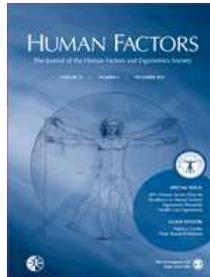


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AEROSPACE SYSTEMS

Christopher K. McClernon, Michael E. McCauley, Paul E. O'Connor, and Joel S. Warm. *Stress Training Improves Performance During a Stressful Flight*. S. 207-218.

Objective: This study investigated whether stress training introduced during the acquisition of simulator-based flight skills enhances pilot performance during subsequent stressful flight operations in an actual aircraft. **Background:** Despite knowledge that preconditions to aircraft accidents can be strongly influenced by pilot stress, little is known about the effectiveness of stress training and how it transfers to operational flight settings. **Method:** For this study, 30 participants with no flying experience were assigned at random to a stress-trained treatment group or a control group. Stress training consisted of systematic pairing of skill acquisition in a flight simulator with stress coping mechanisms in the presence of a cold pressor. Control participants received identical flight skill acquisition training but without stress training. Participants then performed a stressful flying task in a Piper Archer aircraft. **Results:** Stress-trained research participants flew the aircraft more smoothly, as recorded by aircraft telemetry data, and generally better, as recorded by flight instructor evaluations, than did control participants. **Conclusions:** Introducing stress coping mechanisms during flight training improved performance in a stressful flying task. **Application:** The results of this study indicate that stress training during the acquisition of flight skills may serve to enhance pilot performance in stressful operational flight and, therefore, might mitigate the contribution of pilot stress to aircraft mishaps.

- **Keywords:** stress exposure training, performance under stress pilot training, aviation safety, flight training, pilot performance, cold pressor, stress coping

AUTOMATION, EXPERT SYSTEMS

Joseph B. Lyons, Charlene K. Stokes, Kevin J. Eschleman, Gene M. Alarcon, Alex J. Barelka. *Trustworthiness and IT Suspicion : An Evaluation of the Nomological Network*. S. 219-229.

Objective: The authors evaluated the validity of trust in automation and information technology (IT) suspicion by examining their factor structure and relationship with decision confidence. **Background:** Research on trust has burgeoned, yet the dimensionality of trust remains elusive. Researchers suggest that trust is a unidimensional construct, whereas others believe it is multidimensional. Additionally, novel constructs, such as IT suspicion, have yet to be distinguished from trust in

automation. Research is needed to examine the overlap between these constructs and to determine the dimensionality of trust in automation. **Method:** Participants ($N = 72$) engaged in a computer-based convoy scenario involving an automated decision aid. The aid fused real-time sensor data and provided route recommendations to participants who selected a route based on (a) a map with historical enemy information, (b) sensor inputs, and (c) automation suggestions. Measures for trust in automation and IT suspicion were administered after individuals interacted with the automation. **Results:** Results indicated three orthogonal factors: trust, distrust, and IT suspicion. Each variable was explored as a predictor of decision confidence. Distrust and trust evidenced unique influences on decision confidence, albeit at different times. Higher distrust related to less confidence, whereas trust related to greater confidence. **Conclusion:** The current study found that trust in automation was best characterized by two orthogonal dimensions (trust and distrust). Both trust and distrust were found to be independent from IT suspicion, and both distrust and trust uniquely predicted decision confidence. **Application:** Researchers may consider using separate measures for trust and distrust in future studies.

- **Keywords:** trust in automation, suspicion, trustworthiness, decision confidence

Nirit Yuviler-Gavish, Daniel Gopher. *Effect of Descriptive Information and Experience on Automation Reliance*. S. 230-244.

Objective: The present research addresses the issue of reliance on decision support systems for the long term (DSSLT), which help users develop decision-making strategies and long-term planning. It is argued that providing information about a system's future performance in an experiential manner, as compared with a descriptive manner, encourages users to increase their reliance level. **Background:** Establishing appropriate reliance on DSSLT is contingent on the system developer's ability to provide users with information about the system's future performance. **Method:** A sequence of three studies contrasts the effect on automation reliance of providing descriptive information versus experience for DSSLT with two different positive expected values of recommendations. **Results:** Study 1 demonstrated that when automation reliance was determined solely on the basis of description, it was relatively low, but it increased significantly when a decision was made after experience with 50 training simulations. Participants were able to learn to increase their automation reliance levels when they encountered the same type of recommendation again. Study 2 showed that the absence of preliminary descriptive information did not affect the automation reliance levels obtained after experience. Study 3 demonstrated that participants were able to generalize their learning about increasing reliance levels to new recommendations. **Conclusion:** Using experience rather than description to give users information about future performance in DSSLT can help increase automation reliance levels. **Applications:** Implications for designing DSSLT and decision support systems in general are discussed.

