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#### ACCIDENTS, SAFETY, AND HUMAN ERROR

**Al-Awar Smither, Janan; Torrez, Lorenzo I. *Motorcycle Conspicuity : Effects of Age and Daytime Running Lights. S. 355-369(15).***

**Objective:** This study investigated variables that may contribute to motorcycle conspicuity within a high-fidelity simulated environment. The variables included motorcycle lighting, vehicular daytime running lights (DRLs), and age of the driver of the other vehicle. **Background:** Research suggests that decreased levels of conspicuity associated with riding a small two-wheeled vehicle reduce the ability of other drivers to detect and respond to that vehicle effectively. This lack of conspicuity is often responsible for the frequent injuries and fatalities incurred by motorcycle riders. **Method:** The 75 participants who took part in this study watched a series of video clips of roadway traffic and were asked to indicate when they saw a hazardous situation, such as the presence of pedestrians, motorcycles, or traffic cones. Both motorcycle and following-vehicle lights were manipulated, and participant reaction times were collected and analyzed. **Results:** Analyses indicated main effects for all three variables as well as interaction effects between motorcycle lighting and vehicle-following conditions. Overall, findings showed a link between DRLs and the effective detection of motorcycles and suggested that age-related changes affect the ability to detect and respond to a motorcycle effectively. **Conclusion:** Although our laboratory findings corroborated previous correlational studies, further research in real-world settings, such as those with high-density traffic or under adverse environmental conditions, needs to be conducted. **Application:** Potential applications of this research include the assessment of appropriate lighting technology to enhance conspicuity of motorcycles and reduce the high rate of fatalities and injuries related to motorcycle crashes.

- **Keywords:** AGING AND INDIVIDUAL DIFFERENCES; SURFACE TRANSPORTATION SYSTEMS; SENSORY AND PERCEPTUAL PROCESSES; ACCIDENTS; CRASHES; SAFETY; AND HUMAN ERROR; MOTORCYCLE CONSPICUITY; VEHICULAR DAYTIME RUNNING LIGHTS; HEADLIGHT MODULATORS; SIMULATED ENVIRONMENTS; MOTORCYCLE LIGHTING; DRIVER BEHAVIOR; ROADWAY TRAFFIC; FOLLOWING-VEHICLE LIGHTS; DRIVER REACTION TIME; AGE-RELATED DRIVING; AGING MOTORISTS; COGNITIVE CONSPICUITY

#### ATTENTIONAL PROCESSES

**Ratwani, Raj. *An Eye Movement Analysis of the Effect of Interruption Modality on Primary Task Resumption. S. 370-380(11).***

**Objective:** We examined the effect of interruption modality (visual or auditory) on primary task (visual) resumption to determine which modality was the least disruptive. **Background:** Theories examining interruption modality have focused on specific periods of the interruption timeline. Preemption theory has focused on the switch from the primary task to the interrupting task. Multiple resource theory has focused on interrupting tasks that are to be performed concurrently with the primary task. Our focus was on examining how interruption modality influences task resumption. We leverage the memory-for-goals theory, which suggests that maintaining an associative link between environmental cues and the suspended primary task goal is important for resumption. **Method:** Three interruption modality conditions were examined: auditory interruption with the primary task visible, auditory interruption with a blank screen occluding the primary task, and a visual interruption occluding the primary task. Reaction time and eye movement data were collected. **Results:** The auditory condition with the primary task visible was the least disruptive. Eye movement data suggest that participants in this condition were actively maintaining an associative link between relevant environmental cues on the primary task interface and the suspended primary task goal during the interruption. **Conclusion:** These data suggest that maintaining cue association is the important factor for reducing the disruptiveness of interruptions, not interruption modality. **Application:** Interruption-prone computing environments should be designed to allow for the user to have access to relevant primary task cues during an interruption to minimize disruptiveness.

