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AGING AND INDIVIDUAL DIFFERENCIES

Nele Wild-Wall, Melanie Hahn, Michael Falkenstein. *Preparatory Processes and Compensatory Effort in Older and Younger Participants in a Driving-Like Dual Task.* S. 91-102).

Objective: The nature of increased-age-related dual-task interference was examined during a driving-like dual task in the laboratory. **Background:** Previous research revealed age-related deficits in dual tasks especially when cognitive and motor demands are involved. The specific contributions of sensory input, working memory demands, and/or coordination of motor responses to dual-task interference are not clear and should be clarified in the present study. **Method:** Younger and older participants performed a driving-like tracking task and a visually cued attention task within a dual task. Behavioral and electrophysiological data were recorded during task performance. **Results:** Overall tracking performance was lower for the older versus younger participants. This age-related decline was particularly pronounced in the time interval after the stimulus when the attention task demanded a motor response. In contrast, older participants tracked relatively better than the younger participants in the time interval preceding the stimulus. In the attention task, the older versus younger participants showed increased responses times and rates of false alarms and misses, suggesting a deficit in retaining the context in the cue-stimulus interval. The electroencephalogram data suggest that the older participants invested more resources than the younger participants in dual-task management during the cue-stimulus interval. **Conclusion:** Evidence was found for increased motor interference and a deficient context processing as well as for an increased investment of processing resources in the older compared with the younger group. **Application:** The results suggest that in-vehicle information systems for older drivers should be designed to support cue maintenance and that simultaneous motor demands should not be required.

- ▪ **Keywords:** dual task, simulated driving, aging, task preparation, cue, CNV

Loïc Caroux, Ludovic Le Bigot, Nicolas Vibert. *Maximizing Players' Anticipation by Applying the Proximity-Compatibility Principle to the Design of Video Games*. S. 103-117.

Objective: Two experiments were conducted to investigate elements of the spatial design of video game interfaces. **Background:** In most video games, both the objects and the background scene are moving. Players must pay attention to what appears in the background to anticipate events while looking at head-up displays. According to the proximity-compatibility principle, game-related information should be placed as close as

possible to the anticipation zone. **Method:** Participants played a video game where they had to anticipate the upward movement of obstacles. The score location was manipulated. The average vertical gaze position and dispersion were used to assess anticipation and extent of visual scanning, respectively. **Results:** Putting the score at the bottom rather than the top of the game window, within the anticipation zone, was expected to minimize attentional moves. Experiment 1 revealed lower average gaze positions and reduced extent of visual scanning in that condition, but the score performance did not improve significantly. Experiment 2 demonstrated that players' performance increased compared with the bottom condition when the score was displayed just below but outside the game window, despite an increased extent of visual scanning. **Conclusion:** Positioning the score just outside the anticipation zone facilitated anticipation of the movement of obstacles and led to better performance than when the score overlapped with the game anticipation zone. **Application:** For games requiring visual anticipation, contextual information should be located in the direction of anticipation but not within the anticipation zone. This recommendation complements the proximity compatibility principle for simple dynamic displays.

- **Keywords:** interactive environments, dynamic visual displays, multiple resources model, moving visual background

Yael Salzer, Tal Oron-Gilad, Adi Ronen, Yisrael Parmet. *Vibrotactile "On-Thigh" Alerting System in the Cockpit*. S. 118-131.

