

## Human Factors – rok 2018, roč. 60

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#### REPLICATIONS

**Grégoire S. Larue, Christian Wullems, Michelle Sheldrake, Andry Rakotonirainy. *Validation of a Driving Simulator Study on Driver Behavior at Passive Rail Level Crossings*. pp. 743–754.**

**Objective:** The behavioral validation of an advanced driving simulator for its use in evaluating passive level crossing countermeasures was performed for stopping compliance and speed profile. **Background:** Despite the fact that most research on emerging interventions for improving level crossing safety is conducted in a driving simulator, no study has validated the use of a simulator for this type of research. **Method:** We monitored driver behavior at a selected passive level crossing in the Brisbane region in Australia for 3 months ( $N = 916$ ). The level crossing was then replicated in an advanced driving simulator, and we familiarized participant drivers ( $N = 54$ ) with traversing this crossing, characterized by low road and rail traffic. **Results:** We established relative validity for the stopping compliance and the approach speed. **Conclusion:** This validation study suggests that driving simulators are an appropriate tool to study the effects of interventions at passive level crossing with low road and rail traffic, which are prone to reduced compliance due to familiarity. **Application:** This study also provides support for the findings of previous driving simulator studies conducted to evaluate compliance and approach speeds of passive level crossings.

- **Keywords:** driving simulation, validation, railway crossing, on-road study

#### AT THE FOREFRONT OF HF/E

**Kim-Phuong L. Vu, Joel Lachter, Vernol Battiste, Thomas Z. Strybel. [\*Single Pilot Operations in Domestic Commercial Aviation\*](#). pp. 755–762.**

**Objective:** To provide an overview of concepts of operation for single pilot operations (SPO) and a synthesis of recently published work evaluating these concepts. **Background:** Advances in technology have made it possible for a commercial aircraft to be flown by a single pilot under normal conditions, and research is being conducted to examine the feasibility of implementing SPO for commercial aviation. **Method:** Context leading up to the consideration of SPO for commercial flight is provided, including the

benefits and challenges. Recent studies examining issues relating to automation, operations, and communications in the SPO context are presented. **Results:** A number of concepts have been proposed and tested for SPO, and no one concept has been shown to be superior. Single pilots were able to successfully resolve off-nominal scenarios with either the ground-support or cockpit-automation tools examined. However, the technologies developed in support of these concepts are in prototype forms and need further development. **Conclusion:** There have been no obvious “show stoppers” for moving toward SPO. However, the current state of research is in its initial stages, and more research is needed to examine other challenges associated with SPO. Moreover, human factors researchers must continue to be involved in the development of the new tools and technologies to support SPO to ensure their effectiveness. **Application:** The research issues highlighted in the context of SPO reflect issues that are associated with the process of reducing crew members or providing remote support of operators and, more generally, human interactions with increasingly autonomous systems.

- **Keywords:** aviation, single pilot operations, reduced crew operations, human-autonomy teaming

## ACCIDENTS, HUMAN ERROR

**Andrew T. Miranda.** [\*Understanding Human Error in Naval Aviation Mishaps\*](#). pp. 763–777.

**Objective:** To better understand the external factors that influence the performance and decisions of aviators involved in Naval aviation mishaps. **Background:** Mishaps in complex activities, ranging from aviation to nuclear power operations, are often the result of interactions between multiple components within an organization. The Naval aviation mishap database contains relevant information, both in quantitative statistics and qualitative reports, that permits analysis of such interactions to identify how the working atmosphere influences aviator performance and judgment. **Method:** Results from 95 severe Naval aviation mishaps that occurred from 2011 through 2016 were analyzed using Bayes’ theorem probability formula. Then a content analysis was performed on a subset of relevant mishap reports. **Results:** Out of the 14 latent factors analyzed, the Bayes’ application identified 6 that impacted specific aspects of aviator behavior during mishaps. Technological environment, misperceptions, and mental awareness impacted basic aviation skills. The remaining 3 factors were used to inform a content analysis of the contextual information within mishap reports. Teamwork failures were the result of plan continuation aggravated by diffused responsibility. Resource limitations and risk management deficiencies impacted judgments made by squadron commanders. **Conclusion:** The application of Bayes’ theorem to historical mishap data revealed the role of latent factors within Naval aviation mishaps. Teamwork failures were seen to be considerably damaging to both aviator skill and judgment. **Application:** Both the methods and findings have direct application for organizations interested in understanding the relationships between external factors and human error. It presents real-world evidence to promote effective safety decisions.

