

Human Factors – rok 2016, roč. 58

Číslo 1 (February)



Strayer, David L., Fisher, Donald L. *SPIDER: A Framework for Understanding Driver Distraction.* pp. 5-12.

ObjectiveThe objective was to identify key cognitive processes that are impaired when drivers divert attention from driving. **Background**Driver distraction is increasingly recognized as a significant source of injuries and fatalities on the roadway. **Method/Results**A "SPIDER" model is developed that identifies key cognitive processes that are impaired when drivers divert attention from driving. SPIDER is an acronym standing for scanning, predicting, identifying, decision making, and executing a response. **Conclusion**When drivers engage in secondary activities unrelated to the task of driving, SPIDER-related processes are impaired, situation awareness is degraded, and the ability to safely operate a motor vehicle may be compromised. **Application**The pattern of interference helps to illuminate the sources of driver distraction and may help guide the integration of new technology into the automobile.

Franke, Thomas, Rauh, Nadine, Gunther, Madlen, Trantow, Maria, Krems, Josef F. *Which Factors Can Protect Against Range Stress in Everyday Usage of Battery Electric Vehicles? Toward Enhancing Sustainability of Electric Mobility Systems.* pp. 13-26.

ObjectiveThe objective of the present research was to advance understanding of factors that can protect against range anxiety, specifically range stress in everyday usage of battery electric vehicles (BEVs). **Background**Range anxiety is a major barrier to the broad adoption of sustainable electric mobility systems. To develop strategies aimed at overcoming range anxiety, a clear understanding of this phenomenon and influencing factors is needed. **Method**We examined range anxiety in the form of everyday range stress (ERS) in a field study setting. Seventy-two customers leased a BEV for 3 months. The field study was specifically designed to enable examination of factors that can contribute to lower ERS. In particular, study design and sample recruitment were targeted at generating vehicle usage profiles that would lead to relatively frequent experience of situations requiring active management of range resources and thereby potentially leading to experienced range stress. **Results**Less frequent encounter with critical range situations, higher practical experience, subjective range competence, tolerance of low range, and experienced trustworthiness of the range estimation system were related to lower ERS. Moreover, range stress was found to be related to range

satisfaction and BEV acceptance. ConclusionThe results underline the importance of the human factors perspective to overcome range anxiety and enhance sustainability of electric mobility systems. ApplicationTrustworthiness should be employed as a key benchmark variable in the design of range estimation systems, and assistance systems should target increasing drivers adaptive capacity (i.e., resilience) to cope with critical range situations.

Kisaalita, William S., Katimbo, Abia, Sempira, Edison J., Mugisa, Dana J. *Cultural Influences in Women-Friendly Labor-Saving Hand Tool Designs: The Milk Churner Case.* pp. 27-42.

ObjectiveThe aim of this study was to highlight the importance of culture in sustainable, labor-saving solutions design for women in low-resource settings. BackgroundOne of the reasons behind the gender asset gap among Sub-Saharan African women is the higher labor burden these women face, making it difficult for them to produce for the home and markets. Hand tools are the simplest form and therefore the best first step to address this problem. But designing women-friendly (sustainable) hand tools calls for better understanding of the low-resource settings where these women reside. MethodA milk churner was redesigned using a human-centered (participatory) approach with groups of women from two dominant ethnolinguistic groups of Bantu and Nilotic of Uganda, and its usability was tested. ResultsThe churner reduced labor up to eightfold and has potential to expand the range of uses to include children and husbands due to its simplicity. Also, the churner significantly reduced undesirable health effects, like pain in knee joints. Based on the experience with the churner, a six-item "survival guide" is proposed to complement human-centered design guiding principles for facilitating the generation of solutions in low-resource settings. ConclusionBy paying great attention to culture in relation to human factors, a labor-reducing churner has been successfully introduced among Ugandan women. The ultimate goal is to make the churner available to female smallholder dairy-farming households throughout Sub-Saharan Africa. ApplicationsThis study provides a survival guide for generating solutions to problems from low-resource settings.