- **Keywords:** HUMAN-COMPUTER INTERACTION (HCI); EYE TRACKING; MULTIPLE RESOURCES; ATTENTIONAL PROCESSES; INTERRUPTION MODALITY; TASK RESUMPTION

## **AUTOMATION, EXPERT SYSTEMS**

**Parasuraman, Raja; Manzey, Dietrich H. *Complacency and Bias in Human Use of Automation : An Attentional Integration*. s. 381-410(30).**

**Objective:** Our aim was to review empirical studies of complacency and bias in human interaction with automated and decision support systems and provide an integrated theoretical model for their explanation. **Background:** Automation-related complacency and automation bias have typically been considered separately and independently. **Methods:** Studies on complacency and automation bias were analyzed with respect to the cognitive processes involved. **Results:** Automation complacency occurs under conditions of multiple-task load, when manual tasks compete with the automated task for the operator's attention. Automation complacency is found in both naive and expert participants and cannot be overcome with simple practice. Automation bias results in making both omission and commission errors when decision aids are imperfect. Automation bias occurs in both naive and expert participants, cannot be prevented by training or instructions, and can affect decision making in individuals as well as in teams. While automation bias has been conceived of as a special case of decision bias, our analysis suggests that it also depends on attentional processes similar to those involved in automation-related complacency. **Conclusion:** Complacency and automation bias represent different manifestations of overlapping automation-induced phenomena, with attention playing a central role. An integrated model of complacency and automation bias shows that they result from the dynamic interaction of personal, situational, and automation-related characteristics. **Application:** The integrated model and attentional synthesis provides a heuristic framework for further research on complacency and automation bias and design options for mitigating such effects in automated and decision support systems.

- **Keywords:** ATTENTION; AUTOMATION-RELATED COMPLACENCY; AUTOMATION BIAS; DECISION MAKING; COGNITIVE PROCESSES; DECISION SUPPORT SYSTEMS; EXPERT SYSTEMS; HUMAN-COMPUTER INTERACTION; TRUST

**Rovira, Ericka; Parasuraman, Raja. *Transitioning to Future Air Traffic Management : effects of Imperfect Automation on Controller Attention and Performance. S. 411-425(15).***

**Objective:** This study examined whether benefits of conflict probe automation would occur in a future air traffic scenario in which air traffic service providers (ATSPs) are not directly responsible for freely maneuvering aircraft but are controlling other nonequipped aircraft (mixed-equipage environment). The objective was to examine how the type of automation imperfection (miss vs. false alarm) affects ATSP performance and attention allocation. **Background:** Research has shown that the type of automation imperfection leads to differential human performance costs. **Method:** Participating in four 30-min scenarios were 12 full-performance-level ATSPs. Dependent variables included conflict detection and resolution performance, eye movements, and subjective ratings of trust and self confidence. **Results:** ATSPs detected conflicts faster and more accurately with reliable automation, as compared with manual performance. When the conflict probe automation was unreliable, conflict detection performance declined with both miss (25% conflicts detected) and false alarm automation (50% conflicts detected). **Conclusion:** When the primary task of conflict detection was automated, even highly reliable yet imperfect automation (miss or false alarm) resulted in serious negative effects on operator performance. **Application:** The further in advance that conflict probe automation predicts a conflict, the greater the uncertainty of prediction; thus, designers should provide users with feedback on the state of the automation or other tools that allow for inspection and analysis of the data underlying the conflict probe algorithm.