Background: Alerts in the cockpit must be robust, difficult to ignore, and easily recognized. Tactile alerts can provide means to direct the pilot's attention in the already visual-auditory overloaded cockpit environment. **Objective:** This research examined the thigh as a placement for vibrotactile display in the cockpit. The authors (a) report initial findings concerning the loci and properties of the display, (b) evaluate the added value of tactile cuing with respect to the existing audio-visual alerting system, and (c) address the issue of tactile orienting—whether the cue should display "flight" or "fight" orienting. The tactor display prototype was developed by a joint venture of Israel Aerospace Industries, Lahav Division, and the Ben Gurion University of the Negev (patent pending 11/968,405). **Method:** A vibrotactile display mounted on the thigh provided directional cues in the vertical plane. Two vibrotactile display modes (eight and four tactors) and two response modes (compatible, i.e., fight [toward vibrotactile cue], and inverse, i.e., flight [away from vibrotactile cue]) were evaluated. **Results:** Vertical directional orienting can be achieved by a vibrotactile display assembled on the thigh. The four-tactor display mode and the compatible response mode produced more accurate results. **Conclusion:** Tactile cues can provide directional orienting in the vertical plane. The benefit of adding compatible tactile cues compared with visual and auditory cues alone has yet to be reinforced. Nevertheless, fight mode, that is, directing the way to escape from hazardous situations, was preferred. **Application:** Potential applications include providing directional collision alerts within the vertical plane, assisting pilot's elevation control, or navigation.

- **Keywords:** tactile displays, patial orienting aviation, alert

William S. Helton, Paul N. Russell. *The Effects of Arousing Negative and Neutral Picture Stimuli on Target Detection in a Vigilance Task*. S. 132-141.

Objectives: The present study was designed to explore whether target detection in a vigilance task is influenced by task-irrelevant negative emotional and neutral picture stimuli and to test predictions derived from the boredom-mindlessness versus resource depletion accounts of vigilance performance. **Background:** Previous research indicates that emotional stimuli can capture spatial attention. Research on the effect of negative emotional and neutral visual stimuli on temporal aspects of attention has not, however,

been researched in detail. **Method:** For this study, 51 participants (15 men and 36 women) were assigned at random to one of three vigilance conditions: a visual vigil with task-irrelevant negative-arousing pictures, a visual vigil with task-irrelevant neutral pictures, or a no-picture visual vigil control. Vigilance performance was assessed in all conditions. **Results:** Overall performance efficiency was negatively influenced by the negative-arousing pictures and was interpreted to favor resource depletion to boredom-mindlessness accounts of vigilance performance. **Conclusion:** Task-unrelated negative emotional stimuli appear to impair absolute levels of target detections in a vigilance task. **Application:** In monitoring settings where negative emotional stimuli are present, the intrusion of negative emotional stimuli should be mitigated via alterations in the system design, or if this is implausible, the monitors may need additional stress coping and emotional resilience training.

- ▪ **Keywords:** attention, emotion, picture processing, sustained attention, vigilance

Kelly S. Steelman, Jason S. McCarley, Christopher D. Wickens. *Modeling the Control of Attention in Visual Workspaces*. S. 142-153.

Objective: The present study developed and validated a stochastic model of overt attention within a visual workspace. **Background:** Technical specifications and recommended practices for the design of visual warning systems emphasize the role of alert salience. Task demands and display context can modulate alert noticeability, however, meaning that salience alone does not guarantee attention capture. **Method:** A stochastic model integrated elements from existing models of visual attention to predict attentional behavior in dynamic environments. Validation studies tested the predictions of the new model against scanning data from a high-fidelity simulator study and behavioral data from an alert detection experiment. **Results:** The model accurately predicted the steady-state distribution of attention within a simulated cockpit as well as the effects of color similarity, eccentricity, and dynamic visual noise on miss rates and response times in the alert detection task. **Conclusion:** The model successfully predicts attentional behavior in complex visual workspaces with the use of parameter values selected by either the modeler or a subject matter expert. **Application:** The model provides a tool to test the effectiveness of visual alerts in various display configurations and with varying task demands.

- ▪ **Keywords:** models of attention, visual attention,display design

DISPLAYS AND CONTROLS

Justin G. Hollands, Matthew Lamb. *Viewpoint Tethering for Remotely Operated Vehicles : Effects on Complex Terrain Navigation and Spatial Awareness*. S. 154-167.

