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ACCIDENTS, HUMAN ERROR

Karl E. Bridges, Paul M. Corballis, Erik Hollnagel. "Failure-to-Identify" Hunting Incidents: A Resilience Engineering Approach. pp. 141–159.

Objective: The objective was to develop an understanding, using the Functional Resonance Analysis Method (FRAM), of the factors that could cause a deer hunter to misidentify their intended target. **Background:** Hunting is a popular activity in many communities. However, hunters vary considerably based on training, experience, and expertise. Surprisingly, safety in hunting has not received much attention, especially failure-to-identify hunting incidents. These are incidents in which the hunter, after spotting and targeting their quarry, discharge their firearm only to discover they have been spotting and targeting another human, an inanimate object, or flora by mistake. The hunter must consider environment, target, time of day, weather, and many other factors—continuously evaluating whether the hunt should continue. To understand how these factors can relate to one another is fundamental to begin to understand how incidents happen. **Method:** Workshops with highly experienced and active hunters led to the development of a FRAM model detailing the functions of a "Hunting FRAM." The model was evaluated for correctness based on confidential and anonymous near-miss event submissions by hunters. **Results:** A FRAM model presenting the functions of a hunt was produced, evaluated, and accepted. Using the model, potential sources of incidents or other unintended outcomes were identified, which in turn helped to improve the model. **Conclusion:** Utilizing principles of understanding and visualization tools of the FRAM, the findings create a foundation for safety improvements potentially through training or safety messages based on an increased understanding of the complexity of hunting.

- **Keywords:** FRAM, behavior, deer hunting, safety, risk assessment

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Mathew B. Brown, Caroline J. Digby-Bowl, Samuel D. Todd. Assessing Infant Carriage Systems: Ground Reaction Force Implications for Gait of the Caregiver. pp. 160–171.

Objective: To assess the acute alterations of anterior infant carriage systems on the ground reaction force experienced during over-ground walking. **Background:** Previous research has identified the alterations in posture and gait associated with an increased anterior load (external or internal); however, the forces applied to the system due to the altered posture during over-ground walking have not been established. **Method:** Thirteen mixed gender participants completed 45 over-ground walking trials at a self-selected pace under three loaded conditions (unloaded, semi-structured carrier 9.9 kg, and structured carrier 9.9 kg). Each trial consisted of a 15-m walkway, centered around a piezoelectric force platform sampling at 1,200 Hz. Differences were assessed between loaded and unloaded conditions and across carriers using paired samples *t* tests and repeated measures ANOVA. **Results:** Additional load increased all ground reaction force parameters; however, the magnitude of force changes was influenced by carrier structure. The structured carrier displayed increased force magnitudes, a reduction in the time to vertical maximum heel contact, and an increased duration of the flat foot phase in walking gait. **Conclusion:** Evidence suggests that the acute application of anterior infant carriers alters both kinetic and temporal measures of walking gait. Importantly, these changes appear to be governed not solely by the additional mass but also by the structure of the carrier. **Application:** These findings indicate carrier structure should be considered by the wearer and may be used to inform policy in the recommendation of anterior infant carriage systems use by caregivers.

- **Keywords:** biomechanics, gait, posture, kinetics, loading, product design

Junfeng Peng, Xuguang Wang, Lisa Denninger. *Effects of Anthropometric Variables and Seat Height on Automobile Drivers' Preferred Posture With the Presence of the Clutch.* pp. 172–190.

Objective: The effects of seat height and anthropometric dimensions on drivers' preferred postures were investigated using a multiadjustable vehicle mock-up with a large number of adjustments and extended ranges. **Background:** Many studies have been conducted on preferred driving posture under different test conditions showing mixed and even contradictory findings. No studies thus far have considered the clutch and compared Chinese and European drivers. **Method:** Four seat height conditions were tested: free and three imposed heights (250, 300, and 350 mm). Sixty-one subjects (40 French-born and 21 Chinese-born) participated in the experiment, covering a large range of stature and sitting height-to-stature ratio. The RAMSIS kinematic model was used to reconstruct postures, and main intersegmental angles were extracted for characterizing posture. **Results:** Under the free seat height condition, no significant differences in preferred intersegmental angles were observed between different participant groups. Seat height mainly affected trunk-thigh angle, whereas it had almost no effect on trunk orientation and other intersegmental angles. Chinese participants sat more forward in the seat, leading to a more opened trunk-thigh angle and a more reclined trunk. **Conclusions:** Results suggest that intersegmental angles of preferred posture are not dependent on anthropometric dimensions, although shorter drivers prefer a slightly less reclined trunk. Self-selected driving posture results from a compromise between maintaining the intersegmental angles in one's preferred range and a preferred trunk orientation in space. **Applications:** The findings contribute to a better understanding of preferred driving postures and would be helpful for improving vehicle interior design.