- **Keywords:** human error, safety, aviation, HFACS

## AUTOMATION, EXPERT SYSTEMS

**Ignacio Solís-Marcos, Christer Ahlström, Katja Kircher.** *Performance of an Additional Task During Level 2 Automated Driving: An On-Road Study Comparing Drivers With and Without Experience With Partial Automation*. pp. 778–792.

**Objective:** To investigate the influence of prior experience with Level 2 automation on additional task performance during manual and Level 2 partially automated driving. **Background:** Level 2 automation is now on the market, but its effects on driver behavior remain unclear. Based on previous studies, we could expect an increase in drivers' engagement in secondary tasks during Level 2 automated driving, but it is yet unknown how drivers will integrate all the ongoing demands in such situations. **Method:** Twenty-one drivers (12 without, 9 with Level 2 automation experience) drove on a highway manually and with Level 2 automation (exemplified by Volvo Pilot Assist generation 2; PA2) while performing an additional task. In half of the conditions, the task could be interrupted (self-paced), and in the other half, it could not (system-paced). Drivers' visual attention, additional task performance, and other compensatory strategies were analyzed. **Results:** Driving with PA2 led to decreased scores in the additional task and more visual attention to the dashboard. In the self-paced condition, all drivers looked more to the task and perceived a lower mental demand. The drivers experienced with PA2 used the system and the task more than the novice group and performed more overtakings. **Conclusions:** The additional task interfered more with Level 2 automation than with manual driving. The drivers, particularly the automation novice drivers, used some compensatory strategies. **Applications:** Automation designers need to consider these potential effects in the development of future automated systems.

- **Keywords:** automated driving, additional task performance, visual attention, compensatory strategies, automation experience

## AVIATION AND AEROSPACE

**Annemarie Landman, Peter van Oorschot, M. M. (René) van Paassen, Eric L. Groen, Adelbert W. Bronkhorst, Max Mulder. *Training Pilots for Unexpected Events: A Simulator Study on the Advantage of Unpredictable and Variable Scenarios*. pp. 793–805.**

**Objective:** This study tested whether simulator-based training of pilot responses to unexpected or novel events can be improved by including unpredictability and variability in training scenarios. **Background:** Current regulations allow for highly predictable and invariable training, which may not be sufficient to prepare pilots for unexpected or novel situations in-flight. Training for surprise will become mandatory in the near future. **Method:** Using an aircraft model largely unfamiliar to the participants, one group of 10 pilots (the unpredictable and variable [U/V] group) practiced responses to controllability issues in a relatively U/V manner. A control group of another 10 pilots practiced the same failures in a highly predictable and invariable manner. After the practice, performance of all pilots was tested in a surprise scenario, in which the pilots had to apply the learned knowledge. To control for surprise habituation and familiarization with the controls, two control tests were included. **Results:** Whereas the U/V group required more time than the control group to identify failures during the practice, the results indicated superior understanding and performance in the U/V group as compared to the control group in the surprise test. There were no significant differences between the groups in surprise or performance in the control tests. **Conclusion:** Given the results, we conclude that organizing pilot training in a more U/V way improves transfer of training to unexpected situations in-flight. **Application:** The outcomes suggest that the inclusion of U/V simulator training scenarios is important when training pilots for unexpected situations.

- **Keywords:** flight simulation, mental models, surprise, startle, training

## BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

**Maria-Gabriela Garcia, Thomas Läubli, Bernard J. Martin. *Muscular and Vascular Issues Induced by Prolonged Standing With Different Work–Rest Cycles With Active or Passive Breaks.* pp. 806–821.**

**Objective:** The aim of this study was to evaluate the long-lasting motor, behavioral, physiological, and perceptual effects of prolonged standing work in three work–rest cycle conditions including passive or active rest breaks. **Background:** Muscle fatigue has been evidenced after prolonged standing work through physiological and neuromotor measures. It has been postulated that muscle fatigue induced by prolonged work could be attenuated by appropriate scheduling of work and rest periods. However, investigations in this domain remain limited. **Method:** Thirty participants simulated standing work for 5 hr with work–rest cycles of short, medium, or long standing periods including passive or active breaks. Lower-leg muscle twitch force (MTF), muscle oxygenation, lower-leg volume, postural stability, force control, and discomfort perception were quantified on 2 days. **Results:** Prolonged standing induced significant changes in all measures immediately after 5 hr of work, indicating a detrimental effect in long-lasting muscle fatigue, performance, discomfort, and vascular aspects. Differences in the measures were not significant between work cycles and/or break type. **Conclusion:** Similar physiological and motor alterations were induced by prolonged standing. The absence of difference in the effects induced by the tested work–rest cycles suggests that simply altering the work–rest cycle may not be sufficient to counteract the effects of mainly static standing work. Finally, standing for 3 hr or more shows clear detrimental effects. **Application:** Prolonged standing is likely to contribute to musculoskeletal and vascular symptoms. A limitation to less than 3 hr of mostly static standing in occupational activities could avoid alterations leading to these symptoms.