Meshkati, Najmedin, Tabibzadeh, Maryam, Farshid, Ali, Rahimi, Mansour, Alhanaee, Ghena. *People-Technology-Ecosystem Integration: A Framework to Ensure Regional Interoperability for Safety, Sustainability, and Resilience of Interdependent Energy, Water, and Seafood Sources in the (Persian) Gulf.* pp. 43-57.

ObjectiveThe aim of this study is to identify the interdependencies of human and organizational subsystems of multiple complex, safety-sensitive technological systems and their interoperability in the context of sustainability and resilience of an ecosystem. BackgroundRecent technological disasters with severe environmental impact are attributed to human factors and safety culture causes. One of the most populous and environmentally sensitive regions in the world, the (Persian) Gulf, is on the confluence of an exponentially growing number of two industries--nuclear power and seawater desalination plants--that is changing its land- and seascape. MethodBuilding upon Rasmussens model, a macrosystem integrative framework, based on the broader context of human factors, is developed, which can be considered in this context as a "meta-ergonomics" paradigm, for the analysis of interactions, design of interoperability, and integration of decisions of major actors whose actions can affect safety and sustainability of the focused industries during routine and nonroutine (emergency) operations. ConclusionBased on the emerging realities in the Gulf region, it is concluded that without such systematic approach toward addressing the interdependencies of water and energy sources, sustainability will be only a short-lived dream and prosperity will be a disappearing mirage for millions of people in the region. ApplicationThis multilayered framework for the integration of people, technology, and ecosystem--which has been

applied to the (Persian) Gulf--offers a viable and vital approach to the design and operation of large-scale complex systems wherever the nexus of water, energy, and food sources are concerned, such as the Black Sea.

Krejci, Caroline C., Stone, Richard T., Dorneich, Michael C., Gilbert, Stephen B. *Analysis of Food Hub Commerce and Participation Using Agent-Based Modeling: Integrating Financial and Social Drivers*. pp. 58-79.

ObjectiveFactors influencing long-term viability of an intermediated regional food supply network (food hub) were modeled using agent-based modeling techniques informed by interview data gathered from food hub participants. **Background**Previous analyses of food hub dynamics focused primarily on financial drivers rather than social factors and have not used mathematical models. **Method**Based on qualitative and quantitative data gathered from 22 customers and 11 vendors at a midwestern food hub, an agent-based model (ABM) was created with distinct consumer personas characterizing the range of consumer priorities. A comparison study determined if the ABM behaved differently than a model based on traditional economic assumptions. Further simulation studies assessed the effect of changes in parameters, such as producer reliability and the consumer profiles, on long-term food hub sustainability. **Results**The persona-based ABM model produced different and more resilient results than the more traditional way of modeling consumers. Reduced producer reliability significantly reduced trade; in some instances, a modest reduction in reliability threatened the sustainability of the system. Finally, a modest increase in price-driven consumers at the outset of the simulation quickly resulted in those consumers becoming a majority of the overall customer base. **Conclusion**Results suggest that social factors, such as desire to support the community, can be more important than financial factors. **Application**An ABM of food hub dynamics, based on human factors data gathered from the field, can be a useful tool for policy decisions. Similar approaches can be used for modeling customer dynamics with other sustainable organizations.

Lo, Julia C., Pluyter, Kari R., Meijer, Sebastiaan A. *Individual Markers of Resilience in Train Traffic Control: The Role of Operators Goals and Strategic Mental Models and Implications for Variation, Expertise, and Performance*. pp. 80-91.

