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Číslo 4

Tématické celky:

- Aerospace systems
- Aging
- Biomechanics, anthropometry, work physiology
- Cognitive processes
- Consumer products, tools
- Displays and controls
- Sensory and perceptual processes

AEROSPACE SYSTEMS

Knecht, William R. *Testing a Multidimensional Nonveridical Aircraft Collision Avoidance System*. S. 565-575(11).

Abstract: Objective: This study explores operators' ability to use a multidimensional, nonveridical control display. **Background:** Veridical displays represent realistic scenes. State space displays represent nonveridical n-dimensional information based on informative coordinate axes plus variable features such as color and shading. Empirical investigation of state space displays is relatively new to human factors research. **Method:** Twelve licensed general aviation pilots flew flight scenarios, trying to deviate as little as possible from a preassigned course while still maintaining standard en route separation from traffic. Flight performance using only a veridical cockpit display of traffic information (CDTI) was compared with performance using the CDTI augmented by a 4-D nonveridical state space collision avoidance system (CDTI+4CAS). **Results:** Using moderate traffic density and complex traffic geometry, the CDTI+4CAS condition showed performance superiority over the baseline CDTI-only condition for five of five dependent measures of maneuver efficiency, four of four measures of maneuver safety, and six of nine measures of user workload. **Conclusion:** Results suggest that nonveridical information display may enhance operator performance on a control task involving simultaneous processing of multidimensional information. **Application:** Nonveridical information displays have potential application wherever human control of multidimensional processes is involved.

- **Keywords:** AIRBORNE SEPARATION ASSURANCE SYSTEMS; NONVERIDICAL DISPLAYS; SYSTEM DESIGN FEATURES; VISUAL DISPLAYS; PICTORIAL

DISPLAYS; OBJECT DISPLAYS; COLLISION AVOIDANCE SYSTEMS; AEROSPACE SYSTEMS; DISPLAYS AND CONTROLS

Thomas, Lisa C.; Wickens, Christopher D. *Display Dimensionality and Conflict Geometry Effects on Maneuver Preferences for Resolving In-Flight Conflicts*. S. 576-588(13).

Abstract: Objective: Two experiments explored the effects of display dimensionality, conflict geometry, and time pressure on pilot maneuvering preferences for resolving en route conflicts. **Background:** With the presence of a cockpit display of traffic information (CDTI) that provides graphical airspace information, pilots can use a variety of conflict resolution maneuvers in response to how they perceive the conflict. Inconsistent preference findings from previous research on conflict resolution using CDTIs may be attributable to inherent ambiguities in 3-D perspective displays and/or a limited range of conflict geometries. **Methods:** Pilots resolved predicted conflicts using CDTIs with three levels of display dimensionality; the first had two 2-D orthogonal views, the second depicted the airspace in two alternating 3-D perspective views, and the third had a pilot-controlled swiveling viewpoint. **Results:** Pilots demonstrated the same preferences that have been observed in previous research for vertical over lateral maneuvers in low workload and climbs over descents for level-flight conflicts. With increasing workload the two 3-D perspective displays, but not the 2-D displays, resulted in an increased preference for lateral over vertical maneuvers. Increased time pressure resulted in increased vertical maneuvers, an effect again limited to the two 3-D perspective displays. **Conclusion:** Resolution preferences were more affected by workload and time pressure when the 3-D perspective displays were used, as compared with the 2-D displays, although overall preferences were milder than in previous studies. **Application:** Investigating maneuver preferences using the strategic flight planning paradigm employed in this study may be the key to better ensure pilot acceptance of computer-generated resolution maneuvers.

- **Keywords:** AVIATION; COCKPIT DISPLAY; CONFLICT AVOIDANCE; STRATEGIC FLIGHT PLANNING; AEROSPACE SYSTEMS; ATTENTIONAL PROCESSES; VISUAL DISPLAYS; PICTORIAL DISPLAYS; OBJECT DISPLAYS; DISPLAYS AND CONTROLS

AGING

Morrow, Daniel G.; Rogers, Wendy A. *Environmental Support : An Integrative Framework*. S. 589-613(25).