- **Keywords:** muscle twitch force, fatigue, standing, oxygenation, postural stability, performance, edema, discomfort

## **COGNITION**

**Victoria L. Claypoole, James L. Szalma. *Independent Coactors May Improve Performance and Lower Workload: Viewing Vigilance Under Social Facilitation.* pp. 822–832.**

**Objective:** The purpose of the present study was to examine the effects of an independent coactor on vigilance task performance. It was hypothesized that the presence of an independent coactor would improve performance in terms of the proportion of false alarms while also increasing perceived workload and stress. **Background:** Vigilance, or the ability to maintain attention for extended periods, is of great interest to human factors psychologists. Substantial work has focused on improving vigilance task performance, typically through motivational interventions. Of interest to vigilance researchers is the application of social facilitation as a means of enhancing vigilance. Social facilitation seeks to explain how social presence may improve performance. **Method:** A total of 100 participants completed a 24-min vigil either alone or in the presence of an independent (confederate) coactor. Participants completed measures of perceived workload and stress. **Results:** The results indicated that performance (i.e., proportion of false alarms) was improved for those who completed the vigil in the presence of an independent coactor. Interestingly, perceived workload was actually lower for those who completed the vigil in the presence of an independent coactor, although perceived stress was not affected by the manipulation. **Conclusion:** Authors of future research should extend these findings to other forms of social facilitation and examine vigilance task performance in social contexts in order to determine the utility of social presence for improving vigilance. **Application:** The use of coactors may be an avenue for organizations to consider utilizing to improve performance because of its relative cost-effectiveness and easy implementation.

- **Keywords:** coacting, social facilitation, sustained attention, human performance

## HUMAN-COMPUTER INTERACTION, COMPUTER SYSTEMS

**Pooya Rahimian, Elizabeth E. O’Neal, Shiwen Zhou, Jodie M. Plumert, Joseph K. Kearney. *Harnessing Vehicle-to-Pedestrian (V2P) Communication Technology: Sending Traffic Warnings to Texting Pedestrians.* pp. 833–843.**

**Objective:** We examined how sending mobile-device warnings to texting pedestrians when they initiate an unsafe road crossing influences their decisions and actions. **Background:** Pedestrian texting has been identified as a key risk factor in pedestrian-vehicle collisions. Advances in sensing and communications technology offer the possibility of providing pedestrians with information about traffic conditions to assist them in safely crossing traffic-filled roadways. However, it is unclear how this information can be most effectively communicated to pedestrians. **Method:** We examined how texting and nontexting pedestrians crossed roads with continuous traffic in a large-screen, immersive pedestrian simulator using a between-subjects design with three conditions: texting, warning, and control. Texting participants in the warning condition received an alarm on their cell phone when they began to cross a dangerously small gap. **Results:** The results demonstrate the detrimental influence of texting on pedestrians’ gap selection, movement timing, and gaze behavior, and show the potential of warnings to improve decision making and safety. However, the results also reveal the limits of warning texting participants once they initiate a crossing and possible overreliance on technology that may lead to reduced situation awareness. **Conclusion:** Mobile devices and short-range communication technologies offer enormous potential to assist pedestrians, but further study is needed to better understand how to provide useful information in a timely manner. **Application:** The technology for communicating traffic information to pedestrians via mobile devices is on the horizon. Research on how such information influences all aspects of pedestrian behavior is critical to developing effective solutions.