Objective: The effect of viewpoint on the navigation of complex terrain and on spatial awareness was examined with the use of a simulated remotely operated vehicle. **Background:** The ability to build terrain models in real time may soon allow remote vehicular control from any viewpoint. A virtual tether couples the viewpoint to the vehicle's position and orientation, but shows more of the terrain than a fully immersive egocentric display. In this sense, it provides visual momentum by providing a view that incorporates egocentric and exocentric qualities. **Method:** For this study, 12 participants navigated a simulated vehicle across complex virtual terrain using five different display viewpoints: egocentric, dynamic tether, rigid tether, 3-D exocentric, and 2-D exocentric. While navigating, participants had to avoid being seen by simulated enemy units. After the navigation task, participants' spatial awareness was assessed using a recognition task. **Results:** The tethered displays minimized the time during which the participant's vehicle was visible to enemy positions. The egocentric display was more effective than exocentric displays (2-D or 3-D) for navigation, and the exocentric displays were more

effective than egocentric for time seen during navigation and the recognition task. The tethered displays produced intermediate results for navigation and recognition. **Conclusion:** Viewpoint tethering produced the most effective displays for minimizing time seen, but tethered displays were less effective than egocentric and exocentric displays for navigation and recognition, respectively. **Application:** A tethered display is recommended for applications in which it is necessary to understand the relation of nearby locations to one's own location.

- ▪ **Keywords:** navigation,remotely operated vehicles, spatial awareness, spatial cognition, tethered displays, unmanned ground vehicles, virtual environments

PSYCHIOLOGICAL STATES AND NEUROERGONOMICS

Shengguang Lei andMatthias Roetting. *Influence of Task Combination on EEG Spectrum Modulation for Driver Workload Estimation*. S. 168-179.

Objective: This study investigates the feasibility of using a method based on electroencephalography (EEG) for deriving a driver's mental workload index. **Background:** The psychophysiological signals provide sensitive information for human functional states assessment in both laboratory and real-world settings and for building a new communication channel between driver and vehicle that allows for driver workload monitoring. **Methods:** An experiment combining a lane-change task and n-back task was conducted. The task load levels were manipulated in two dimensions, driving task load and working memory load, with each containing three task load conditions. **Results:** The frontal theta activity showed significant increases in the working memory load dimension, but differences were not found with the driving task load dimension. However, significant decreases in parietal alpha activity were found when the task load was increased in both dimensions. Task-related differences were also found. The driving task load contributed more to the changes in alpha power, whereas the working memory load contributed more to the changes in theta power. Additionally, these two task load dimensions caused significant interactive effects on both theta and alpha power. **Conclusion:** These results indicate that EEG technology can provide sensitive information for driver workload detection even if the sensitivies of different EEG parameters tend to be task dependent. **Application:** One potential future application of this study is to establish a general driver workload estimator that uses EEG signals.

- ▪ **Keywords:** electroencephalography, operator functional state,sdriver mental states, psychophysiological measures, n-back, lane-change task

David W. Eccles, Paul Ward, Tim Woodman, Christopher M. Janelle, Christine Le Scanff, Joyce Ehrlinger, Carole Castanier, and Stephen A. Coombes. *Where's the Emotion? : How Sport Psychology Can Inform Research on Emotion in Human Factors*. S. 180-202.

Objective: The aim of this study was to demonstrate how research on emotion in sport psychology might inform the field of human factors. **Background:** Human factors historically has paid little attention to the role of emotion within the research on human-system relations. The theories, methods, and practices related to research on emotion within sport psychology might be informative for human factors because fundamentally, sport psychology and human factors are applied fields concerned with enhancing performance in complex, real-world domains. **Method:** Reviews of three areas of theory and research on emotion in sport psychology are presented, and the relevancy of each area for human factors is proposed: (a) emotional preparation and regulation for performance, (b) an emotional trait explanation for risk taking in sport, and (c) the link between emotion and motor behavior. Finally, there are suggestions for how to continue cross-talk between human factors and sport psychology about research on emotion and related topics in the future. **Results:** The relevance of theory and research on emotion in

sport psychology for human factors is demonstrated. **Conclusion:** The human factors field and, in particular, research on human-system relations may benefit from a consideration of theory and research on emotion in sport psychology. **Application:** Theories, methods, and practices from sport psychology might be applied usefully to human factors.