Abstract: Objective: In this qualitative review, we develop an integrative framework to bring coherence to the concept of environmental support (ES) in the fields of human factors and cognitive aging. **Background:** The ES hypothesis, originally formulated to explain effects of retrieval support on age-related differences in memory by reducing need for self-initiated processing, has been applied to many domains, such that the concept now encompasses many manipulations and measures. We developed a framework in which different types of ES share a common function (external support of performance) but differ in how this function is accomplished. ES improves performance by reducing task demands on mental resources or promoting effective use of resources. Previous reviews show that ES can decrease age-related differences in performance (more benefit for older adults), provide equal benefit, or increase differences (more benefit for younger adults). We proposed that the outcome will depend on properties of the ES, task, and person. **Method:** We applied our framework to the domains of language comprehension and human-computer interaction, selecting studies representative of differing outcomes for ES. **Results:** In both domains, we found that outcomes depended on ES, task, and person. Age differences were more likely to be reduced by ES that imposed minimal prerequisites for use and targeted processes that needed support. **Conclusion:** Our review helps refine the ES concept by identifying

conditions under which age differences in performance are reduced or magnified by ES. **Applications:** The framework provides guidance for human factors practitioners to design tasks and environments for older adults.

- **Keywords:** AGING; COGNITION; MEMORY; AGE-SENSITIVE DESIGN; HUMAN-COMPUTER INTERACTION; LANGUAGE COMPREHENSION; ENVIRONMENTAL SUPPORT

Český abstrakt: V tomto kvalitativním přehledu je vyvíjen integrační rámec k zavedení koherence do koncepce environmentální podpory (EP) v oblasti lidských faktorů a kognitivního stárnutí. Byl vyvinut rámec, aplikovaný na oblasti porozumění jazyku a interakci člověk-počítač, a vybrány studie představující různé výsledky EP. Rámec poskytuje směrnice pro praxi v oblasti lidských faktorů při navrhování úkolů a prostředí pro starší osoby.

- prostředí životní - jednání - výkon pracovní - faktor lidský - úkoly kognitivní

Pak, Richard; Price, Margaux M. *Designing an Information Search Interface for Younger and Older Adults.* S. 614-628(15).

Abstract: Objective: The present study examined Web-based information retrieval as a function of age for two information organization schemes: hierarchical organization and one organized around tags or keywords. **Background:** Older adults' performance in information retrieval tasks has traditionally been lower compared with younger adults'. The current study examined the degree to which information organization moderated agerelated performance differences on an information retrieval task. The theory of fluid and crystallized intelligence may provide insight into different kinds of information architectures that may reduce age-related differences in computer-based information retrieval performance. **Method:** Fifty younger (18-23 years of age) and 50 older (55-76 years of age) participants browsed a Web site for answers to specific questions. Half of the participants browsed the hierarchically organized system (taxonomy), which maintained a one-to-one relationship between menu link and page, whereas the other half browsed the tag-based interface, with a many-to-one relationship between menu and page. This difference was expected to interact with age-related differences in fluid and crystallized intelligence. **Results:** Age-related differences in information retrieval performance persisted; however, a tag-based retrieval interface reduced age-related differences, as compared with a taxonomical interface. **Conclusion:** Cognitive aging theory can lead to interface interventions that reduce age-related differences in performance with technology. In an information retrieval paradigm, older adults may be able to leverage their increased crystallized intelligence to offset fluid intelligence declines in a computer-based information search task. **Application:** More research is necessary, but the results suggest that information retrieval interfaces organized around keywords may reduce age-related differences in performance.

- **Keywords:** AGING; HUMAN-COMPUTER INTERACTION; HCI; MENUS; INTERFACE EVALUATION; USABILITY; COMPUTER SYSTEMS; COGNITIVE PROCESSES

Český abstrakt: Studie zkoumala vyhledávání webových informací jako funkci věku pro dvě informační organizační schémata: hierarchickou organizaci a schéma uspořádané kolem tagů nebo klíčových slov. Bylo zjištěno, že přetrvávají věkové rozdíly v této činnosti; rozhraní pro vyhledávání založené na "tags" však tyto rozdíly omezuje ve srovnání s taxonomickým rozhraním.

