Human Factors – rok 2023, roč. 65

Číslo 2 (March)

AUTOMATION, EXPERT SYSTEMS

Shala Knocton, Aren Hunter, Warren Connors, Lori Dithurbide, Heather F. Neyedli. *The Effect of Informing Participants of the Response Bias of an Automated Target Recognition System on Trust and Reliance Behavior*. S. 189–199.

Objective: To determine how changing and informing a user of the false alarm (FA) rate of an automated target recognition (ATR) system affects the user's trust in and reliance on the system and their performance during an underwater mine detection task. **Background:** ATR systems are designed to operate using a high sensitivity and a liberal decision criterion to reduce the risk of the ATR system missing a target. A high number of FAs in general may lead to a decrease in operator trust and reliance. **Methods:** Participants viewed sonar images and were asked to identify mines in the images. They performed the task without ATR and with ATR at a lower and higher FA rate. The participants were split into two groups—one informed and one uninformed of the changed FA rate. Trust and/or confidence in detecting mines was measured after each block. **Results:** When not informed of the FA rate, the FA rate had a significant effect on the participants' response bias. Participants had greater trust in the system and a more consistent response bias when informed of the FA rate. Sensitivity and confidence were not influenced by disclosure of the FA rate but were significantly worse for the high FA rate condition compared with performance without the ATR. **Conclusion and application:** Informing a user of the FA rate of automation may positively influence the level of trust in and reliance on the aid.

- human–automation interaction, defense, underwater mine detection, military psychology

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Vicki Komisar, Alison C. Novak. *Effect of Handrail Height and Age on Trunk and Shoulder Kinematics Following Perturbation-Evoked Grasping Reactions During Gait*. S. 200–211

Objective: To characterize the effect of handrail height and age on trunk and shoulder kinematics, and concomitant handrail forces, on balance recovery reactions during gait. **Background:** Falls are the leading cause of unintentional injury in adults in North America. Handrails can significantly enhance balance recovery and help individuals to avoid falls, provided that their design allows users across the lifespan to reach and grasp the rail after balance loss, and control their trunk by applying hand-contact forces to the rail. However, the effect of handrail height and age on trunk and shoulder kinematics when recovering from perturbations during gait is unknown. **Method:** Fourteen younger and 13 older adults experienced balance loss (sudden platform translations) while walking beside a height-adjustable handrail. Handrail height was varied from 30 to 44 inches (76 to 112 cm). Trunk and shoulder kinematics were measured via 3D motion capture; applied handrail forces were collected from load cells mounted to the rail. **Results:** As handrail height increased (up to 42 inches/107 cm), peak trunk angular displacement and velocity generally decreased, while shoulder elevation angles during reaching and peak handrail forces did not differ significantly between 36 and 42 inches (91 and 107 cm). Age was associated with reduced peak trunk angular displacements, but did not affect applied handrail forces. **Conclusion:** Higher handrails (up to 42 inches) may be advantageous for trunk control when recovering from destabilizations during gait. **Application:** Our results can inform building codes, workplace safety standards, and accessibility standards, for safer handrail design.

- slips and falls, biomechanics, gait and posture, built environment design, design for older adults

COGNITION

Samantha L. Smith, William S. Helton, Gerald Matthews, Gregory J. Funke. *Performance, Hemodynamics, and Stress in a Two-Day Vigilance Task: Practical and Theoretical Implications*. S. 212–226.

Objective: To explore vigilance task performance, cerebral blood flow velocity (CBFV), workload, and stress in a within-subjects, two-session experiment. **Background:** Vigilance, or sustained attention, tasks are often characterized by a decline in operator performance and CBFV with time on task, and high workload and stress. Though performance is known to improve with practice, past research has not included measures of CBFV, stress, and workload in a within-subjects multi-session design, which may also provide insight into ongoing theoretical debate. **Method:** Participants performed a vigilance task on two separate occasions. Performance, CBFV, workload, and self-reported stress were measured. **Results:** Within each session, results were consistent with the vigilance profile found in prior research. Across sessions, performance improved but the time on task decrement remained. Mean CBFV and workload ratings did not differ between sessions, but participants reported significantly less distress, worry, and engagement after session two compared to one. **Conclusion:** Though practice may not disrupt the standard vigilance profile, it may serve to improve overall performance and reduce stress. However, repeated exposure may have negative implications for engagement and mind-wandering. **Application:** It is important to better understand the relationship between experience, performance, physiological response, and self-reported stress and workload in vigilance because real-world environments often require operators

to do the same task over many occasions. While performance improvement and reduced distress is an encouraging result, the decline in engagement requires further research. Results across sessions fail to provide support to the mind-wandering theory of vigilance.

