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AT THE FOREFRONT OF HF/E

Robert W. Proctor and Jing Chen. *The Role of Human Factors/Ergonomics in the Science of Security : Decision Making and Action Selection in Cyberspace. S. 721-727.*

Objective: The overarching goal is to convey the concept of science of security and the contributions that a scientifically based, human factors approach can make to this interdisciplinary field. **Background:** Rather than a piecemeal approach to solving cybersecurity problems as they arise, the U.S. government is mounting a systematic effort to develop an approach grounded in science. Because humans play a central role in security measures, research on security-related decisions and actions grounded in principles of human information-processing and decision-making is crucial to this interdisciplinary effort. **Method:** We describe the science of security and the role that human factors can play in it, and use two examples of research in cybersecurity—detection of phishing attacks and selection of mobile applications—to illustrate the contribution of a scientific, human factors approach. **Results:** In these research areas, we show that systematic information-processing analyses of the decisions that users make and the actions they take provide a basis for integrating the human component of security science. **Conclusion:** Human factors specialists should utilize their foundation in the science of applied information processing and decision making to contribute to the science of cybersecurity.

- **Keywords:** human information processing, information security, privacy, risk communication, risk perception

AUTOMATION, EXPERT SYSTEMS

Christopher D. Wickens, Benjamin A. Clegg, Alex Z. Vieane, and Angelia L. Sebok. *Complacency and Automation Bias in the Use of Imperfect Automation. S. 728-739.*

Objective We examine the effects of two different kinds of decision-aiding automation errors on human-automation interaction (HAI), occurring at the first failure following repeated exposure to correctly functioning automation. The two errors are incorrect

advice, triggering the automation bias, and missing advice, reflecting complacency. **Background** Contrasts between analogous automation errors in alerting systems, rather than decision aiding, have revealed that alerting false alarms are more problematic to HAI than alerting misses are. Prior research in decision aiding, although contrasting the two aiding errors (incorrect vs. missing), has confounded error expectancy. **Method** Participants performed an environmental process control simulation with and without decision aiding. For those with the aid, automation dependence was created through several trials of perfect aiding performance, and an unexpected automation error was then imposed in which automation was either gone (one group) or wrong (a second group). A control group received no automation support. **Results** The correct aid supported faster and more accurate diagnosis and lower workload. The aid failure degraded all three variables, but "automation wrong" had a much greater effect on accuracy, reflecting the automation bias, than did "automation gone," reflecting the impact of complacency. Some complacency was manifested for automation gone, by a longer latency and more modest reduction in accuracy. **Conclusions** Automation wrong, creating the automation bias, appears to be a more problematic form of automation error than automation gone, reflecting complacency. **Implications** Decision-aiding automation should indicate its lower degree of confidence in uncertain environments to avoid the automation bias.

- **Keywords:** automation, complacency, automation bias, process control, first failure

Stephanie M. Merritt, Jennifer L. Unnerstall, Deborah Lee, and Kelli Huber. *Measuring Individual Differences in the Perfect Automation Schema*. S. 740-753.

Objective A self-report measure of the perfect automation schema (PAS) is developed and tested. **Background** Researchers have hypothesized that the extent to which users possess a PAS is associated with greater decreases in trust after users encounter automation errors. However, no measure of the PAS currently exists. We developed a self-report measure assessing two proposed PAS factors: high expectations and all-or-none thinking about automation performance. **Method** In two studies, participants responded to our PAS measure, interacted with imperfect automated aids, and reported trust. **Results** Each of the two PAS measure factors demonstrated fit to the hypothesized factor structure and convergent and discriminant validity when compared with propensity to trust machines and trust in a specific aid. However, the high expectations and all-or-none thinking scales showed low intercorrelations and differential relationships with outcomes, suggesting that they might best be considered two separate constructs rather than two subfactors of the PAS. All-or-none thinking had significant associations with decreases in trust following aid errors, whereas high expectations did not. Results therefore suggest that the all-or-none thinking scale may best represent the PAS construct. **Conclusion** Our PAS measure (specifically, the all-or-none thinking scale) significantly predicted the severe trust decreases thought to be associated with high PAS. Further, it demonstrated acceptable psychometric properties across two samples. **Application** This measure may be used in future work to assess levels of PAS in users of automated systems in either research or applied settings.