- věk - internet - rozhraní - informace - vyhledávání

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSILOGY

Bush, Tamara Reid; Hubbard, Robert P. *A Comparison of Four Office Chairs Using Biomechanical Measures*. S. 629-642(14).

Abstract: Objective: The authors sought to use biomechanical measures, including motion and pressure, to compare four office chairs. **Background:** The fit of a person to a chair is related to the geometric and kinematic compatibility between the two. This geometric compatibility influences the motions that are allowed or prohibited and the support pressures at the body-chair interface. Thus, during evaluation, it is necessary to treat the chair and user as a system. **Method:** Four dynamic test conditions were evaluated with 14 participants of varying anthropometries. Test conditions were selected to compare the ability to accommodate primary and secondary motions (recline and spinal articulation) of seated occupants. The ability of a chair to allow recline, yet maintain head and hand positions, was compared across chairs. Also, the ability of each chair to allow and support spinal articulation was evaluated. Motion data for the chair, head, thorax, pelvis, and extremities were collected along with chair back pressures. Upon completion of testing, subjective assessments were also conducted. **Results:** Statistically significant differences were found between chairs relative to head and hand motions. Also, significant differences were noted for the chairs' ability to move with the body during spinal articulation and the ability to provide support. Subjective assessments also yielded differences. **Conclusions:** Biomechanical analyses using motions and pressures can be conducted on office chairs with significant differences detected in their performance. **Application:** Biomechanical assessments can be used to compare and contrast office chairs in terms that are relatable to fatigue reduction as well as operator performance.

- **Keywords:** BIOMECHANICS; ANTHROPOMETRY; WORK PHYSIOLOGY; MODELS AND MEASURES; WORKSPACE; BUILT ENVIRONMENT DESIGN; MACROERGONOMICS AND THE ENVIRONMENT; COMFORT; OFFICE CHAIRS; OBJECTIVE MEASURES; KINEMATICS; SEATING MECHANICS

Český abstrakt: Jsou použita biomechanická měření, včetně pohybu a tlaku, ke srovnání čtyř kancelářských židlí. Vhodnost osoby pro použití židle má vazbu na geometrickou a kinematickou kompatibilitu mezi nimi. Ta ovlivňuje pohyby, jež jsou povoleny nebo zakázány, a podpůrné tlaky na rozhraní tělo-sedadlo. Statisticky významné rozdíly mezi sedadly byly zjištěny při pohybu hlavy a rukou.

- židle - kanceláře - sedadla - nábytek sedací

COGNITIVE PROCESSES

Neth, Hansjörg; Khemlani, Sangeet S.; Gray, Wayne D. *Feedback Design for the Control of a Dynamic Multitasking System : Dissociating Outcome Feedback From Control Feedback.* S. 643-651(9).

Abstract: Objective: We distinguish outcome feedback from control feedback to show that suboptimal performance in a dynamic multitasking system may be caused by limits inherent to the information provided rather than human resource limits. **Background:** Tardast is a paradigm for investigating human multitasking behavior, complex system management, and supervisory control. Prior research attributed the suboptimal performance of Tardast operators to poor strategic task management. **Methods:** We varied the nature of performance feedback in the Tardast paradigm to compare continuous, cumulative feedback (global feedback) on performance outcome with feedback limited to the most recent system state (local feedback). **Results:** Participants in both conditions improved with practice, but those with local feedback performed better than those with global feedback. An eye gaze analysis showed increased visual attention directed toward the feedback display in the local feedback condition. **Conclusion:** Predicting performance in the control of a dynamic multitasking system requires

understanding the interactions between embodied cognition, the task being performed, and characteristics of performance feedback. In the current case, at least part of what had been diagnosed as a deficit caused by limited cognitive resources has been shown to be data limited. **Application:** Perfect outcome feedback can provide inadequate control feedback. Instances of suboptimal performance can be alleviated by better feedback design that takes into account the temporal dynamics of the human-system interaction.

