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Strathie, Ailsa, Walker, Guy H. *Can Link Analysis Be Applied to Identify Behavioral Patterns in Train Recorder Data?* pp. 205-217.

ObjectiveA proof-of-concept analysis was conducted to establish whether link analysis could be applied to data from on-train recorders to detect patterns of behavior that could act as leading indicators of potential safety issues. **Background**On-train data recorders capture data about driving behavior on thousands of routine journeys every day and offer a source of untapped data that could be used to offer insights into human behavior. **Method**Data from 17 journeys undertaken by six drivers on the same route over a 16-hr period were analyzed using link analysis, and four key metrics were examined: number of links, network density, diameter, and sociometric status. **Results**The results established that link analysis can be usefully applied to data captured from on-vehicle recorders. The four metrics revealed key differences in normal driver behavior. These differences have promising construct validity as leading indicators. **Conclusion**Link analysis is one method that could be usefully applied to exploit data routinely gathered by on-vehicle data recorders. It facilitates a proactive approach to safety based on leading indicators, offers a clearer understanding of what constitutes normal driving behavior, and identifies trends at the interface of people and systems, which is currently a key area of strategic risk. **Application**These research findings have direct applications in the field of transport data monitoring. They offer a means of automatically detecting patterns in driver behavior that could act as leading indicators of problems during operation and that could be used in the proactive monitoring of driver competence, risk management, and even infrastructure design.

Meuter, Renata F. I., Lacherez, Philippe F. *When and Why Threats Go Undetected: Impacts of Event Rate and Shift Length on Threat Detection Accuracy During Airport Baggage Screening.* pp. 218-228.

ObjectiveWe aimed to assess the impact of task demands and individual characteristics on threat detection in baggage screeners. **Background**Airport security staff work under time constraints to ensure optimal threat detection. Understanding the impact of individual characteristics and task demands on performance is vital to ensure accurate threat detection. **Method**We examined threat detection in baggage screeners as a function of event rate (i.e., number of bags per minute) and time on task across 4 months. We measured performance in terms of the accuracy of detection of Fictitious

Threat Items (FTIs) randomly superimposed on X-ray images of real passenger bags. Results Analyses of the percentage of correct FTI identifications (hits) show that longer shifts with high baggage throughput result in worse threat detection. Importantly, these significant performance decrements emerge within the first 10 min of these busy screening shifts only. Conclusion Longer shift lengths, especially when combined with high baggage throughput, increase the likelihood that threats go undetected. Application Shorter shift rotations, although perhaps difficult to implement during busy screening periods, would ensure more consistently high vigilance in baggage screeners and, therefore, optimal threat detection and passenger safety.

Payre, William, Cestac, Julien, Delhomme, Patricia. *Fully Automated Driving: Impact of Trust and Practice on Manual Control Recovery*. pp. 229-241.

Objective An experiment was performed in a driving simulator to investigate the impacts of practice, trust, and interaction on manual control recovery (MCR) when employing fully automated driving (FAD). Background To increase the use of partially or highly automated driving efficiency and to improve safety, some studies have addressed trust in driving automation and training, but few studies have focused on FAD. FAD is an autonomous system that has full control of a vehicle without any need for intervention by the driver. Method A total of 69 drivers with a valid license practiced with FAD. They were distributed evenly across two conditions: simple practice and elaborate practice. Results When examining emergency MCR, a correlation was found between trust and reaction time in the simple practice group (i.e., higher trust meant a longer reaction time), but not in the elaborate practice group. This result indicated that to mitigate the negative impact of overtrust on reaction time, more appropriate practice may be needed. Conclusions Drivers should be trained in how the automated device works so as to improve MCR performance in case of an emergency. Application The practice format used in this study could be used for the first interaction with an FAD car when acquiring such a vehicle.

Barg-Walkow, Laura H., Rogers, Wendy A. *The Effect of Incorrect Reliability Information on Expectations, Perceptions, and Use of Automation*. pp. 242-260.

Objective We examined how providing artificially high or low statements about automation reliability affected expectations, perceptions, and use of automation over time. Background One common method of introducing automation is providing explicit statements about the automations capabilities. Research is needed to understand how expectations from such introductions affect perceptions and use of automation. Method Explicit-statement introductions were manipulated to set higher-than (90%), same-as (75%), or lower-than (60%) levels of expectations in a dual-task scenario with 75% reliable automation. Two experiments were conducted to assess expectations, perceptions, compliance, reliance, and task performance over (a) 2 days and (b) 4 days. Results The baseline assessments showed initial expectations of automation reliability matched introduced levels of expectation. For the duration of each experiment, the lower-than groups perceptions were lower than the actual automation reliability. However, the higher-than groups perceptions were no different from actual automation reliability after Day 1 in either study. There were few differences between groups for automation use, which generally stayed the same or increased with experience using the system. Conclusion Introductory statements describing artificially low automation reliability have a long-lasting impact on perceptions about automation performance. Statements including incorrect automation reliability do not appear to affect use of automation. Application Introductions should be designed according to desired outcomes for expectations, perceptions, and use of the automation. Low expectations have long-lasting effects.