- **Keywords:** mobile devices, virtual environments, perception-action, pedestrian safety, distraction

## HUMAN-SYSTEMS INTEGRATION

**Fouaz S. Ayachi, Jean-Marc Drouet, Yvan Champoux, Catherine Guastavino. *Perceptual Thresholds for Vibration Transmitted to Road Cyclists.* pp. 844–854.**

**Objectives:** In this article, we seek to determine how sensitive road cyclists are to vertical vibration transmitted while riding a road bicycle and to propose metrics for the evaluation of dynamic comfort. **Background:** Road cyclists are exposed to random-type excitation due to road roughness. Vibration transmitted affects dynamic comfort. But how sensitive are cyclists to vibration level? What are the best metrics to measure the amount of vibration transmitted to cyclists? Previous studies used sinusoidal excitation with participants on rigid seats and measured acceleration. **Methods:** We use a psychophysical estimation of Just Noticeable Differences in Level (JNDL) for vertical vibration transmitted to cyclists on a road simulator. In Experiment 1, we estimate the JNDL for whole-body vibration using vertical excitation on both wheels simultaneously (20 male cyclists). In Experiment 2, we estimate the JNDL at two different points of contact by applying the same signal to only the hands or the buttocks (9 male cyclists). **Results:** The JNDLs are expressed in terms of acceleration and power transmitted to the cyclist. We compare the JNDLs expressed with these 2 metrics and measured at different points of contact. **Conclusion:** Using these two metrics and at all points of contact,

vibration magnitude needs to be reduced by at least 15%, for the change to be detectable by road cyclists. **Application:** A road bicycle needs to transmit at least 15% less vibration for male cyclists to detect an improvement in dynamic comfort. Dynamic bicycle comfort can be measured in terms of a new metric: power transmitted to the cyclist.

- **Keywords:** road bicycle, dynamic comfort, vibration, perceptual thresholds, JNDL, transmitted power, acceleration

## **SENSORY AND PERCEPTUAL PROCESSES**

**Wim van Winsum. *The Effects of Cognitive and Visual Workload on Peripheral Detection in the Detection Response Task*. pp. 855–869.**

**Objective:** The independent effects of cognitive and visual load on visual Detection Response Task (vDRT) reaction times were studied in a driving simulator by performing a backwards counting task and a simple driving task that required continuous focused visual attention to the forward view of the road. The study aimed to unravel the attentional processes underlying the Detection Response Task effects. **Background:** The claim of previous studies that performance degradation on the vDRT is due to a general interference instead of visual tunneling was challenged in this experiment. **Method:** vDRT stimulus eccentricity and stimulus conspicuity were applied as within-subject factors. **Results:** Increased cognitive load and visual load both resulted in increased response times (RTs) on the vDRT. *Cognitive load* increased RT but revealed no task by stimulus eccentricity interaction. However, effects of *visual load* on RT showed a strong task by stimulus eccentricity interaction under conditions of low stimulus conspicuity. Also, more experienced drivers performed better on the vDRT while driving. **Conclusion:** This was seen as evidence for a differential effect of cognitive and visual workload. The results supported the tunnel vision model for visual workload, where the sensitivity of the peripheral visual field reduced as a function of visual load. However, the results supported the general interference model for cognitive workload. **Application:** This has implications for the diagnosticity of the vDRT: The pattern of results differentiated between visual task load and cognitive task load. It also has implications for theory development and workload measurement for different types of tasks.

## **SURFACE TRANSPORTATION**

**Bernhard Wandtner, Nadja Schömig, Gerald Schmidt. *Effects of Non-Driving Related Task Modalities on Takeover Performance in Highly Automated Driving*. pp. 870–881.**

**Objective:** Aim of the study was to evaluate the impact of different non-driving related tasks (NDR tasks) on takeover performance in highly automated driving. **Background:** During highly automated driving, it is allowed to engage in NDR tasks temporarily. However, drivers must be able to take over control when reaching a system limit. There is evidence that the type of NDR task has an impact on takeover performance, but little is known about the specific task characteristics that account for performance decrements. **Method:** Thirty participants drove in a simulator using a highly automated driving system. Each participant faced five critical takeover situations. Based on assumptions of Wickens's multiple resource theory, stimulus and response modalities of a prototypical NDR task were systematically manipulated. Additionally, in one experimental group, the task was locked out simultaneously with the takeover request. **Results:** Task modalities had significant effects on several measures of takeover performance. A visual-manual texting task degraded performance the most, particularly when performed handheld. In contrast, takeover performance with an auditory-vocal task was comparable to a baseline without any task. Task lockout was associated with faster hands-on-wheel times but not altered brake response times. **Conclusion:** Results showed that NDR task modalities are

relevant factors for takeover performance. An NDR task lockout was highly accepted by the drivers and showed moderate benefits for the first takeover reaction. **Application:** Knowledge about the impact of NDR task characteristics is an enabler for adaptive takeover concepts. In addition, it might help regulators to make decisions on allowed NDR tasks during automated driving.

- **Keywords:** vehicle automation, autonomous driving, multiple resource models, distraction, driver behavior, human-automation interaction