- **Keywords:** FEEDBACK DESIGN; MULTITASKING; COMPLEX SYSTEM MANAGEMENT; PROCESS CONTROL; ATTENTION ALLOCATION; DYNAMIC DECISION MAKING; MONITORING; SUPERVISORY CONTROL; DISPLAY-CONTROL COMPATIBILITY; DISPLAYS AND CONTROLS; FUNCTIONAL ANALYSIS; UNIT TASK; INTEGRATED COGNITIVE SYSTEMS; HUMAN PERFORMANCE MODELING; COGNITIVE PROCESSES

Český abstrakt: Účelem bylo ukázat, že suboptimální výkon v dynamickém víceúkolovém systému může být způsoben spíše limity inherentními poskytovaným informacím spíše než limity lidského zdroje. Tardast je paradigma pro výzkum lidského víceúkolového jednání, managementu složitého systému a kontroly. Účastníci v obou podmínkách se zlepšovali s praxí, ale ti s lokální zpětnou vazbou měli výkon lepší než s globální.

- výkon pracovní - jednání - vazba zpětná - management - kontroly

CONSUMER PRODUCTS, TOOLS

Martin, Cortney V.; Smith-Jackson, Tonya L. *Evaluation of Pictorial Assembly Instructions for Young Children.* S. 652-662(11).

Abstract: Objective: We examined the usability of common formats of pictorial toy assembly instructions for 6- and 9-year-old children. **Background:** Interlocking building toys and models are increasingly prevalent and important for developing spatial abilities and fine motor skills among children. Little is known about how effectively the intended child users can interpret and carry out the instructions. **Method:** Twenty-four children used five sets of manufacturer-supplied pictorial toy assembly instructions. We evaluated the impact of toy instruction set, age, gender, and previous experience on usability problems, assembly speed and accuracy, instruction gaze time, and subjective ratings. **Results:** The children had difficulty with all but the simplest instructions and assemblies. As predicted, older participants assembled more quickly, with fewer errors and fewer instruction looks. However, the 6-year-old girls assembled the fewest parts correctly, and the 9-year-old girls reported having the least fun. Instruction look time and frequency revealed differences in instruction complexity and were correlated with subjective ratings of fun. Thirty-two usability problems were observed, and 10 are described in detail. **Conclusion:** Product age recommendations may not reflect developmentally appropriate instructions. Small design changes should contribute to improved instruction usability among young children. For instance, designers should avoid complex graphic syntax, depict colors accurately, select clear angles of view, and support natural tendencies to assemble top to bottom. **Application:** This research provides pictorial assembly instruction guidelines to inform instruction designers and describes performance and look-time benchmarks for future usability studies.

- **Keywords:** ASSEMBLY; INSTRUCTIONS; PICTORIAL INSTRUCTIONS; ASSEMBLY INSTRUCTIONS; TOY ASSEMBLY; CHILDREN; CONSUMER PRODUCTS; TOOLS; USABILITY; DESIGN GUIDELINES; GRAPHIC SYNTAX; CONSTRUCTION; PLAY

DISPLAYS AND CONTROLS

Burns, Catherine M.; Skraaning, Gyrd; Jamieson, Greg A.; Lau, Nathan; Kwok, Jordanna; Welch, Robin; Andresen, Gisle. *Evaluation of Ecological Interface Design for Nuclear Process Kontrol : Situation Awareness Effects*. S. 663-679(17).

