcycles are detected less frequently because they fall lower on the attentional hierarchy for driving. **Method:** A driving-related IB task with photographs of driving situations investigated whether an additional stimulus, a taxi or motorcycle, would be more likely to be missed by participants. In Experiments 2 and 3, the "threat value" of objects in the scene were varied to determine the degree to which this influences participants' tendency to notice motorcycles. **Results:** Participants were twice as likely to miss a motorcycle compared with a taxi. Moreover, participants reported that they would expect to miss a motorcycle on the road. In Experiments 2 and 3, participants modulated their attention to accommodate motorcycles when necessary, suggesting that motorcycles are afforded the lowest level of attentional bandwidth. **Conclusion:** Inattentional blindness forms a good psychological framework for understanding LBFTS crashes, particularly in the context of attentional set, such that LBFTS crashes occur because motorcycles do not feature strongly in a typical driver's attentional set for driving. **Application:** The findings here are important because LBFTS crashes can be reduced if we can change the expectations of road users around the presence of motorcycles on the road.

- **Keywords:** attention, perceptual cycle, driving, situation awareness, inattentional blindness

Federica Caffaro, Michele Roccato, Margherita Micheletti Cremasco, Eugenio Cavallo. *Falls From Agricultural Machinery: Risk Factors Related to Work Experience, Worked Hours, and Operators' Behavior*. pp. 20–30.

Objective: We investigated the risk factors for falls when egressing from agricultural tractors, analyzing the role played by worked hours, work experience, operators' behavior, and near misses. **Background:** Many accidents occur within the agricultural sector each year. Among them, falls while dismounting the tractor represent a major source of injuries. Previous studies pointed out frequent hazardous movements and incorrect behaviors adopted by operators to exit the tractor cab. However, less is known about the determinants of such behaviors. In addition, near misses are known to be important predictors of accidents, but they have been under-investigated in the agricultural sector in general and as concerns falls in particular. **Method:** A questionnaire assessing dismounting behaviors, previous accidents and near misses, and participants' relation with work was administered to a sample of Italian tractor operators (n = 286). **Results:** A mediated model showed that worked hours increase unsafe behaviors, whereas work experience decreases them. Unsafe behaviors in turn show a positive association with accidents, via the mediation of near misses. **Conclusions:** We gave a novel contribution to the knowledge of the chain of events leading to fall accidents in the agricultural sector, which is one of the most hazardous industries. **Applications:**Besides tractor design improvements, preventive training interventions may focus on the redesign of the actual working strategies and the adoption of engaging training methods in the use of machinery to optimize the learning of safety practices and safe behaviors.

- **Keywords:** accident analysis, agricultural systems, motor behavior, slips and falls, structural equation modeling

AVIATION AND AEROSPACE

Adrian Cornelius Marinescu, Sarah Sharples, Alastair Campbell Ritchie, Tomas Sánchez López, Michael McDowell, Hervé P. Morvan. *Physiological Parameter Response to Variation of Mental Workload*. pp. 31–56.

Objective: To examine the relationship between experienced mental workload and physiological response by noninvasive monitoring of physiological parameters. **Background:** Previous studies have examined how individual physiological measures respond to changes in mental demand and subjective reports of workload. This study explores the response of multiple physiological parameters and quantifies their added value when estimating the level of demand. **Method:** The study presented was conducted in laboratory conditions and required participants to perform a visual-motor task that imposed varying levels of demand. The data collected consisted of physiological measurements (heart interbeat intervals, breathing rate, pupil diameter, facial thermography), subjective ratings of workload (Instantaneous Self-Assessment Workload Scale [ISA] and NASA-Task Load Index), and the performance. **Results:** Facial thermography and pupil diameter were demonstrated to be good candidates for noninvasive workload measurements: For seven out of 10 participants, pupil diameter showed a strong correlation (R values between .61 and .79 at a significance value of .01) with mean ISA normalized values. Facial thermography measures added on average 47.7% to the amount of variability in task performance explained by a regression model. As with the ISA ratings, the relationship between the physiological measures and performance showed strong interparticipant differences, with some individuals demonstrating a much stronger relationship between workload and performance measures than others. **Conclusion:** The results presented in this paper demonstrate that physiological and pupil diameter can be used for noninvasive real-time measurement of workload. **Application:** The methods presented in this article, with current technological capabilities, are better suited for workplaces where the person is seated, offering the possibility of being applied to pilots and air traffic controllers.