ObjectiveThe aim of this study was to examine individual markers of resilience and obtain quantitative insights into the understanding and the implications of variation and expertise levels in train traffic operators goals and strategic mental models and their impact on performance. **Background**The Dutch railways are one of the worlds most heavy utilized railway networks and have been identified to be weak in system and organizational resilience. **Method**Twenty-two train traffic controllers enacted two scenarios in a human-in-the-loop simulator. Their experience, goals, strategic mental models, and performance were assessed through questionnaires and simulator logs. Goals were operationalized through performance indicators and strategic mental models through train completion strategies. **Results**A variation was found between operators for both self-reported primary performance indicators and completion strategies. Further, the primary goal of only 14% of the operators reflected the primary organizational goal (i.e., arrival punctuality). An incongruence was also found between train traffic controllers self-reported performance indicators and objective performance in a more disrupted condition. The level of experience tends to affect performance differently. **Conclusion**There is a gap between primary organizational goals and preferred individual goals. Further, the relative strong diversity in primary operator goals and strategic mental models indicates weak resilience at the individual level. **Application**With recent and upcoming large-scale changes throughout the sociotechnical space of the railway

infrastructure organization, the findings are useful to facilitate future railway traffic control and the development of a resilient system.

Jipp, Meike. *Expertise Development With Different Types of Automation: A Function of Different Cognitive Abilities*. pp. 92-106.

ObjectiveI explored whether different cognitive abilities (information-processing ability, working-memory capacity) are needed for expertise development when different types of automation (information vs. decision automation) are employed. **Background**It is well documented that expertise development and the employment of automation lead to improved performance. Here, it is argued that a learners ability to reason about an activity may be hindered by the employment of information automation. Additional feedback needs to be processed, thus increasing the load on working memory and decelerating expertise development. By contrast, the employment of decision automation may stimulate reasoning, increase the initial load on information-processing ability, and accelerate expertise development. Authors of past research have not investigated the interrelations between automation assistance, individual differences, and expertise development. **Method**Sixty-one naive learners controlled simulated air traffic with two types of automation: information automation and decision automation. Their performance was captured across 16 trials. Well-established tests were used to assess information-processing ability and working-memory capacity. **Results**As expected, learners performance benefited from expertise development and decision automation. Furthermore, individual differences moderated the effect of the type of automation on expertise development: The employment of only information automation increased the load on working memory during later expertise development. The employment of decision automation initially increased the need to process information. **Conclusion**These findings highlight the importance of considering individual differences and expertise development when investigating human-automation interaction. **Application**The results are relevant for selecting automation configurations for expertise development.

Kingston, David C., Riddell, Maureen F., McKinnon, Colin D., Gallagher, Kaitlin M., Callaghan, Jack P. *Influence of Input Hardware and Work Surface Angle on Upper Limb Posture in a Hybrid Computer Workstation*. pp. 107-119.

ObjectiveWe evaluated the effect of work surface angle and input hardware on upper-limb posture when using a hybrid computer workstation. **Background**Offices use sit-stand and/or tablet workstations to increase worker mobility. These workstations may have negative effects on upper-limb joints by increasing time spent in non-neutral postures, but a hybrid standing workstation may improve working postures. **Method**Fourteen participants completed office tasks in four workstation configurations: a horizontal or sloped 15{degrees} working surface with computer or tablet hardware. Three-dimensional right upper-limb postures were recorded during three tasks: reading, form filling, and writing e-mails. Amplitude probability distribution functions determined the median and range of upper-limb postures. **Results**The sloped-surface tablet workstation decreased wrist ulnar deviation by 5{degrees} when compared to the horizontal-surface computer when reading. When using computer input devices (keyboard and mouse), the shoulder, elbow, and wrist were closest to neutral joint postures when working on a horizontal work surface. The elbow was 23{degrees} and 15{degrees} more extended, whereas the wrist was 6{degrees} less ulnar deviated, when reading compared to typing forms or e-mails. **Conclusion**We recommend that the horizontal-surface computer configuration be used for typing and the sloped-surface tablet configuration be used for intermittent reading tasks in this hybrid workstation. **Application**Offices with mobile employees could use this workstation for alternating their upper-extremity postures; however, other aspects of the device need further investigation.

Cudlip, Alan C., Meszaros, Kimberly A., Dickerson, Clark R. *The Influence of Hand Location and Force Direction on Shoulder Muscular Activity in Females During Nonsagittal Multidirectional Overhead Exertions.* pp. 120-139.