- attentional processes, mental workload, neuroergonomics, physiological measurement

Colleen E. Patton, Christopher D. Wickens, C. A. P. Smith, Benjamin A. Clegg. *Detection of Hostile Intent by Spatial Movements*. S. 227–236.

Objective: The ability of people to infer intentions from movement of other vessels was investigated. Across three levels of variability in movements in the path of computer-controlled ships, participants attempted to determine which entity was hostile. **Background:** Detection of hostile intentions through spatial movements of vessels is important in an array of real-world scenarios. This experiment sought to determine baseline abilities of humans to do so. **Methods:** Participants selected a discrete movement direction of their ship. Six other ships' locations then updated. A single entity displayed one of two hostile behaviors: shadowing, which involved mirroring the participant's vessel's movements; and hunting, which involved closing in on the participant's vessel. Trials allowed up to 35 moves before identifying the hostile ship and its behavior. Uncertainty was introduced through adding variability to ships' movements such that their path was 0%, 25%, or 50% random. **Results:** Even with no variability in the ships' movements, accurate detection was low, identifying the hostile entity about 60% of the time. Variability in the paths decreased detection. Detection of hunting was strongly degraded by distance between ownship and the hostile ship, but shadowing was not. Strategies employing different directions of movement across the trial, but also featuring some runs of consecutive movements, facilitated detection. **Conclusions:** Early identification of threats based on movement characteristics alone is likely to be difficult, but particularly so when adversaries employ some level of uncertainty to mask their intentions. These findings highlight the need to develop decision aids to support human performance.

HEALTH CARE/HEALTH SYSTEMS

April Savoy, Himalaya Patel, Daniel R. Murphy, Ashley N. D. Meyer, Jennifer Herout, Hardeep Singh. *Electronic Health Records' Support for Primary Care Physicians' Situation Awareness: A Metanarrative Review*. s. 237–259.

Objective: Situation awareness (SA) refers to people's perception and understanding of their dynamic environment. In primary care, reduced SA among physicians increases errors in clinical decision-making and, correspondingly, patients' risk of experiencing adverse outcomes. Our objective was to understand the extent to which electronic health records (EHRs) support primary care physicians (PCPs)' SA during clinical decision-making. **Method:** We conducted a metanarrative review of papers in selected academic databases, including CINAHL and MEDLINE. Eligible studies included original peer-reviewed research published between January 2012 and August 2020 on PCP–EHR interactions. We iteratively queried, screened, and summarized literature focused on EHRs supporting PCPs' clinical decision-making and care management for adults. Then, we mapped findings to an established SA framework to classify external factors (individual, task, and system) affecting PCPs' levels of SA (1–Perception, 2–Comprehension, and 3–Projection) and identified SA barriers. **Results:** From 1504 articles identified, we included and synthesized 19 studies. Study designs were largely noninterventional. Studies described EHR workflow misalignments, usability issues, and communication challenges. EHR information, including lab results and care plans, was

characterized as incomplete, untimely, or irrelevant. Unmet information needs made it difficult for PCPs to obtain even basic SA, Level 1 SA. Prevalent barriers to PCPs developing SA with EHRs were errant mental models, attentional tunneling, and data overload. **Conclusion:** Based on our review, EHRs do not support the development of higher levels of SA among PCPs. Review findings suggest SA-oriented design processes for health information technology could improve PCPs' SA, satisfaction, and decision-making.

- situation awareness, primary care, electronic health record, cognition, decision-making, safety

INDIVIDUAL DIFFERENCES

Federico Scholcover, Douglas J. Gillan. *Temporal Sensitivity and Latency During Teleoperation: Using Track Clearance to Understand Errors in Future Projection*. S. 260–274.

