

## Human Factors – rok 2020, roč. 62

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#### RAPID REVIEWS: COVID-19

**Jack T. Dennerlein, Lisa Burke, Erika L. Sabbath, Jessica A. R. Williams, Susan E. Peters, Lorraine Wallace, Melissa Karapanos, Glorian Sorensen.**  
[\*An Integrative Total Worker Health Framework for Keeping Workers Safe and Healthy During the COVID-19 Pandemic.\*](#) pp. 689–696.

**Objective:** The aim was to recommend an integrated Total Worker Health (TWH) approach which embraces core human factors and ergonomic principles, supporting worker safety, health, and well-being during the COVID-19 pandemic. **Background:** COVID-19 has resulted in unprecedented challenges to workplace safety and health for workers and managers in essential businesses, including healthcare workers, grocery stores, delivery services, warehouses, and distribution centers. Essential workers need protection, accurate information, and a supportive work environment with an unwavering focus on effective infection control. **Method:** The investigators reviewed emerging workplace recommendations for reducing workers' exposures to the novel coronavirus and the challenges to workers in protecting their health. Using a theoretical framework and guidelines for integrating safety and health management systems into an organization for TWH, the investigators adapted the framework's key characteristics to meet the specific worker safety and health issues for effective infection control, providing supports for increasing psychological demands while ensuring a safe work environment. **Results:** The recommended approach includes six key characteristics: focusing on working conditions for infection control and supportive environments for increased psychological demands; utilizing participatory approaches involving workers in identifying daily challenges and unique solutions; employing comprehensive and collaborative efforts to increase system efficiencies; committing as leaders to supporting workers through action and communications; adhering to ethical and legal standards; and using data to guide actions and evaluate progress. **Conclusion:** Applying an integrative TWH approach for worker safety, health, and well-being provides a framework to help managers systematically organize and protect themselves, essential workers, and the public during the COVID-19 pandemic. **Application:** By using the systems approach provided by the six implementation characteristics, employers of essential workers can organize their own

efforts to improve system performance and worker well-being during these unprecedented times.

- **Keywords:** human factors and ergonomics, safety management systems, coronavirus, Total Worker Health

**P. A. Hancock. *Specifying and Mitigating Thermal Stress Effects on Cognition During Personal Protective Equipment Use.* pp. 697–703.**

**Objective:** To report present understanding concerning selected task and environmental factors influencing the changing performance capacity associated with use of personal protective equipment (PPE). **Background:** Much knowledge is available concerning change in complex cognitive capacities under the effects of thermal stress. Our science can inform critical care facilities as to remediation strategies such as work–rest schedules to minimize performance error in highly cognitively demanding circumstances such as intensive care units. **Method:** The present exposition draws from the state-of-the-art understanding concerning thermal stress effects on cognition and workload in complex and demanding tasks. **Results:** The summation and synthesis of HF/E findings provides important insights into combinatorial effects of forms of stress, typically dealt with only as discrete sources in traditional standards and regulations. The identified interaction between ascending thermal stress and cognitive task demand provides an instance of the plurality of ways HF/E can specify performance limitations in safety-critical circumstances, as witnessed in the current pandemic. **Conclusion:** Accumulated HF/E insights provide systematic ways in which to address and ameliorate the combined forces of physical and cognitive stress on medical personnel constrained to use varying forms of PPE. These principles extend beyond this specific domain to all who are required to work in differential and isolated microclimates. **Application:** To minimize the possibility of critical and life-threatening error in intensive care facilities which necessitate PPE use, we need principled work–rest ratio and heat stress mitigation guidance. To promote health, we need to champion healthy work practices in our health workers. HF/E insights can help achieve this important goal.

- **Keywords:** thermal stress, cognitive workload, work–rest ratio, physiological recovery, cognitive resilience, personal protective equipment

## AGING

**Dawn M. Sarno, Joanna E. Lewis, Corey J. Bohil, Mark B. Neider. *Which Phish Is on the Hook? Phishing Vulnerability for Older Versus Younger Adults.* pp. 704–717.**

**Objective:** To determine if there are age-related differences in phishing vulnerability and if those differences exist under various task conditions (e.g., framing and time pressure). **Background:** Previous research suggests that older adults may be a vulnerable population to phishing attacks. Most research exploring age differences has used limiting designs, including retrospective self-report measures and restricted email sets. **Method:** The present studies explored how older and younger adults classify a diverse sample of 100 legitimate and phishing emails. In Experiment 1, participants rated the emails as either spam or not spam. Experiment 2 explored how framing would alter the results when participants rated emails as safe or not safe. In Experiment 3, participants performed the same task as Experiment 1, but were put under time pressure. **Results:** No age differences were observed in overall classification accuracy across the three experiments, rather all participants exhibited poor performance (20%–30% errors). Older adults took significantly longer to make classifications and were more liberal in classifying emails as spam or not safe. Time pressure seemed to remove this bias but did

not influence overall accuracy. **Conclusion:** Older adults appear to be more cautious when classifying emails. However, being extra careful may come at the cost of classification speed and does not seem to improve accuracy. **Application:** Age demographics should be considered in the implementation of a cyber-training methodology. Younger adults may be less vigilant against cyber threats than initially predicted; older adults might be less prone to deception when given unlimited time to respond.