ObjectiveWe examined interactions of overhead work location and direction of force application on shoulder muscular activity. **Background**Overhead work tasks are common occupational stressors. Previous research has quantified influences of overhead work spatial placement and different force application directions but typically separately or exclusively for tasks done in the median plane. **Method**Twenty female participants exerted 40 N of force in six directions (forward/backward, upward/downward, left/right) 150 cm off the floor while seated. An asymmetric pattern of 14 work locations spaced 15 cm centered directly overhead were evaluated. **Results**Force direction and work location strongly influenced mean muscle activity ($F = 559, p < .01$). Interaction effects existed between force direction and hand location in the transverse plane ($F = 21, p < .01$), with increases as high as 49% in normalized mean muscle activity. **Conclusion**Backward exertions produced the highest mean overall muscle activity across hand force directions, exceeding 30% maximum voluntary isometric exertion (MVE) across work locations, with higher activation of anterior deltoid, biceps, infraspinatus, supraspinatus, and upper and lower trapezius. Downward exertions had the lowest mean overall activity, with $<_{10}$ mve="mve" across="across" work="work" locations.="locations." altered="altered" up="up" to="to" _47="_47" muscular="muscular" activity="activity" occurred="occurred" as="as" exertions="exertions" moved="moved" laterally="laterally" from="from" the="the" origin="origin" and="and" increasingly="increasingly" forward="forward" hand="hand" positions="positions" generally="generally" yielded="yielded" decreased="decreased" mean="mean" overall="overall" for="for" most="most" force="force" directions.="directions." applicationthis="applicationthis" study="study" provides="provides" previously="previously" unavailable="unavailable" submaximal="submaximal" shoulder="shoulder" data="data" a="a" wide="wide" range="range" of="of" overhead="overhead" tasks.="tasks." such="such" it="it" enables="enables" novel="novel" design="design" considerations="considerations" that="that" include="include" modifying="modifying" existing="existing" elements="elements" reduce="reduce" or="or" redistribute="redistribute" associated="associated" demands.="demands." _="_" p="p">

Bantoft, Christina, Summers, Mathew J., Tranent, Peter J., Palmer, Matthew A., Cooley, P. Dean, Pedersen, Scott J. *Effect of Standing or Walking at a Workstation on Cognitive Function: A Randomized Counterbalanced Trial.* pp. 140-149.

ObjectiveIn the present study, we examined the effect of working while seated, while standing, or while walking on measures of short-term memory, working memory, selective and sustained attention, and information-processing speed. **Background**The advent of computer-based technology has revolutionized the adult workplace, such that average adult full-time employees spend the majority of their working day seated. Prolonged sitting is associated with increasing obesity and chronic health conditions in children and adults. One possible intervention to reduce the negative health impacts of the modern office environment involves modifying the workplace to increase incidental activity and exercise during the workday. Although modifications, such as sit-stand desks, have been shown to improve physiological function, there is mixed information regarding the impact of such office modification on individual cognitive performance and thereby the efficiency of the work environment. **Method**In a fully counterbalanced randomized control trial, we assessed the cognitive performance of 45 undergraduate students for up to a 1-hr period in each condition. **Results**The results indicate that there is no significant change in the measures used to assess cognitive performance associated with working while seated, while standing, or while walking at low intensity.

Conclusion These results indicate that cognitive performance is not degraded with short-term use of alternate workstations.

Banducci, Sarah E., Ward, Nathan, Gaspar, John G., Schab, Kurt R., Crowell, James A., Kaczmarek, Henry, Kramer, Arthur F. *The Effects of Cell Phone and Text Message Conversations on Simulated Street Crossing*. pp. 150-162.