Objective: This study investigates the role of individual differences in time perception on task performance during teleoperation with latency. **Background:** Long distance teleoperation induces latency, causing performance issues for the operator. Previous research demonstrated that individual differences in time perception predicted performance on a similar task, having participants navigate a radio controlled (RC) car around a track. This work extends the relationship into routes of varying course width to test whether differences in time perception predict movement over-/underestimation. **Method:** Participants completed a time estimation task and a route navigation task while experiencing latency. In the time estimation task, participants estimated the duration of multiple visual stimuli (2 s or less). In the route navigation task, participants moved a virtual cube across a route. Each trial varied in the amount of latency and the amount of horizontal clearance in the track (4–10 m for a 1.2-m-long/wide cube). **Results:** The results showed fairly consistent latency by time estimation and latency by clearance interaction effects on a wide set of trial-level variables, such as completion time, and action-level performance variables, such as time spent moving per move event. However, the results were not consistently in the predicted direction. **Conclusion:** Results suggest that clearance and timing affect performance across latency, at both the overall level (i.e., trial completion time) and at the action level (time spent moving). An open question remains as to how these contextual factors affect movement strategy selection.

SOCIAL PROCESSES

Miriam E. Armstrong, Keith S. Jones, Akbar Siami Namin. *How Perceptions of Caller Honesty Vary During Vishing Attacks That Include Highly Sensitive or Seemingly Innocuous Requests*. S. 275–287.

Objective: To understand how aspects of vishing calls (phishing phone calls) influence perceived visher honesty. **Background:** Little is understood about how targeted individuals behave during vishing attacks. According to truth-default theory, people assume others are being honest until something triggers their suspicion. We investigated whether that was true during vishing attacks. **Methods:** Twenty-four participants read written descriptions of eight real-world vishing calls. Half included highly sensitive requests; the remainder included seemingly innocuous requests. Participants rated visher honesty at multiple points during conversations. **Results:** Participants initially perceived

vishers to be honest. Honesty ratings decreased before requests occurred. Honesty ratings decreased further in response to highly sensitive requests, but not seemingly innocuous requests. Honesty ratings recovered somewhat, but only after highly sensitive requests. **Conclusions:** The present results revealed five important insights: (1) people begin vishing conversations in the truth-default state, (2) certain aspects of vishing conversations serve as triggers, (3) other aspects of vishing conversations do not serve as triggers, (4) in certain situations, people's perceptions of visher honesty improve, and, more generally, (5) truth-default theory may be a useful tool for understanding how targeted individuals behave during vishing attacks. **Application:** Those developing systems that help users deal with suspected vishing attacks or penetration testing plans should consider (1) targeted individuals' truth-bias, (2) the influence of visher demeanor on the likelihood of deception detection, (3) the influence of fabricated situations surrounding vishing requests on the likelihood of deception detection, and (4) targeted individuals' lack of concern about seemingly innocuous requests.

SURFACE TRANSPORTATION

Hananeh Alambeigi, Anthony D. McDonald. *A Bayesian Regression Analysis of the Effects of Alert Presence and Scenario Criticality on Automated Vehicle Takeover Performance.* S. 288–305.

Objective: This study investigates the impact of silent and alerted failures on driver performance across two levels of scenario criticality during automated vehicle transitions of control. **Background:** Recent analyses of automated vehicle crashes show that many crashes occur after a transition of control or a silent automation failure. A substantial amount of research has been dedicated to investigating the impact of various factors on drivers' responses, but silent failures and their interactions with scenario criticality are understudied. **Method:** A driving simulator study was conducted comparing scenario criticality, alert presence, and two driving scenarios. Bayesian regression models and Fisher's exact tests were used to investigate the impact of alert and scenario criticality on takeover performance. **Results:** The results show that silent failures increase takeover times and the intensity of posttakeover maximum accelerations and decrease the posttakeover minimum time-to-collision. While the predicted average impact of silent failures on takeover time was practically low, the effects on minimum time-to-collision and maximum accelerations were safety-significant. The analysis of posttakeover control interaction effects shows that the effect of alert presence differs by the scenario criticality. **Conclusion:** Although the impact of the absence of an alert on takeover performance was less than that of scenario criticality, silent failures seem to play a substantial role—by leading to an unsafe maneuver—in critical automated vehicle takeovers. **Application:** Understanding the implications of silent failure on driver's takeover performance can benefit the assessment of automated vehicles' safety and provide guidance for fail-safe system designs.

Joseph Snider, Ryan J. Spence, Anne-Marie Engler, Ryan Moran, Sarah Hacker [...]. *Distraction "Hangover": Characterization of the Delayed Return to Baseline Driving Risk After Distracting Behaviors.* S. 306–320.