- **Keywords:** AUTOMATION RELIABILITY; TRUST; ATTENTION ALLOCATION; FREE FLIGHT; NEXTGEN; AEROSPACE SYSTEMS; AUTOMATION; MENTAL WORKLOAD; ATTENTIONAL PROCESSES; EYE MOVEMENT; AIR TRAFFIC MANAGEMENT; AUTOMATION IMPERFECTION; CONFLICT-PROBE AUTOMATION; CONTROLLER ATTENTION AND PERFORMANCE; AIR TRAFFIC SERVICE PROVIDERS; NON-EQUIPPED AIRCRAFT; CONFLICT DETECTION; AIR TRAFFIC CONTROL

## **BIOMECHANICS, ANTHROPOMETRY, AND WORK PHYSIOLOGY**

**Chen, Wen-Lin; Shih, Yuh-Chuan; Chi, Chia-Fen. *Hand and Finger Dexterity as a Function of Skin Temperature, EMG, and Ambient Condition. S. 426-440(15).***

**Objective:** This article examines the changes in skin temperature (finger, hand, forearm), manual performance (hand dexterity and strength), and forearm surface electromyograph (EMG) through 40-min, 11 °C water cooling followed by 15-min, 34 °C water rewarming; additionally, it explores the relationship between dexterity and the factors of skin temperature, EMG, and ambient condition. **Background:** Hand exposure in cold conditions is unavoidable and significantly affects manual performance. **Method:** Two tasks requiring gross and fine dexterity were designed, namely, nut loosening and pin insertion, respectively. The nested-factorial design includes factors of gender, participant (nested within gender), immersion duration, muscle type (for EMG), and location (for skin temperature). The responses are changes in dexterity, skin temperature, normalized amplitude of EMG, and grip strength. Finally, factor analysis and stepwise regression are used to explore factors affecting hand and finger dexterity. **Results:** Dexterity, EMG, and skin temperature fell with prolonged cooling, but the EMG of the flexor digitorum superficialis remained almost unchanged during the nut loosening task. All responses but the forearm skin temperature recovered to the baseline level at the end of rewarming. The three factors extracted by factor analysis are termed skin temperature, ambient condition, and EMG. They explain approximately two thirds of the variation of the linear models for both dexterities, and the factor of skin temperature is the most influential. **Conclusion:** Sustained cooling and warming significantly decreases

and increases finger, hand, and forearm skin temperature. Dexterity, strength, and EMG are positively correlated to skin temperature. Therefore, keeping the finger, hand, and forearm warm is important to maintaining hand performance. **Application:** The findings could be helpful to building safety guidelines for working in cold environments.

- **Keywords:** COLD IMMERSION; HAND MANIPULATION; GRIP STRENGTH; ELECTROMYOGRAPH (EMG); SKIN TEMPERATURE

**Kociolek, Aaron M.; Keir, Peter J. *Reliability of Distal Upper Extremity Posture Matching Using Slow-Motion and Frame-by-Frame Video Methods.* S. 441-455(15).**

**Objective:** The aim of this study was to determine the effects of video playback speed on posture matching reliability of the distal upper extremity. **Background:** Video is frequently used in ergonomic assessments, yet there remains a need to determine the effects of viewing speed on posture observations. **Method:** Participants were 7 graduate students experienced with posture-based observational methods. Categorical posture scales were used to evaluate forearm pronation/supination, wrist flexion/extension, wrist radioulnar deviation, and hand activity from workplace video at three playback speeds (quarter, half, and real time). Wrist flexion/extension was also evaluated with a frame-by-frame video method. **Results:** Posture counts increased with slower viewing speeds for the wrist and hand, but percentage durations in each posture category were similar for all methods. Posture matching interrater reliability scores increased with slow-motion video playback but remained low even for quarter-time video playback. The highest interrater scores were found in the frame-by-frame analysis of wrist flexion/extension for three posture categories (percentage agreement = 84.9%±1.3%; kappa = 0.54±0.02). **Conclusion:** Although slower video playback speeds increased the number of posture counts for the wrist and hand scales, percentage durations were similar, and reliability scores increased only slightly with slow-motion video playback. **Application:** Reviewing video using slow-motion or frame-by-frame methods improves distal upper extremity posture matching reliability. However, ergonomic assessment tools based on percentage duration may not be appreciably enhanced by slowing viewing speed. Thus, the increased viewing time with slower playback should be justified with respect to assessment needs.