Objective A fully immersive, high-fidelity street-crossing simulator was used to examine the effects of texting on pedestrian street-crossing performance. Background Research suggests that street-crossing performance is impaired when pedestrians engage in cell phone conversations. Less is known about the impact of texting on street-crossing performance. Method Thirty-two young adults completed three distraction conditions in a simulated street-crossing task: no distraction, phone conversation, and texting. A hands-free headset and a mounted tablet were used to conduct the phone and texting conversations, respectively. Participants moved through the virtual environment via a manual treadmill, allowing them to select crossing gaps and change their gait. Results During the phone conversation and texting conditions, participants had fewer successful crossings and took longer to initiate crossing. Furthermore, in the texting condition, smaller percentage of time with head orientation toward the tablet, fewer number of head orientations toward the tablet, and greater percentage of total characters typed before initiating crossing predicted greater crossing success. Conclusion Our results suggest that (a) texting is as unsafe as phone conversations for street-crossing performance and (b) when subjects completed most of the texting task before initiating crossing, they were more likely to make it safely across the street. Application Sending and receiving text messages negatively impact a range of real-world behaviors. These results may inform personal and policy decisions.

Kujala, Tuomo, Makela, Jakke, Kotilainen, Ilkka, Tokkonen, Timo. *The Attentional Demand of Automobile Driving Revisited: Occlusion Distance as a Function of Task-Relevant Event Density in Realistic Driving Scenarios*. pp. 163-180.

Objective We studied the utility of occlusion distance as a function of task-relevant event density in realistic traffic scenarios with self-controlled speed. Background The visual occlusion technique is an established method for assessing visual demands of driving. However, occlusion time is not a highly informative measure of environmental task-relevant event density in self-paced driving scenarios because it partials out the effects of changes in driving speed. Method Self-determined occlusion times and distances of 97 drivers with varying backgrounds were analyzed in driving scenarios simulating real Finnish suburban and highway traffic environments with self-determined vehicle speed. Results Occlusion distances varied systematically with the expected environmental demands of the manipulated driving scenarios whereas the distributions of occlusion times remained more static across the scenarios. Systematic individual differences in the preferred occlusion distances were observed. More experienced drivers achieved better lane-keeping accuracy than inexperienced drivers with similar occlusion distances; however, driving experience was unexpectedly not a major factor for the preferred occlusion distances. Conclusion Occlusion distance seems to be an informative measure for assessing task-relevant event density in realistic traffic scenarios with self-controlled speed. Occlusion time measures the visual demand of driving as the task-relevant event rate in time intervals, whereas occlusion distance measures the experienced task-relevant event density in distance intervals. Application The findings can be utilized in context-aware distraction mitigation systems, human-automated vehicle interaction, road speed prediction and design, as well as in the testing of visual in-vehicle tasks for inappropriate in-vehicle glancing behaviors in any dynamic traffic scenario for which appropriate individual occlusion distances can be defined.

Gorman, Jamie C., Martin, Melanie J., Dunbar, Terri A., Stevens, Ronald H., Galloway, Trysha L., Amazeen, Polemnia G., Likens, Aaron D. *Cross-Level Effects Between Neurophysiology and Communication During Team Training*. pp. 181-199.

ObjectiveWe investigated cross-level effects, which are concurrent changes across neural and cognitive-behavioral levels of analysis as teams interact, between neurophysiology and team communication variables under variations in team training. **Background**When people work together as a team, they develop neural, cognitive, and behavioral patterns that they would not develop individually. It is currently unknown whether these patterns are associated with each other in the form of cross-level effects. **Method**Team-level neurophysiology and latent semantic analysis communication data were collected from submarine teams in a training simulation. We analyzed whether (a) both neural and communication variables change together in response to changes in training segments (briefing, scenario, or debriefing), (b) neural and communication variables mutually discriminate teams of different experience levels, and (c) peak cross-correlations between neural and communication variables identify how the levels are linked. **Results**Changes in training segment led to changes in both neural and communication variables, neural and communication variables mutually discriminated between teams of different experience levels, and peak cross-correlations indicated that changes in communication precede changes in neural patterns in more experienced teams. **Conclusion**Cross-level effects suggest that teamwork is not reducible to a fundamental level of analysis and that training effects are spread out across neural and cognitive-behavioral levels of analysis. Cross-level effects are important to consider for theories of team performance and practical aspects of team training. **Application**Cross-level effects suggest that measurements could be taken at one level (e.g., neural) to assess team experience (or skill) on another level (e.g., cognitive-behavioral).