- **Keywords:** automotive, driving posture, anthropometry, digital human modeling, vehicle packaging

Kurt E. Beschorner, Gregory P. Slota, Erika M. Pliner, Egli Spaho, Na Jin Seo. *Effects of Gloves and Pulling Task on Achievable Downward Pull Forces on a Rung.* pp. 191–200.

Objective: We examined the impacts of pulling task (breakaway and pull-down tasks at different postures), glove use, and their interaction on achievable downward pull forces from a ladder rung. **Background:** Posture, glove use, and the type of pulling task are known to affect the achievable forces. However, a gap in the literature exists regarding how these factors affect achievable downward pulling forces, which are relevant to recovery from a perturbation during ladder climbing. **Methods:** Forty subjects completed four downward pulling tasks (breakaway force; pull force at maximum height, shoulder height, and a middle height), using three glove conditions with varying coefficient of friction (COF) levels (cotton glove, low COF; bare hand, moderate COF; and latex-coated glove, high COF) with their dominant and nondominant hand. The outcome variable was the maximum force normalized to body weight. **Results:** The highest forces were observed for the highest hand postures (breakaway and maximum height). Increased COF led to higher forces and had a larger effect on breakaway force than the other tasks. The dominant hand was associated with higher forces than the nondominant hand. Male subjects generated greater forces than female subjects, particularly for higher hand positions. **Conclusion:** This study suggests that a higher hand position on the ladder, while avoiding low-friction gloves, may be effective for improving recovery from ladder perturbations. **Application:** This study may guide preferred climbing strategies (particularly those that lead to a higher hand position) for improving recovery from a perturbation during ladder climbing.

- **Keywords:** hand forces, pull strength, falls, ladder climbing, biomechanics

COGNITION

Stephen R. Mitroff, Justin M. Ericson, Benjamin Sharpe. Predicting Airport Screening Officers' Visual Search Competency With a Rapid Assessment. pp. 201–211.

Objective: The study's objective was to assess a new personnel selection and assessment tool for aviation security screeners. A mobile app was modified to create a tool, and the question was whether it could predict professional screeners' on-job performance. **Background:** A variety of professions (airport security, radiology, the military, etc.) rely on visual search performance—being able to detect targets. Given the importance of such professions, it is necessary to maximize performance, and one means to do so is to select individuals who excel at visual search. A critical question is whether it is possible to predict search competency within a professional search environment. **Method:** Professional searchers from the USA Transportation Security Administration (TSA) completed a rapid assessment on a tablet-based X-ray simulator (XRAY Screener, derived from the mobile technology app Airport Scanner; Kedlin Company). The assessment contained 72 trials that were simulated X-ray images of bags. Participants searched for prohibited items and tapped on them with their finger. **Results:** Performance on the assessment significantly related to on-job performance measures for the TSA officers such that those who were better XRAY Screener performers were both more accurate and faster at the actual airport checkpoint. **Conclusion:** XRAY Screener successfully predicted on-job performance for professional aviation security officers. While questions remain about the underlying cognitive mechanisms, this quick assessment was found to significantly predict on-job success for a task that relies on visual search performance. **Application:** It may be possible to quickly assess an individual's visual search competency, which could help organizations select new hires and assess their current workforce.

- **Keywords:** visual search, performance prediction, aviation security, personnel selection, personnel assessment

HEALTH CARE/HEALTH SYSTEMS

Joel M. Mumma, Francis T. Durso, Michelle Dyes, Rogelio dela Cruz, Valerie P. Fox, Mary Hoey. Bag Valve Mask Ventilation as a Perceptual-Cognitive Skill. pp. 212–221.