- **Keywords:** MUSCULOSKELETAL DISORDERS; ERGONOMIC ASSESSMENT; OBSERVATION METHOD; VIDEO; SLOW MOTION; FRAME-BY-FRAME; POSTURE MATCHING; UPPER EXTREMITY; FOREARM; WRIST; HAND; RELIABILITY

## **SENSORY AND PERCEPTUAL PROCESSES**

**Kim, Dae Shik; Wall Emerson, Robert S.; Curtis, Amy B. *Ergonomic Factors Related to Drop-Off Detection With the Long Cane : Effects of Cane Tips and Techniques.* S. 456-465(10).**

**Objective:** This study examined the effect of cane tips and cane techniques on drop-off detection with the long cane. **Background:** Blind pedestrians depend on a long cane to detect drop-offs. Missing a drop-off may result in falls or collision with moving vehicles in the street. Although cane tips appear to affect a cane user's ability to detect drop-offs, few experimental studies have examined such effect. **Method:** A repeated-measures design with block randomization was used for the study. Participants were 17 adults who were legally blind and had no other disabilities. Participants attempted to detect the drop-offs of varied depths using different cane tips and cane techniques. **Results:** Drop-off detection rates were similar between the marshmallow tip (77.0%) and the marshmallow roller tip (79.4%) when both tips were used with the constant contact technique,  $p = .294$ . However, participants detected drop-offs at a significantly higher percentage when they used the constant contact technique with the marshmallow roller tip (79.4%) than when they used the two-point touch technique with the marshmallow

tip (63.2%),  $p < .001$ . **Conclusion:** The constant contact technique used with a marshmallow roller tip (perceived as a less advantageous tip) was more effective than the two-point touch technique used with a marshmallow tip (perceived as a more advantageous tip) in detecting drop-offs. **Application:** The findings of the study may help cane users and orientation and mobility specialists select appropriate cane techniques and cane tips in accordance with the cane user's characteristics and the nature of the travel environment.

- **Keywords:** BLIND MOBILITY; TWO-POINT TOUCH; CONSTANT CONTACT; MARSHMALLOW TIP; ROLLER TIP; VISUALLY IMPAIRED

## **SURFACE TRANSPORTATION SYSTEMS**

### **Smith, Kip; Källhammer, Jan-Erik. *Driver Acceptance of False Alarms to Simulated Encroachment*. S. 466-476(11).**

**Objective:** We investigated driver acceptance of alerts to left-turn encroachment incidents that do not produce a crash. If an event that produces a crash is the criterion for a "true" alert, all the alerts we studied are technically false alarms. Our aim was to inform the design of intersection-assist active safety systems. **Background:** The premise of this study is that it may be possible to overcome driver resistance to alerts that are false alarms by designing systems to issue alerts when and only when drivers would expect and accept them. **Method:** Participants were passengers in a driving simulator that presented left-turn encroachment incidents. Participant point of view, the direction of encroachment, and postencroachment time (PET) were manipulated to produce 36 near-crash incidents. After viewing each incident, the participant rated the relative acceptability of a hypothetical alert to it. **Results:** Repeated-measures ANOVA and logistic regression indicate that acceptability varies inversely with PET. At PET intervals less than 2.2 s, driver point of view and encroachment direction interact. At PET intervals more than 2.2 s, alerts to lateral encroachments are more acceptable than alerts to oncoming encroachments. **Conclusion:** Driver acceptance of alerts by active safety systems will be sensitive to context. **Application:** This study demonstrates the utility of eliciting subjective criteria to inform system design to match driver (user) expectations. Intersection-assist active safety systems will need to be designed to adapt to the interaction of driver point of view, the direction of encroachment, and PET.

- **Keywords:** FALSE ALARMS; ACTIVE SAFETY SYSTEMS; ALERT ACCEPTANCE; KNOWLEDGE ELICITATION; SIMULATION; LEFT-TURN ENCROACHMENT INCIDENTS; DRIVER BEHAVIOR; AUTOMATION