- **Keywords:** trust, automation,, perfect automation schema, high expectations, all-or-none thinking, propensity to trust machines

COGNITION

Sabrina R. Cohen-Hatton, Philip C. Butler, and Robert C. Honey. *An Investigation of Operational Decision Making in Situ: Incident Command in the U.K. Fire and Rescue Service*. S. 793-804.

Objective The aim of this study was to better understand the nature of decision making at operational incidents in order to inform operational guidance and training. **Background** Normative models of decision making have been adopted in the guidance and training for emergency services. In these models, it is assumed that decision makers assess the current situation, formulate plans, and then execute the plans. However, our understanding of how decision making unfolds at operational incidents remains limited. **Method** Incident commanders, attending 33 incidents across six U.K. Fire and Rescue Services, were fitted with helmet-mounted cameras, and the resulting video footage was later independently coded and used to prompt participants to provide a running commentary concerning their decisions. **Results** The analysis revealed that assessment of the operational situation was most often followed by plan execution rather than plan formulation, and there was little evidence of prospection about the potential consequences of actions. This pattern of results was consistent across different types of incident, characterized by level of risk and time pressure, but was affected by the operational experience of the participants. **Conclusion** Decision making did not follow the sequence of phases assumed by normative models and conveyed in current operational guidance but instead was influenced by both reflective and reflexive processes. **Application** These results have clear implications for understanding operational decision making as it occurs in situ and suggest a need for future guidance and training to acknowledge the role of reflexive processes.

- **Keywords:** dynamic decision making, emergency services, operational models

HEALTH CARE/HEALTH SYSTEMS

Maryam Zahabi, David B. Kaber, and Manida Swangnetr. *Usability and Safety in Electronic Medical Records Interface Design : A Review of Recent Literature and Guideline Formulation. S. 805-834.*

Objective The objectives of this study were to (a) review electronic medical record (EMR) and related electronic health record (EHR) interface usability issues, (b) review how EMRs have been evaluated with safety analysis techniques along with any hazard recognition, and (c) formulate design guidelines and a concept for enhanced EMR interfaces with a focus on diagnosis and documentation processes. **Background** A major impact of information technology in health care has been the introduction of EMRs. Although numerous studies indicate use of EMRs to increase health care quality, there remain concerns with usability issues and safety. **Method** A literature search was conducted using Compendex, PubMed, CINAHL, and Web of Science databases to find EMR research published since 2000. Inclusion criteria included relevant English-language papers with subsets of keywords and any studies (manually) identified with a focus on EMR usability. **Results** Fifty studies met the inclusion criteria. Results revealed EMR and EHR usability problems to include violations of natural dialog, control consistency, effective use of language, effective information presentation, and customization principles as well as a lack of error prevention, minimization of cognitive load, and feedback. Studies focusing on EMR system safety made no objective assessments and applied only inductive reasoning methods for hazard recognition. **Conclusion** On the basis of the identified usability problems and structure of safety analysis techniques, we provide EMR design guidelines and a design concept focused on the diagnosis process and documentation. **Application** The design guidelines and new interface concept can be used for prototyping and testing enhanced EMRs.

- **Keywords:** electronic medical records, electronic health records, interface design, usability, systems safety, literature review

MACROERGONOMICS AND THE ENVIRONMENT

Nita Lewis Shattuck, Panagiotis Matsangas, Elke Eriksen, and Spiros Kulubis. *Comparison of Two Watch Schedules for Personnel at the White House Military Office President's Emergency Operations Center.* S. 864-878.