- **Keywords:** signal-detection theory, cybersecurity, decision making, designing for the elderly, age

## **AUTOMATION, EXPERT SYSTEMS**

**Johannes Kraus, David Scholz, Dina Stiegemeier, Martin Baumann. *The More You Know: Trust Dynamics and Calibration in Highly Automated Driving and the Effects of Take-Overs, System Malfunction, and System Transparency.* pp. 718–736.**

**Objective:** This paper presents a theoretical model and two simulator studies on the psychological processes during early trust calibration in automated vehicles. **Background:** The positive outcomes of automation can only reach their full potential if a calibrated level of trust is achieved. In this process, information on system capabilities and limitations plays a crucial role. **Method:** In two simulator experiments, trust was repeatedly measured during an automated drive. In Study 1, all participants in a two-group experiment experienced a system-initiated take-over, and the occurrence of a system malfunction was manipulated. In Study 2 in a 2 × 2 between-subject design, system transparency was manipulated as an additional factor. **Results:** Trust was found to increase during the first interactions progressively. In Study 1, take-overs led to a temporary decrease in trust, as did malfunctions in both studies. Interestingly, trust was reestablished in the course of interaction for take-overs and malfunctions. In Study 2, the high transparency condition did not show a temporary decline in trust after a malfunction. **Conclusion:** Trust is calibrated along provided information prior to and during the initial drive with an automated vehicle. The experience of take-overs and malfunctions leads to a temporary decline in trust that was recovered in the course of error-free interaction. The temporary decrease can be prevented by providing transparent information prior to system interaction. **Application:** Transparency, also about potential limitations of the system, plays an important role in this process and should be considered in the design of tutorials and human-machine interaction (HMI) concepts of automated vehicles.

## **AVIATION AND AEROSPACE**

**Lana Kinney, David O'Hare. *Responding to an Unexpected In-Flight Event: Physiological Arousal, Information Processing, and Performance.* pp. 737–750.**

**Objective:** The study was designed to investigate whether a simulated unexpected abnormal flight event can lead to startle and explore differences in behavioral responses between expected and unexpected abnormal flight events. **Background:** Recent research suggests startle (an autonomic response to an acute stimulus) following unexpected abnormal flight events can impact pilot performance and can increase the probability of a negative outcome following the event. **Method:** Information processing,

physiological measures, and performance differences between responses to expected and unexpected flight events were compared. General aviation (GA) pilots flew a series of flights in a fixed-base flight simulator including two experimental flights which included an unexpected and an expected, engine failure. During the flights, heart rate, eye tracking, and flight data were recorded. **Results:** During the unexpected engine failure, pilots showed greater increases in heart rate and pupil dilation. Significant differences in scanning were evident with fewer areas scanned following the unexpected event. During the unexpected engine failure, performance was impaired when compared to the expected events. However, poor performance was not associated with higher levels of arousal. **Conclusion:** The study provides an empirical demonstration of impaired pilot response to unexpected events with associated symptoms consistent with the induction of startle. The present research builds on Landman et al.'s conceptual model of startle and surprise. **Application:** Standardized training protocols may not adequately prepare pilots to deal with the unexpected effects of startle in real-world encounters. Introducing greater variety into training events may be useful. The effects of startle in disrupting well-trained responses may also occur in areas other than aviation where critical events may occur unexpectedly or present in an unfamiliar manner.

- **Keywords:** pilot, crew behavior, aviation and aerospace, attentional processes, cognition, eye movements, tracking, motor behavior, skilled performance, stress, physiological and psychological conditions, simulation and training

## COGNITION

**Emma C. Falkland, Mark W. Wiggins, Johanna I. Westbrook. *Cue Utilization Differentiates Performance in the Management of Interruptions*. pp. 751–769.**