Park, Jangwoon, Ebert, Sheila M., Reed, Matthew P., Hallman, Jason J. *Statistical Models for Predicting Automobile Driving Postures for Men and Women Including Effects of Age.* pp. 261-278.

BackgroundPreviously published statistical models of driving posture have been effective for vehicle design but have not taken into account the effects of age. **Objective**The present study developed new statistical models for predicting driving posture. **Methods**Driving postures of 90 U.S. drivers with a wide range of age and body size were measured in laboratory mockup in nine package conditions. Posture-prediction models for female and male drivers were separately developed by employing a stepwise regression technique using age, body dimensions, vehicle package conditions, and two-way interactions, among other variables. **Results**Driving posture was significantly associated with age, and the effects of other variables depended on age. A set of posture-prediction models is presented for women and men. The results are compared with a previously developed model. **Conclusion**The present study is the first study of driver posture to include a large cohort of older drivers and the first to report a significant effect of age. **Application**The posture-prediction models can be used to position computational human models or crash-test dummies for vehicle design and assessment.

Cummings, Mary L., Gao, Fei, Thornburg, Kris M. *Boredom in the Workplace: A New Look at an Old Problem.* pp. 279-300.

ObjectiveWe review historical and more recent efforts in boredom research and related fields. A framework is presented that organizes the various facets of boredom, particularly in supervisory control settings, and research gaps and future potential areas for study are highlighted. **Background**Given the ubiquity of boredom across a wide spectrum of work environments--exacerbated by increasingly automated systems that remove humans from direct, physical system interaction and possibly increasing tedium in the workplace--there is a need not only to better understand the multiple facets of boredom in work environments but to develop targeted mitigation strategies. **Method**To better understand the relationships between the various influences and outcomes of boredom, a systems-based framework, called the Boredom Influence Diagram, is proposed that describes various elements of boredom and their interrelationships. **Results**Boredom is closely related to vigilance, attention management, and task performance. This review highlights the need to develop more naturalistic experiments that reflect the characteristics of a boring work environment. **Conclusion**With the increase in automation, boredom in the workplace will likely become a more prevalent issue for motivation and retention. In addition, developing continuous measures of boredom based on physiological signals is critical. **Application**Personnel selection and improvements in system and task design can potentially mitigate boredom. However, more work is needed to develop and evaluate other potential interventions.

Marusich, Laura R., Bakdash, Jonathan Z., Onal, Emrah, Yu, Michael S., Schaffer, James, ODonovan, John, Höllerer, Tobias, Buchler, Norbou, Gonzalez, Cleotilde. *Effects of Information Availability on Command-and-Control Decision Making: Performance, Trust, and Situation Awareness.* pp. 301-321.

ObjectiveWe investigated how increases in task-relevant information affect human decision-making performance, situation awareness (SA), and trust in a simulated command-and-control (C2) environment. **Background**Increased information is often associated with an improvement of SA and decision-making performance in networked organizations. However, previous research suggests that increasing information without considering the task relevance and the presentation can impair performance. **Method**We used a simulated C2 task across two experiments. Experiment 1 varied the information volume provided to individual participants and measured the speed and accuracy of

decision making for task performance. Experiment 2 varied information volume and information reliability provided to two participants acting in different roles and assessed decision-making performance, SA, and trust between the paired participants. Results In both experiments, increased task-relevant information volume did not improve task performance. In Experiment 2, increased task-relevant information volume reduced self-reported SA and trust, and incorrect source reliability information led to poorer task performance and SA. Conclusion These results indicate that increasing the volume of information, even when it is accurate and task relevant, is not necessarily beneficial to decision-making performance. Moreover, it may even be detrimental to SA and trust among team members. Application Given the high volume of available and shared information and the safety-critical and time-sensitive nature of many decisions, these results have implications for training and system design in C2 domains. To avoid decrements to SA, interpersonal trust, and decision-making performance, information presentation within C2 systems must reflect human cognitive processing limits and capabilities.

Wickens, Christopher Dow, Gutzwiller, Robert S., Vieane, Alex, Clegg, Benjamin A., Sebok, Angelia, Janes, Jess. *Time Sharing Between Robotics and Process Control: Validating a Model of Attention Switching*. pp. 322-343.