Objective: This study used a high-fidelity infant mannequin to examine the relationship between the quality of bag valve mask ventilation (BVMV) and how providers of varying levels of experience use visual feedback (e.g., electronic vital signs) to guide their performance. **Background:** BVMV is a common and critical procedure for managing pediatric respiratory emergencies. However, providers do not consistently deliver effective BVMV. Efforts to improve BVMV have ignored the question of how providers effectively use feedback often available during BVMV. **Method:** Six expert and six novice respiratory therapists completed two simulations of an infant requiring BVMV. In one, the technology failed to display SpO₂, an important but somewhat redundant visual cue. Eye movements, verbal reports, and ventilation rate (in breaths per minute) were measured in each simulation. **Results:** Regardless of SpO₂ availability, eye movements and verbal reports suggested that novices depended strongly on electronic vital signs and when SpO₂ was absent ventilated at a faster rate (exceeding the recommended range of ventilation rates) than when SpO₂ was present. Experts' ventilation rates were comparable and within the recommended range in both conditions. When SpO₂ was absent, experts emphasized information from direct observation of the patient that novices neglected. **Conclusion:** Individual differences in the use of feedback during BVMV contribute to the quality of BVMV. This work bears on the theoretical discussions involving the use of automation and nontechnological cues to guide performance. **Application:** These results have the potential to expand the current understanding of factors underlying effective BVMV with implications for training novice providers.

- **Keywords:** expert-novice differences, human-automation interaction, critical care, emergency medicine and resuscitation, medical simulation/training and assessment, pediatrics and neonatology, skilled performance, eye tracking

PHYSIOLOGICAL AND PSYCHOLOGICAL CONDITIONS ("INTERNAL ENVIRONMENT")

Keaton A. Fletcher, Sean M. Potter, Britany N. Telford. Stress Outcomes of Four Types of Perceived Interruptions. pp. 222–235.

Objective: We sought to define and measure four types of perceived interruptions and to examine their relationships with stress outcomes. **Background:** Interruptions have been defined and measured in a variety of inconsistent ways. No study has simultaneously examined the subjective experience of all types of interruptions. **Method:** First, we provide a synthesized definition and model of interruptions that aligns interruptions along two qualities: origin and degree of multitasking. Second, we create and validate a self-report measure of these four types of perceived interruptions within two samples (working undergraduate students and working engineers). Last, we correlate this measure with self-reported psychological and physical stress outcomes. **Results:** Our results support the four-factor model of interruptions. Results further support the link between each of the four types of interruptions (intrusions, breaks, distractions, and a specific type of ruminations, discrepancies) and stress outcomes. Specifically, results suggest that distractions explain a unique portion of variance in stress outcomes above and beyond the shared variance explained by intrusions, breaks, and discrepancies. **Conclusion:** The synthesized four-factor model of interruptions is an adequate representation of the overall construct of interruptions. Further, perceived interruptions can be measured and are significantly related to stress outcomes. **Application:** Measuring interruptions by observation can be intrusive and resource intensive. Additionally, some types of interruptions may be internal and therefore

unobservable. Our survey measure offers a practical alternative method for practitioners and researchers interested in the outcomes of interruptions, especially stress outcomes.

- **Keywords:** distractions and interruptions, attentional processes, job stress, psychometrics, mental workload

SURFACE TRANSPORTATION

Nathan Ward, John G. Gaspar, Mark B. Neider, James Crowell, Ronald Carbonari, Hank Kaczmarek, Ryan V. Ringer, Aaron P. Johnson, Lester C. Loschky, Arthur F. Kramer. *Older Adult Multitasking Performance Using a Gaze-Contingent Useful Field of View.* pp. 236–247.