**Objective:** To examine the role of cue utilization in the management of interruptions during a high workload, rail control simulation. **Background:** High-risk, high-consequence environments are characterized by cognitively demanding, time-critical activities, in which operators are required to manage frequent interruptions under conditions of high workload. Interruptions are deleterious to performance as they impose excessive cognitive demand on limited working memory resources, thereby depleting residual resources for the primary task. Cue utilization may enable superior performance in managing interruptions through efficiencies gained by the application of implicit patterns stored in long-term memory. **Method:** Two experiments were conducted. In Experiment 1, 46 university students undertook an assessment of cue utilization and subsequently engaged in a high workload, simulated rail control task while managing multiple interruptive tasks. Experiment 2 replicated and extended Experiment 1, wherein 52 university students completed a measure of cue utilization and engaged in a high workload, simulated rail control task while managing multiple interruptions and breaks. **Results:** The analyses revealed that participants who demonstrated a greater capacity for cue utilization also demonstrated a reduced loss of performance following interruptions. **Conclusion:** The outcomes suggest a relationship between a greater capacity for cue utilization and superior performance in the management of interruptions in high workload conditions. **Application:** Assessments of cue utilization may assist in the selection and training of operators in high-consequence, high-risk environments, to ensure efficient and accurate performance during the management of interruptions.

- **Keywords:** cue utilization, distractions, mental workload, task switching, dual tasks, decision making

## CONSUMER PRODUCTS, TOOLS

**Songil Lee, Gyouhyung Kyung, Minjoong Kim, Donghee Choi, Hyeun Choi, Kitae Hwang, Seonghyeok Park, Su Young Kim, Seungbae Lee. *Shaping Rollable Display Devices: Effects of Gripping Condition, Device Thickness, and Hand Length on Bimanual Perceived Grip Comfort*. pp. 770–786.**

**Objective:** To examine the effects of the gripping condition, device thickness, and hand length on bimanual perceived grip comfort associated with unrolling hand-held rollable screens. **Background:** Rollable displays can be rolled and unrolled to change screen size. Although diverse rollable display device concepts have been suggested, little is known regarding ergonomic forms for comfortable screen unrolling. **Method:** Thirty young individuals (10 in each hand-length group) evaluated three rollable display device prototypes in three gripping conditions (no restriction on using side bezels, minimal use of side bezels, and restriction on the gripping type). Prototypes differed in their right-side thickness (2, 6, and 10 mm). Side bezel regions grasped during screen unrolling and corresponding bimanual grip comfort ratings were obtained. **Results:** To improve perceived grip comfort and accommodate user-preferred gripping methods, rollable display devices should be 6 mm (preferably 10 mm) thick (vs. 2 mm) and have at least 20-mm-wide side bezels. Relative to device thickness, gripping conditions were more influential on grip comfort ratings. The “no restriction” condition improved grip comfort ratings and strengthened bimanual coupling in terms of grip comfort ratings. **Conclusion:** Contrary to current smartphone trends toward thinner and bezel-less designs, hand-held rollable display devices should be sufficiently thick and have sufficiently wide side bezels for screen unrolling. **Application:** Hand-held rollable display devices should be 6- or preferably 10-mm thick (vs. 2 mm) and have at least 20-mm-wide side bezels to ensure higher perceived grip comfort during bilateral screen unrolling.

- **Keywords:** rollable screen, bimanual coupling, gripping comfort, bilateral pulling, screen unrolling

## MOTOR BEHAVIOR

**James Head, Matthew S. Tenan, Andrew J. Tweedell, Kyle M. Wilson, William S. Helton. *Response Complexity Reduces Errors on a Response Inhibition Task*. pp. 787–799.**

**Objective:** The purpose of this investigation was to elucidate the role of button-response complexity to targets in a response inhibition task. **Background:** Response inhibition is the ability to correctly inhibit an overt response to a target. The U.S. military is actively pursuing development of armed, combat robots as a force multiplier, which may present challenges to operators of combat robots in the form of response inhibition errors. **Method:** A total of 15 participants completed two 51-min versions of a modified sustained attention to response task (SART). Participants were outfitted with an electrocardiogram to index heart-rate variability and completed the NASA-Task Load Index (NASA-TLX) to index workload. **Results:** The results demonstrated that the complex SART reduced errors of commission (4%) and slowed response times (874 ms) to correct Go targets relative to the simple SART (14%, 739 ms). The NASA-TLX did not show differences between the modified SARTs; however, heart-rate variability did demonstrate that Soldiers had an increased autonomic stress response to the complex SART. **Conclusion:** Increasing the behavioral response requirement during a response inhibition task can decrease errors of commission; however, it comes at the cost of slower response times to target stimuli. Heart-rate variability may provide better insight

into objective workload relative to subjective measures. **Application:** The use of complex behavioral responses may provide a viable option to reduce potential “friendly fire” or collateral damage by Soldiers remotely engaging a target-rich environment.