Objective The aim of this study was to validate the strategic task overload management (STOM) model that predicts task switching when concurrence is impossible. Background The STOM model predicts that in overload, tasks will be switched to, to the extent that they are attractive on task attributes of high priority, interest, and salience and low difficulty. But more-difficult tasks are less likely to be switched away from once they are being performed. Method In Experiment 1, participants performed four tasks of the Multi-Attribute Task Battery and provided task-switching data to inform the role of difficulty and priority. In Experiment 2, participants concurrently performed an environmental control task and a robotic arm simulation. Workload was varied by automation of arm movement and both the phases of environmental control and existence of decision support for fault management. Attention to the two tasks was measured using a head tracker. Results Experiment 1 revealed the lack of influence of task priority and confirmed the differing roles of task difficulty. In Experiment 2, the percentage attention allocation across the eight conditions was predicted by the STOM model when participants rated the four attributes. Model predictions were compared against empirical data and accounted for over 95% of variance in task allocation. More-difficult tasks were performed longer than easier tasks. Task priority does not influence allocation. Conclusions The multiattribute decision model provided a good fit to the data. Applications The STOM model is useful for predicting cognitive tunneling given that human-in-the-loop simulation is time-consuming and expensive.

Hinckfuss, Kelly, Sanderson, Penelope, Loeb, Robert G., Liley, Helen G., Liu, David. *Novel Pulse Oximetry Sonifications for Neonatal Oxygen Saturation Monitoring: A Laboratory Study*. pp. 344-359.

Objective We aimed to test whether the use of novel pulse oximetry sounds (sonifications) better informs listeners when a neonates oxygen saturation (SpO₂) deviates from the recommended range. Background Variable-pitch pulse oximeters do not accurately inform clinicians via sound alone when SpO₂ is outside the target range of 90% to 95% for neonates on supplemental oxygen. Risk of blindness, organ damage, and death increase if SpO₂ remains outside the target range. A more informative sonification may improve clinicians ability to maintain the target range. Method In two desktop experiments, nonclinicians ability to detect SpO₂ range and direction of change was tested with novel versus conventional sonifications of simulated patient data. In Experiment 1, a "shoulder" sonification used larger pitch differences between adjacent

saturation percentages for SpO2 values outside the target range. In Experiment 2, a "beacon" sonification used equal-appearing pitch differences, but when SpO2 was outside the target range, a fixed-pitch reference tone from the center of the target SpO2 range preceded every fourth pulse tone. ResultsThe beacon sonification improved range identification accuracy over the control display (85% vs. 60%; $p < .001$), but the shoulder sonification did not (55% vs. 52%). ConclusionThe beacon provided a distinct auditory alert and reference that significantly improved nonclinical participants ability to identify SpO2 range. ApplicationAdding a beacon to the variable-pitch pulse oximeter sound may help clinicians identify when, and by how much, a neonates SpO2 deviates from the target range, particularly during patient transport situations when auditory information becomes essential.

Schmidlin, Elizabeth A., Jones, Keith S. Do Tele-Operators Learn to Better Judge Whether a Robot Can Pass Through an Aperture? pp. 360-369.

ObjectiveThis experiment examined whether tele-operators learn to better judge a robots ability to pass through an aperture, hereafter referred to as pass-ability judgments, and detailed the nature of such learning. BackgroundJones, Johnson, and Schmidlin reported that tele-operators pass-ability judgments did not improve over the course of their experiment, which was surprising. MethodIn each of seven blocks, tele-operators made pass-ability judgments about 10 apertures whose width varied. During each trial, participants drove the robot toward the aperture, answered yes or no to whether it could pass through that aperture, and then attempted to drive the robot through the aperture. Pass-ability judgments were analyzed in terms of percentage correct and absolute thresholds; the latter mimicked how Jones et al. analyzed their data. ResultsLearning was revealed when judgments were analyzed in terms of percentage correct and not when analyzed in terms of absolute thresholds. Further analyses revealed that tele-operators only improved their pass-ability judgments for impassable apertures, and tele-operators perceptual sensitivity and response bias changed over the course of the experiment. ConclusionThe percentage correct-based analyses revealed that tele-operators learned to make better pass-ability judgments. Jones et al.s decision to analyze their data in terms of absolute thresholds obscured learning. ApplicationThe present results suggested that researchers should employ percentage correct when studying learning in this domain, training protocols should focus on improving tele-operators abilities to judge the pass-ability of impassable apertures, and tele-operators truly learned to better discriminate passable and impassable apertures.