Objective The aim of this study was to assess effectiveness of an alternative, 24-hr-on/72-hr-off watchstanding schedule on sleep and morale of personnel assigned to the President's Emergency Operations Center (PEOC). **Background** As part of the White House Military Office, PEOC personnel historically worked a 12-hr "Panama" watch schedule. Personnel reported experiencing chronic insufficient and disrupted sleep patterns and sought advice for improving their watchstanding schedule. **Method** Participants ($N = 14$ active-duty military members, ages 29 to 42 years) completed the Profile of Mood State (POMS) three times: before, during, and after switching to the alternative schedule with 5-hr sleep periods built into their workday. Participants completed a poststudy questionnaire to assess individual schedule preferences. Sleep was measured actigraphically, supplemented by activity logs. **Results** As indicated by POMS scores, mood improved significantly on the new schedule. Although average total sleep amount did not change substantively, the timing of sleep was more consistent on the new schedule, resulting in better sleep hygiene. PEOC personnel overwhelmingly preferred the new schedule, reporting not only that they felt more rested but that the new schedule was more conducive to the demands of family life. **Conclusions** Demands of family life and time spent commuting were found to be critical factors for acceptance of the alternative schedule. This new schedule will be most effective if personnel adhere to the scheduled rest periods assigned during their 24-hr duty. **Application** A successful schedule should avoid conflicts between social life and operational demands. Results may lead to changes in the work schedules of other departments with similar 24/7 responsibilities.

- **Keywords:** shiftwork, sleep deprivation, fatigue, continuous operations, Profile of Mood State

SENSORY AND PERCEPTUAL PROCESSES

Numa Babilio, Antoine H. P. Morice, Geoffrey Marti, and Gilles Montagne. *High- and Low-Order Overtaking-Ability Affordances: Drivers Rely on the Maximum Velocity and Acceleration of Their Cars to Perform Overtaking Maneuvers.* S. 879-894.

Objective: The aim of this study was to answer the question, Do drivers take into account the action boundaries of their car when overtaking? **Background:** The Morice et al. affordance-based approach to visually guided overtaking suggests that the "overtake-ability" affordance can be formalized as the ratio of the "minimum satisfying velocity" (MSV) of the maneuver to the maximum velocity (V_{max}) of the driven car. In this definition, however, the maximum acceleration (A_{max}) of the vehicle is ignored. We hypothesize that drivers may be sensitive to an affordance redefined with the ratio of the "minimum satisfying acceleration" (MSA) to the A_{max} of the car. **Method:** Two groups of nine drivers drove cars differing in their A_{max} . They were instructed to attempt overtaking maneuvers in 25 situations resulting from the combination of five MSA and five MSV values. **Results:** When overtaking frequency was expressed as a function of MSV and MSA, maneuvers were found to be initiated differently for the two groups. However, when expressed as a function of MSV/V_{max} and MSA/A_{max} , overtaking frequency was quite similar for both groups. Finally, a multiple regression coefficient analysis demonstrated that overtaking decisions are fully explained by a composite variable comprising MSA/A_{max} and the time required to reach MSV. **Conclusion:** Drivers reliably decide whether overtaking is safe (or not) by using low- and high-order variables taking into account their car's maximum velocity and acceleration, respectively, as predicted by

“affordance-based control” theory. **Application:** Potential applications include the design of overtaking assistance, which should exploit the MSA/A_{max} variables in order to suggest perceptually relevant overtaking solutions.

- **Keywords:** driving, overtaking, affordance, acceleration, virtual reality

SIMULATION AND VIRTUAL REALITY

Frank M. F. Verberne, Jaap Ham, and Cees J. H. Midden. *Trusting a Virtual Driver That Looks, Acts, and Thinks Like You*. S. 895-909.

Objective: We examined whether participants would trust an agent that was similar to them more than an agent that was dissimilar to them. **Background:** Trust is an important psychological factor determining the acceptance of smart systems. Because smart systems tend to be treated like humans, and similarity has been shown to increase trust in humans, we expected that similarity would increase trust in a virtual agent. **Methods:** In a driving simulator experiment, participants ($N = 111$) were presented with a virtual agent that was either similar to them or not. This agent functioned as their virtual driver in a driving simulator, and trust in this agent was measured. Furthermore, we measured how trust changed with experience. **Results:** Prior to experiencing the agent, the similar agent was trusted more than the dissimilar agent. This effect was mediated by perceived similarity. After experiencing the agent, the similar agent was still trusted more than the dissimilar agent. **Conclusion:** Just as similarity between humans increases trust in another human, similarity also increases trust in a virtual agent. When such an agent is presented as a virtual driver in a self-driving car, it could possibly enhance the trust people have in such a car. **Application:** Displaying a virtual driver that is similar to the human driver might increase trust in a self-driving car.

- **Keywords:** virtual agent, similarity, facial similarity, mimicry, shared goals, trust, liking, perceived similarity