- **Keywords:** system design, decision making, recommendation, decision aid, acceptance

CONSUMER PRODUCTS, TOOLS

Liang Zeng, Robert W. Proctor, Gavriel Salvendy. *Fostering Creativity in Product and Service Development: Validation in the Domain of Information Technology*. S. 245-270.

Objective: This research is intended to empirically validate a general model of creative product and service development proposed in the literature. **Background:** A current research gap inspired construction of a conceptual model to capture fundamental phases and pertinent facilitating metacognitive strategies in the creative design process. The model also depicts the mechanism by which design creativity affects consumer behavior. The validity and assets of this model have not yet been investigated. **Method:** Four

laboratory studies were conducted to demonstrate the value of the proposed cognitive phases and associated metacognitive strategies in the conceptual model. Realistic product and service design problems were used in creativity assessment to ensure ecological validity. **Results:** Design creativity was enhanced by explicit problem analysis, whereby one formulates problems from different perspectives and at different levels of abstraction. Remote association in conceptual combination spawned more design creativity than did near association. Abstraction led to greater creativity in conducting conceptual expansion than did specificity, which induced mental fixation. Domain-specific knowledge and experience enhanced design creativity, indicating that design can be of a domain-specific nature. Design creativity added integrated value to products and services and positively influenced customer behavior. **Conclusion:** The validity and value of the proposed conceptual model is supported by empirical findings. **Application:** The conceptual model of creative design could underpin future theory development. Propositions advanced in this article should provide insights and approaches to facilitate organizations pursuing product and service creativity to gain competitive advantage.

- **Keywords:** product/service creativity, ergonomic design, creative process, metacognitive strategy, customer behavior

DISPLAYS AND CONTROLS

Select this article Richard H. Y. So, N. M. Leung, Andrew B. Horner, Jonas Braasch, K. L. Leung. *Effects of Spectral Manipulation on Nonindividualized Head-Related Transfer Functions (HRTFs)*. S. 271-283.

Background: Directional sounds simulated using nonindividualized head-related transfer functions (HRTFs) often result in front-back confusion. **Objective:** This study was designed to examine how manipulating these nonindividualized HRTF spectra can reduce front-back confusion in headphone-simulated directional sounds. **Method:** HRTFs of six ear-level directions were studied (angles of 0°, 45°, 135°, 180°, 225°, and 315°). The HRTF gains in each of six frequency bands (200 to 690 Hz, 690 to 2400 Hz, 2400 to 6500 Hz, 6500 to 10000 Hz, 10000 to 14000 Hz, and 14000 to 22000 Hz) were amplified or attenuated by 0, 12, or 18 dB. Each manipulated HRTF generated a directional sound stimulus. For this study, 32 participants were invited to localize the randomly ordered stimuli. **Results:** The results indicate that a 12- or 18-dB manipulation of five of the six frequency bands produced significantly better directional accuracy, with significantly less front-back confusion. A reduction of up to 70% in localization error was obtained, along with 66% less front-back confusion. Significant interactions were found between the manipulation level and frequency. **Conclusion:** A 12-dB spectral manipulation of selected HRTF frequency bands produces better directional accuracy. **Application:** The results of this research could be applied to the development of tunable nonindividualized HRTFs for audio products.

- **Keywords:** spectral cues, HRTFs, virtual surround sound, sound localization, binaural directional cues

SENSORY AND PERCEPTUAL PROCESSES

Daniel Oberfeld, Heiko Hecht. *Fashion Versus Perception : the Impact of Surface Lightness on the Perceived Dimensions of Interior Space*. S. 284-298.