Objective: We implemented a gaze-contingent useful field of view paradigm to examine older adult multitasking performance in a simulated driving environment. **Background:** Multitasking refers to the ability to manage multiple simultaneous streams of information. Recent work suggests that multitasking declines with age, yet the mechanisms supporting these declines are still debated. One possible framework to better understand this phenomenon is the useful field of view, or the area in the visual field where information can be attended and processed. In particular, the useful field of view allows for the discrimination of two competing theories of real-time multitasking, a general interference account and a tunneling account. **Methods:** Twenty-five older adult subjects completed a useful field of view task that involved discriminating the orientation of lines in gaze-contingent Gabor patches appearing at varying eccentricities (based on distance from the fovea) as they operated a vehicle in a driving simulator. In half of the driving scenarios, subjects also completed an auditory two-back task to manipulate cognitive workload, and during some trials, wind was introduced as a means to alter general driving difficulty. **Results:** Consistent with prior work, indices of driving performance were sensitive to both wind and workload. Interestingly, we also observed a decline in Gabor patch discrimination accuracy under high cognitive workload regardless of eccentricity, which provides support for a general interference account of multitasking. **Conclusion:** The results showed that our gaze-contingent useful field of view paradigm was able to successfully examine older adult multitasking performance in a simulated driving environment. **Application:** This study represents the first attempt to successfully measure dynamic changes in the useful field of view for older adults completing a multitasking scenario involving driving.

- **Keywords:** dual task, time sharing, task switching, attentional processes, mental workload, aging processes, working memory, simulation and training, distraction, driver behavior, useful field of view, gaze-contingent displays

Bridget A. Lewis, Jesse L. Eisert, Carryl L. Baldwin. *Validation of Essential Acoustic Parameters for Highly Urgent In-Vehicle Collision Warnings.* pp. 248–261.

Objective: The aim of this study was to validate the importance of key acoustic criteria for use as in-vehicle forward collision warning (FCW) systems. **Background:** Despite recent advances in vehicle safety, automobile crashes remain one of the leading causes of death. As automation allows for more control of noncritical functions by the vehicle, the potential for disengagement and distraction from the driving task also increases. It is, therefore, as important as ever that in-vehicle safety-critical interfaces are intuitive and unambiguous, promoting effective collision avoidance responses upon first exposure even under divided-attention conditions. **Method:** The current study used a driving simulator to assess the effectiveness of two warnings, one that met all essential acoustic parameters, one that met only some essential parameters, and a no-warning control in the context of a lead vehicle-following task in conjunction with a cognitive distractor task

and collision event. **Results:** Participants receiving an FCW comprising five essential acoustic components had improved collision avoidance responses relative to a no-warning condition and an FCW missing essential elements on their first exposure. Responses to a consistently good warning (GMU Prime) improved with subsequent exposures, whereas continued exposure to the less optimal FCW (GMU Sub-Prime) resulted in poorer performance even relative to receiving no warning at all. **Conclusions:** This study provides support for previous warning design studies and for the validity of five key acoustic parameters essential for the design of effective in-vehicle FCWs. **Application:** Results from this study have implications for the design of auditory FCWs and in-vehicle display design.

- **Keywords:** forward collision warnings, acoustic parameters, in-vehicle warnings, auditory warnings, auditory displays, collision avoidance

TEAMS AND GROUPS

Nathan J. McNeese, Mustafa Demir, Nancy J. Cooke, Christopher Myers. Teaming With a Synthetic Teammate: Insights into Human-Autonomy Teaming. pp. 262–273.

Objective: Three different team configurations are compared with the goal of better understanding human-autonomy teaming (HAT). **Background:** Although an extensive literature on human-automation interaction exists, much less is known about HAT in which humans and autonomous agents interact as coordinated units. Further research must be conducted to better understand how all-human teams compare to HAT. **Methods:** In an unmanned aerial system (UAS) context, a comparison was made among three types of three-member teams: (1) synthetic teams in which the pilot role is assigned to a synthetic teammate, (2) control teams in which the pilot was an inexperienced human, and (3) experimenter teams in which an experimenter served as an experienced pilot. Ten of each type of team participated. Measures of team performance, target processing efficiency, team situation awareness, and team verbal behaviors were analyzed. **Results:** Synthetic teams performed as well at the mission level as control (all human) teams but processed targets less efficiently. Experimenter teams performed better across all other measures compared to control and synthetic teams. **Conclusion:** Though there is potential for a synthetic agent to function as a full-fledged teammate, further advances in autonomy are needed to improve team-level dynamics in HAT teams. **Application:** This research contributes to our understanding of how to make autonomy a good team player.

- **Keywords:** human-autonomy teaming, synthetic agent, teamwork, team cognition