- **Keywords:** mental workload, human performance, facial thermography, pupil diameter, physiological measures

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Giulia Stucchi, Natale Battevi, Monica Pandolfi, Luca Galinotti, Simona Iodice, Chiara Favero. *Cumulative Mass and NIOSH Variable Lifting Index Method for Risk Assessment: Possible Relations*. pp. 57–67.

Objective: The aim of this study was to explore whether the Variable Lifting Index (VLI) can be corrected for cumulative mass and thus test its efficacy in predicting the risk of low-back pain (LBP). **Background:** A validation study of the VLI method was published in this journal reporting promising results. Although several studies highlighted a positive correlation between cumulative load and LBP, cumulative mass has never been considered in any of the studies investigating the relationship between manual material handling and LBP. **Method:** Both VLI and cumulative mass were calculated for 2,374 exposed subjects using a systematic approach. Due to high variability of cumulative mass values, a stratification within VLI categories was employed. Dummy variables (1–4) were assigned to each class and used as a multiplier factor for the VLI, resulting in a new index (VLI_CMM). Data on LBP were collected by occupational physicians at the study sites. Logistic regression was used to estimate the risk of acute LBP within levels of risk exposure when compared with a control group formed by 1,028 unexposed subjects. **Results:** Data showed greatly variable values of cumulative mass across all VLI classes. The potential effect of cumulative mass on damage emerged as not significant (*p* value = .6526). **Conclusion:** When comparing VLI_CMM with raw VLI, the former failed to prove itself as a better predictor of LBP risk. **Application:** To recognize cumulative mass as a modifier, especially for lumbar degenerative spine diseases, authors of future studies should investigate potential association between the VLI and other damage variables.

- **Keywords:** manual materials handling, job risk assessment, low-back pain, biomechanics, cumulative mass, cumulative load

Peter Le, Alexander Aurand, Thomas M. Best, Safdar N. Khan, Ehud Mendel, William S. Marras. An *Exploratory Electromyography-Based Coactivation Index for the Cervical Spine*. pp. 68–79.

Objective: Develop a coactivation index for the neck and test its effectiveness with complex dynamic head motions. **Background:** Studies describing coactivation for the cervical spine are sparse in the literature. Of those in existence, they were either limited to a priori definitions of agonist/antagonist activity that limited the testing to sagittal and lateral planes or consisted of isometric exertions. Multiplanar movements would allow for a more realistic understanding of naturalistic movements in the cervical spine and propensity for neck pain. However, a gap in the literature exists in which a method to describe coactivation during complex dynamic motions does not exist for the cervical spine. **Methods:** An electromyography-based coactivation index was developed for the cervical spine based on previously tested methodology used on the lumbar spine without a high-end model and tested using a series of different postures and speeds. **Results:** Complex motions involving twisting (i.e., flexion and twisting) and higher speed had higher magnitudes of coactivation than uniplanar motions in the sagittal or lateral plane, which was expected. The coupled motion of flexion and twisting showed four to five times higher coactivation than uniplanar (sagittal or lateral) movements. **Conclusion:** The coactivation index developed accommodates multiplanar, naturalistic movements. Testing of the index showed that motions requiring higher degrees of head control had higher effort due to coactivation, which was expected. **Application:** Overall, this coactivation index may be utilized to understand the neuromuscular effort of various tasks in the cervical spine.

- **Keywords:** co-contraction, neuromuscular, neck muscles, cactivation

INDIVIDUAL DIFFERENCES

Federico Scholcover, Douglas J. Gillan. *Using Temporal Sensitivity to Predict Performance Under Latency in Teleoperation*. pp. 80–91.