Objectives: We compare expert opinion with perceptual judgment regarding the influence of color on the perceived height and width of interior rooms. **Background:** We hypothesize that contrary to popular belief, ceiling and wall lightness have additive effects on perceived height, whereas the lightness contrast between these surfaces is

less important. We assessed the intuitions of architectural experts as to which surface colors maximize apparent height and compared these intuitions with psychophysical height and width estimates for rooms differing in ceiling, floor, and wall lightness. **Method:** Experiment 1 was a survey of architectural experts and nonexperts. Experiments 2 and 3 presented virtual rooms varying in physical height, physical width, and surface lightness. **Results:** In Experiment 1, both experts and nonexperts erroneously assumed that the lightness contrast between ceiling and walls influences perceived height. Experiment 2 showed that the lightness contrast does not determine apparent height but that ceiling and wall lightness have additive effects. Experiment 3 demonstrated a decrease in perceived width with physical height, whereas the perceived height was not related to physical width. Apparent width was unaffected by ceiling lightness. **Conclusion:** Light ceiling and light walls make a room appear higher, whereas floor color has a weaker effect. We also found evidence for an asymmetric interaction between height and width. **Application:** The question of how to color walls and ceiling to maximize the apparent size of a room can be answered empirically. Aesthetic considerations may interfere with the correct assessment of the effects of color in experts.

- **Keywords:** room perception, architecture, architectural psychology, interior design, height, color, brightness, contrast, depth, psychophysics, visual perception, lighting, illumination, interior space, spaciousness, virtual reality

Yusuke Yamani, Jason S. McCarley. *Visual Search Asymmetries in Heavy Clutter : Implications for Display Design. S. 199-307.*

Objective: An experiment aimed to test whether design of symbology to produce visual search asymmetries might facilitate target detection in cluttered displays. **Background:** A visual search asymmetry exists between two stimuli when a target of one type is found efficiently among distractors of the second type but a target of the second type is found with difficulty among distractors of the first type. Asymmetries have generally been studied within relatively sparse displays. In the present study, the authors tested whether an asymmetry driven by stimulus familiarity persists within heavily cluttered imagery. **Method:** In this study, 10 participants performed a visual search task using stimuli (canonical vs. reversed *N*s) known to produce a search asymmetry. Search stimuli were embedded within geospatial images containing either low or high levels of clutter. A decision theoretic index of sensitivity served as the dependent measure. **Results:** The search asymmetry was robust against the presence of heavy display clutter. Specifically, sensitivity was greater when the target was a reversed *N* rather than an *N*, and this pattern remained within cluttered displays. Time-accuracy analysis revealed that the search asymmetry increased the rate of information accumulation roughly equally within low- and high- clutter images. **Conclusion:** Search asymmetries are robust against heavy, spatially continuous visual clutter. **Application:** Design of display symbology to produce visual search asymmetries can offset the costs of visual clutter, maximizing detectability of task-critical information in complex displays.

- **Keywords:** visual search, visual clutter, attention, displays

SIMULATION AND VIRTUAL REALITY

Jason D. Moss, Eric R. Muth. *Characteristics of Head-Mounted Displays and Their Effects on Simulator Sickness. S. 308-319.*

Objective: We examined the effects of several display characteristics of head-mounted displays (HMDs) on simulator sickness (SS). **Background:** Technological limitations, such as display delay and reduced field of view (FOV), affect perception when using an HMD and are often thought to be related to SS. Few studies have examined the relationship between FOV and geometric FOV (image scale factor) or how HMD

characteristics may interact. **Method:** Participants made active head movements to locate objects when viewing a live video via an HMD. **Results:** Compared with no added delay, an additional 200 ms of display delay did not result in increased SS, as measured by the Simulator Sickness Questionnaire. Furthermore, an effect of image scale factor on SS was not revealed. However, SS was greater when peripheral vision was occluded than when it was not. Peripheral vision moderated the effects of image scale factor and delay on head movement velocity. **Conclusion:** Occluding peripheral vision may subject HMD users to the potential detrimental consequences of HMD characteristics more than when peripheral vision of the external environment is available, resulting in more SS. Future research should investigate to what extent peripheral vision can be occluded without increasing SS and without sacrificing realism and presence. **Application:** To reduce the occurrence of SS, a degree of peripheral vision of the external world should be provided. Furthermore, users and designers should be aware that head movement behavior may be affected by HMD characteristics.

- **Keywords:** simulator sickness, virtual environments, delay, field of view, image scale factor, peripheral vision