- **Keywords:** response inhibition, motor control

## NEUROERGONOMICS

**Guoying Lu, Guanhua Hou. *Effects of Semantic Congruence on Sign Identification: An ERP Study.* pp. 800–811.**

**Objective:** The purpose of this study was to investigate the effects of semantic congruence and incongruence on sign identification by using event-related potentials (ERPs). **Background:** Sign systems have crucial roles in public spaces and traffic facilities. Poorly designed signs can easily confuse pedestrians and drivers and reduce the efficiency of public activities and urban administration. **Method:** Thirty-one participants completed a sign identification experiment independently in a laboratory setting. Experimental materials were selected from GB/T 10001, a Chinese national recommendation standard that is officially named Public Information Graphical Symbols for Use on Signs. All ERP data were processed using MATLAB 13b, and behavioral data were analyzed using Stata 14. **Results:** N170, P200, N300, and N400 components were induced during semantic processing. Statistical analysis revealed that semantic congruence has a main effect on N300 in the frontal region and has a main effect on N400 at FZ in the frontal region, CPZ in the parietal-central region, and PZ in the parietal region. Amplitudes of N300 induced by picture–word matching were considerably different between the two experimental conditions at electrodes FZ and FCZ. Amplitudes of N400 were significantly larger in the incongruent condition than in the congruent condition. **Conclusion:** The study demonstrated that N300 and N400 are promising indicators for measuring semantic congruence in future sign design. **Application:** Our findings provide ERP indicators for measuring the semantic congruence of sign design, which can be easily applied to improve the efficiency of sign design and sign comprehension.

- **Keywords:** neurodesign, neuroergonomics, sign identification, ERPs, semantic cognition

## SENSORY AND PERCEPTUAL PROCESSES

**Brittney Hartle, Aishwarya Sudhama, Lesley M. Deas, Robert S. Allison, Elizabeth L. Irving, Mackenzie G. Glaholt, Laurie M. Wilcox. *Contributions of Stereopsis and Aviation Experience to Simulated Rotary Wing Altitude Estimation.* pp. 812–824.**

**Objective:** We examined the contribution of binocular vision and experience to performance on a simulated helicopter flight task. **Background:** Although there is a long history of research on the role of binocular vision and stereopsis in aviation, there is no consensus on its operational relevance. This work addresses this using a naturalistic task in a virtual environment. **Method:** Four high-resolution stereoscopic terrain types were viewed monocularly and binocularly. In separate experiments, we evaluated performance of undergraduate students and military aircrew on a simulated low hover altitude judgment task. Observers were asked to judge the distance between a virtual helicopter skid and the ground plane. **Results:** Our results show that for both groups, altitude

judgments are more accurate in the binocular viewing condition than in the monocular condition. However, in the monocular condition, aircrew were more accurate than undergraduate observers in estimating height of the skid above the ground. **Conclusion:** At simulated altitudes of 5 ft (1.5 m) or less, binocular vision provides a significant advantage for estimation of the depth separation between the landing skid and the ground, regardless of relevant operational experience. However, when binocular cues are unavailable aircrew outperform undergraduate observers, a result that likely reflects the impact of training on the ability to interpret monocular depth cues.

- **Keywords:** stereopsis, altitude, binocular vision, magnitude estimation, aircrew

## TEAMS AND GROUPS

**Jamie C. Gorman, David A. Grimm, Ronald H. Stevens, Trysha Galloway, Ann M. Willemsen-Dunlap, Donald J. Halpin. *Measuring Real-Time Team Cognition During Team Training*. pp. 825–860.**

**Objective:** A method for detecting real-time changes in team cognition in the form of significant communication reorganizations is described. We demonstrate the method in the context of scenario-based simulation training. **Background:** We present the dynamical view that individual- and team-level aspects of team cognition are temporally intertwined in a team's real-time response to challenging events. We suggest that this real-time response represents a fundamental team cognitive skill regarding the rapidity and appropriateness of the response, and methods and metrics are needed to track this skill. **Method:** Communication data from medical teams (Study 1) and submarine crews (Study 2) were analyzed for significant communication reorganization in response to training events. Mutual information between team members informed post hoc filtering to identify which team members contributed to reorganization. **Results:** Significant communication reorganizations corresponding to challenging training events were detected for all teams. Less experienced teams tended to show delayed and sometimes ineffective responses that more experienced teams did not. Mutual information and post hoc filtering identified the individual-level inputs driving reorganization and potential mechanisms (e.g., leadership emergence, role restructuring) underlying reorganization. **Conclusion:** The ability of teams to rapidly and effectively reorganize coordination patterns as the situation demands is a team cognitive skill that can be measured and tracked. **Application:** Potential applications include team monitoring and assessment that would allow for visualization of a team's real-time response and provide individualized feedback based on team member's contributions to the team response.

- **Keywords:** communication analysis, dynamical systems, real-time analysis, simulation training, team cognition