Objective: This article establishes a relationship between temporal sensitivity and task performance under one-way latency between input and response. **Background:** As the latency between human input and telerobot response increases, performance (e.g., speed to complete task and accuracy) declines. Tools, such as predictive displays, have been developed to ameliorate performance costs. However, more work is needed to understand the relationship between individual differences and task performance. Temporal sensitivity in particular was the focus of this research. **Method:** Participants completed two tasks. In the time estimation task, participants estimated the duration of a series of visual stimuli. In the second task, participants drove a remote-controlled (RC) car through a track. On each trial, there was a latency between the participant's input into the controller and the response by the RC car, with latencies ranging from 400 to 1,000 milliseconds between trials. Completion time and the number of errors made were recorded. **Results:** Temporal sensitivity predicted the total number of errors made during a trial but was not found to be a predictor of completion time. It was however predictive of error rate (i.e., errors per minute), suggesting a possible speed/accuracy trade-off. **Conclusion:** This was an initial step in establishing a link between temporal sensitivity and performance with latency. **Application:** The study has applications toward training teleoperators who may experience latency, such as astronauts and surgeons.

- **Keywords:** teleoperation, human-robot interaction, individual differences, time perception, psychophysical methods

MOTOR BEHAVIOR

Matthew Ray, Elizabeth Sanli, Robert Brown, Kerri Ann Ennis, Heather Carnahan. *The Combined Effect of Cold and Moisture on Manual Performance*. pp. 92–100.

Objective: The aim of this study was to investigate the combined effect of cold and moisture on manual performance and tactile sensitivity. **Background:** People working in the ocean environment often perform manual work in cold and wet conditions. Although the independent effects of cold and moisture on hand function are known, their combined effect has not been investigated. **Method:** Participants completed sensory (Touch-Test, two-point discrimination) and motor (Purdue Pegboard, Grooved Pegboard, reef knot untying) tests in the following conditions: dry hand, wet hand, cold hand, and cold and wet hand. **Results:** For the Purdue Pegboard and knot untying tasks, the greatest decrement in performance was observed in the cold-and-wet-hand condition, whereas the decrements seen in the cold-hand and wet-hand conditions were similar. In the Grooved Pegboard task, the performance decrements exhibited in the cold-and-wet-hand condition and the cold-hand condition were similar, whereas no decrement was observed in the wet-hand condition. Tactile sensitivity was reduced in the cold conditions for the Touch-Test but not the two-point discrimination test. **Conclusion:** The combined effect of cold and moisture led to the largest performance decrements except when intrinsic object properties helped with grasp maintenance. The independent effects of cold and moisture on manual performance were comparable. **Application:** Tools and equipment for use in the cold ocean environment should be designed to minimize the effects of cold and moisture on manual performance by including object properties that enhance grasp maintenance and minimize the fine-dexterity requirements.

- **Keywords:** manual performance, hand moisture, cold, tactile sensitivity, cold ocean environment

SURFACE TRANSPORTATION

Jeff K. Caird, Sarah M. Simmons, Katelyn Wiley, Kate A. Johnston, William J. Horrey. *Does Talking on a Cell Phone, With a Passenger, or Dialing Affect Driving Performance? An Updated Systematic Review and Meta-Analysis of Experimental Studies*. pp. 101–133.

Objective: An up-to-date meta-analysis of experimental research on talking and driving is needed to provide a comprehensive, empirical, and credible basis for policy, legislation, countermeasures, and future research. **Background:** The effects of cell, mobile, and smart phone use on driving safety continues to be a contentious societal issue. **Method:** All available studies that measured the effects of cell phone use on driving were identified through a variety of search methods and databases. A total of 93 studies containing 106 experiments met the inclusion criteria. Coded independent variables included conversation target (handheld, hands-free, and passenger), setting (laboratory, simulation, or on road), and conversation type (natural, cognitive task, and dialing). Coded dependent variables included reaction time, stimulus detection, lane positioning, speed, headway, eye movements, and collisions. **Results:** The overall sample had 4,382 participants, with driver ages ranging from 14 to 84 years (M = 25.5, SD = 5.2). Conversation on a handheld or hands-free phone resulted in performance costs when compared with baseline driving for reaction time, stimulus detection, and collisions. Passenger conversation had a similar pattern of effect sizes. Dialing while driving had large performance costs for many variables. **Conclusion:** This meta-analysis found that cell phone and passenger conversation produced moderate performance costs. Drivers minimally compensated while conversing on a cell phone by increasing headway or reducing speed. A number of additional meta-analytic questions are discussed. **Application:** The results can be used to guide legislation, policy, countermeasures, and future research.

- **Keywords:** cell, mobile and smart phone conversation, passenger conversation, dialing, driving performance, meta-analysis, research synthesis, driver distraction