Abstract: Objective: We determine whether an ecological interface display for nuclear power plant operations supports improved situation awareness over traditional and user-centered displays in a realistic environment. **Background:** Ecological interface design (EID) has not yet been fully evaluated with real operators facing realistic scenarios. **Method:** Ecological displays were evaluated alongside traditional and user-centered "advanced" displays in a full-scope nuclear power plant simulation. Licensed plant operators used the displays in realistic scenarios that either had procedural support or did not have procedural support. All three displays were evaluated for their ability to support operator situation awareness. **Results:** A significant three-way interaction effect was observed on two independent measures of situation awareness. For both measures, ecological displays improved situation awareness in scenarios that did not have procedural support, primarily in the detection phases of those scenarios. No other pronounced effects appeared across both measures. **Conclusions:** The observed improvement was sufficiently large to suggest that EID could improve situation awareness in situations where procedures are unavailable. However, the EID displays did not lead to improved situation awareness in the other conditions of the evaluation, and participants using these displays occasionally underperformed on single measures of situation awareness. This suggests that the approach requires further development, particularly in integrating EID with procedural support. **Application:** This research has important findings for the ongoing development of the EID approach, the design of industrial operator displays, and design to support situation awareness.

- **Keywords:** ECOLOGICAL INTERFACE DESIGN; SITUATION AWARENESS; DISPLAYS AND CONTROLS; OBJECT DISPLAYS; DECISION MAKING; COGNITIVE PROCESSES; NATURALISTIC DECISION MAKING; INTERFACE EVALUATION; USABILITY; PROBLEM SOLVING; REASONING; VISUAL DISPLAYS; PICTORIAL DISPLAYS; COGNITIVE PROCESSES; COMPUTER SYSTEMS; PROCESS CONTROL; NUCLEAR POWER; DISPLAYS AND CONTROLS

Český abstrakt: Bylo zjišťováno, zda displej ekologického rozhraní pro podporu operací jaderné elektrárny zlepšil uvědomění situace ve srovnání s tradičními a na uživatele zaměřenými displeji v reálném prostředí. Jsou uvedeny výsledky hodnocení tří displejů z hlediska významného trojcestného efektu interakce při dvou nezávislých měřeních.

- displeje - rozhraní - ekologie - elektrárny jaderné

O'Brien, Marita A.; Rogers, Wendy A.; Fisk, Arthur D.; Richman, Mark. *Assessing Design Features of Virtual Keyboards for Text Entry*. S. 680-698(19).

Abstract: Objective: The present research examined design of a virtual keyboard for text entry with a rotary controller, emphasizing users who differ in age and system experience. **Background:** Existing research has minimally addressed usage frequency, age, and the effects of display shape and letter arrangement on movement and visual search components of text entry tasks. The present research was conducted to close these gaps. **Method:** Two experiments were completed to examine younger (18-28 years) and older (60-75 years) adults' movement and visual search capabilities using four keyboard shapes and three keyboard arrangements. In a third experiment examining combined effects on shape design, 32 younger (18-28 years) and 32 older (60-75 years) adults entered words on the two best shapes from the first experiments. **Results:** For the movement task, movement time was lowest for shapes with higher shape-controller compatibility. For the visual search task, search time and accuracy were best on the alphabetic arrangement. In the combined task, shape did not significantly

influence performance at different levels of practice. Transfers, however, suggested that the shape with salient visual features elicited a text entry strategy for older adults that may promote more consistent performance under occasional usage. **Conclusion:** The studies together demonstrate that keyboard shape is important for efficient performance. Shape-controller compatibility facilitated performance in both age groups. Salient features facilitate performance, especially for older adults. In nearly all cases alphabetic arrangement yielded the best performance. **Application:** Recommendations are provided for virtual keyboard design for different usage frequencies, contexts, and users.

- **Keywords:** AGE DIFFERENCES; AGING; DESIGN; INCIDENTAL LEARNING; INPUT DEVICES; KEYBOARD; MOVEMENT; ROTARY CONTROLLER; TEXT ENTRY; TRANSFER; USABILITY TESTING; VISUAL SEARCH; DISPLAYS AND CONTROLS

Český abstrakt: Byla zkoumána konstrukce klávesnice pro textový vstup s otočným ovládačem, používané osobami různého věku a zkušeností. Pro pohybové úkoly byl čas pohybu nejnižší u tvarů s vyšší kompatibilitou mezi tvarem klávesnice a ovládačem. U vizuálního vyhledávání byl čas a přesnost nejlepší při abecedním uspořádání. U kombinovaného úkolu neměl tvar významný vliv na výkon u různých úrovní praxe.