Objective: We measured how long distraction by a smartphone affects simulated driving behaviors after the tasks are completed (i.e., the distraction hangover). **Background:** Most drivers know that smartphones distract. Trying to limit distraction, drivers can use hands-free devices, where they only briefly glance at the smartphone. However, the cognitive cost of switching tasks from driving to communicating and back to driving adds an underappreciated, potentially long period to the total distraction time. **Method:** Ninety-seven 21- to 78-year-old individuals who self-identified as active drivers and

smartphone users engaged in a simulated driving scenario that included smartphone distractions. Peripheral-cue and car-following tasks were used to assess driving behavior, along with synchronized eye tracking. **Results:** The participants' lateral speed was larger than baseline for 15 s after the end of a voice distraction and for up to 25 s after a text distraction. Correct identification of peripheral cues dropped about 5% per decade of age, and participants from the 71+ age group missed seeing about 50% of peripheral cues within 4 s of the distraction. During distraction, coherence with the lead car in a following task dropped from 0.54 to 0.045, and seven participants rear-ended the lead car. Breadth of scanning contracted by 50% after distraction. **Conclusion:** Simulated driving performance drops dramatically after smartphone distraction for all ages and for both voice and texting. **Application:** Public education should include the dangers of any smartphone use during driving, including hands-free.

SYSTEM DESIGN AND ANALYSIS (GENERAL)

Christoph Bernhard, René Reinhard, Michael Kleer, Heiko Hecht. *A Case for Raising the Camera: A Driving Simulator Test of Camera-Monitor Systems*. S. 321–336.

Objective: This experiment provides a first-of-its-kind driving-simulator study to investigate the feasibility of camera-monitor systems (CMS) with displaced side-mounted cameras in sedans. **Background:** Among the increasing number of studies investigating the replacement of side-mounted rearview mirrors with CMS, the placement of side-mounted cameras has been largely neglected. Moreover, user preferences with respect to camera placement have not been validated in a driving simulator. Past research merely has shown that the vertical camera position can affect distance perception. **Method:** In a driving simulator experiment, we investigated the effects of rearward camera placement on driver acceptance and performance. Thirty-six participants performed multiple lane changes in a last safe-gap paradigm. The camera position, ego-velocity, and velocity of the approaching vehicle varied across the experiment. **Results:** The results suggest a clear preference for a high rearward perspective, whereas participants disliked the lower viewpoint. However, these stark differences were only marginally mirrored in lane change performance. Average safety margins tended to decrease and their variation tended to increase for the low camera position. **Conclusion:** Even if the impact of the camera position on driving behavior seems to be small in sedans, driver expectations show clear-cut preferences. When designing CMS, this should be taken into account, as these preferences could promote the use of CMS and thus their positive impact on safety. **Application:** Designers should place side-mounted cameras as high as possible to increase acceptance of CMS. Low camera positions are not recommended, as they might decrease safety margins and are not appreciated by drivers.

TEAMS AND GROUPS

Alexandra D. Kaplan, Theresa T. Kessler, J. Christopher Brill, P. A. Hancock. *Trust in Artificial Intelligence: Meta-Analytic Findings*. S. 337–359.

Objective: The present meta-analysis sought to determine significant factors that predict trust in artificial intelligence (AI). Such factors were divided into those relating to (a) the human trustor, (b) the AI trustee, and (c) the shared context of their interaction. **Background:** There are many factors influencing trust in robots, automation, and technology in general, and there have been several meta-analytic attempts to

understand the antecedents of trust in these areas. However, no targeted meta-analysis has been performed examining the antecedents of trust in AI. **Method:** Data from 65 articles examined the three predicted categories, as well as the subcategories of human characteristics and abilities, AI performance and attributes, and contextual tasking. Lastly, four common uses for AI (i.e., chatbots, robots, automated vehicles, and nonembodied, plain algorithms) were examined as further potential moderating factors. **Results:** Results showed that all of the examined categories were significant predictors of trust in AI as well as many individual antecedents such as AI reliability and anthropomorphism, among many others. **Conclusion:** Overall, the results of this meta-analysis determined several factors that influence trust, including some that have no bearing on AI performance. Additionally, we highlight the areas where there is currently no empirical research. **Application:** Findings from this analysis will allow designers to build systems that elicit higher or lower levels of trust, as they require.