- klávesnice - konstrukce - ovládače - věk - praxe - úkoly pracovní

SENSORY AND PERCEPTUAL PROCESSES

Gibb, Randy; Schvaneveldt, Roger; Gray, Rob. *Visual Misperception in Aviation : Glide Path Performance in a Black Hole Environment*. S. 699-711(13).

Abstract: Objective: We sought to improve understanding of visual perception in aviation to mitigate mishaps in approaches to landing. **Background:** Research has attempted to identify the most salient visual cues for glide path performance in impoverished visual conditions. Numerous aviation accidents caused by glide path overestimation (GPO) have occurred when a low glide path was induced by a black hole illusion (BHI) in featureless terrain during night approaches. **Method:** Twenty pilots flew simulated approaches under various visual cues of random terrain objects and approach lighting system (ALS) configurations. Performance was assessed relative to the desired 3° glide path in terms of precision, bias, and stability. **Results:** With the high-ratio (long, narrow) runway, the overall performance between 8.3 and 0.9 km from the runway depicted a concave approach shape found in BHI mishaps. The addition of random terrain objects failed to improve glide path performance, and an ALS commonly used at airports induced GPO and the resulting low glide path. The worst performance, however, resulted from a combination ALS consisting of both side and approach lights. Surprisingly, novice pilots flew more stable approaches than did experienced pilots. **Conclusions:** Low, unsafe approaches occur frequently in conditions with limited global and local visual cues. Approach lights lateral of the runway may counter the bias of the BHI. The variability suggested a proactive, cue-seeking behavior among experienced pilots as compared with novice pilots. **Application:** Visual spatial disorientation training in flight simulators should be used to demonstrate visual misperceptions in black hole environments and reduce pilots' confidence in their limited visual capabilities.

- **Keywords:** BLACK HOLE ILLUSION; FEATURELESS TERRAIN ILLUSION; CONTROLLED FLIGHT INTO TERRAIN; AVIATION SAFETY; AVIATION VISUAL PERCEPTION; AVIATION VISUAL ILLUSIONS; GLIDE-PATH PERFORMANCE DEVIATIONS; APPROACH LIGHTING SYSTEMS; AVIATION RESEARCH; SENSORY AND PERCEPTUAL PROCESSES

Mayeur, Anaïs; Brémond, Roland; Bastien, J. M. Christian. *Effect of Task and Eccentricity of the Target on Detection Thresholds in Mesopic Vision : Implications for Road Lighting*. S. 712-721(10).

Abstract: Objective: The aim of this work is to assess how adding a driving-related task affects the detection of objects in peripheral vision, under mesopic conditions. **Background:** The main index used to assess the quality of road lighting installations refers to simple detection tasks in foveal vision, which raises methodological and practical questions. **Method:** The experimental design consisted of a three-phase experiment. In the first phase, two groups (control and experimental) performed a peripheral detection task (simple task). Based on these results an individual detection threshold was computed for each participant and eccentricity. A tracking task was performed in Phase 2 for both groups (steering a tracking target along a circuit, on a screen). In the third phase, the control group performed the same task as in Phase 2. The experimental group performed a double task, with a tracking (primary) task and a peripheral detection (secondary) task. **Results:** The data show an effect of the tracking task and eccentricity on peripheral event detection. The tracking task caused detection performance to decrease from 84.2% to 67.5%, $p < .001$. **Conclusion:** The small target visibility model used in road lighting may be improved, taking into account the effects of task and eccentricity on target detection. **Application:** This study supports improved roadway lighting design by guiding consideration of sign eccentricity and task load.

- **Keywords:** ROAD LIGHTING DESIGN; DETECTION THRESHOLD; MESOPIC VISION; SENSORY AND PERCEPTUAL PROCESSES; DOUBLE TASK PARADIGM