Summer 2010, IDTG Newsletter

Individual Differences in Human Performance TG

Featured Laboratory: Applied Sensory Psychology Laboratory at Old Dominion

J. Christopher Brill

The Applied Sensory Psychology Laboratory was originally founded in September of 2001 at the University of Central Florida. At the time, I named it the Applied Tactile Research Laboratory based upon our research focus: the human factors of vibrotactile display design and implementation. Soon our investigations expanded to include spatial audio and visual displays, leading me to adopt a less restrictive moniker (Applied Sensory Psychology -ASP Laboratory) reflect more accurately the evolving nature of our research. From 2001 to 2007, nineteen undergraduate research assistants were mentored in the ASP Laboratory. In August of 2007, the ASP Laboratory moved to the great white north, as I accepted a faculty position at Michigan Technological University in Michigan's Upper Peninsula. If I were to choose a single word to characterize this period in the lab's history, it would be … (continued on page 3)

Left to Right: Christina Reiger, Christopher Brill, and Rachael Foglesong in a lab meeting.

Development of an Automation System Being Adaptive to the Cognitive and Fine Motor Abilities of its User

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Within the last year at the University of Heidelberg and Mannheim (Germany) we have been working on automating the assessment of individual differences especially in cognitive and fine motor abilities. This assessment is expected to enable complex technical systems to adapt their level of automation such that the dependability of joint human-automation systems can be improved. Due to its focus on individual differences, this research might be of general interest for the readers of this newsletter. (Continued on page 4)

Wheel Chair System

Recently Published Articles

Special Issues:

Szalma, J. L. (2009b). Individual differences: incorporating human variation into human factors/ergonomics research and practice. *Theoretical Issues in Ergonomics Science, 10*(5), 377-379.

Burger, J. M. (2010). Participants are people too: Introduction to the special issue on individual differences and social influence. *Social Influence, 5*(3), 149-151.

Recent Journal Articles:

Baldwin, C. L., & Reagan, I. (2009). Individual differences in route-learning strategy and associated working memory resources. *Human Factors, 51*(3), 368-377.

Baldwin, C. L. (2009). Individual differences in navigational strategy: Implications for display design. *Theoretical Issues in Ergonomics Science, 10*(5), 443-458.

Chen, J. Y. C., & Terrence, P. I. (2009). Effects of imperfect automation and individual differences on concurrent performance of military and robotics tasks in a simulated multitasking environment. *Ergonomics, 52*(8), 907-920.

Drury, C. G., Holness, K., Ghylin, K. M., & Green, B. D. (2009). Using individual differences to build a common core dataset for aviation security studies. *Theoretical Issues in Ergonomics Science, 10*(5), 459-479.

Hancock, P. A., Hancock, G. M., & Warm, J. S. (2009). Individuation: The N = 1 revolution. *Theoretical Issues in Ergonomics Science, 10*(5), 481-488.

Ivanov, M., & Werner, P. D. (2010). Behavioral communication: Individual differences in communication style. *Personality and Individual Differences, 49*(1), 19-23.

Matthews, G., & Campbell, S. E. (2009). Sustained performance under overload: personality and individual differences in stress and coping. *Theoretical Issues in Ergonomics Science, 10*(5), 417-442.

Naugraiya, M., & Drury, C. G. (2009). A fractional factorial screening experiment to determine factors affecting discrete part process control. *Theoretical Issues in Ergonomics Science, 10*(1), 1-17.

Parasuraman, R. (2009). Assaying individual differences in cognition with molecular genetics: theory and application. *Theoretical Issues in Ergonomics Science, 10*(5), 399-416.

Salthouse, T. A. (2010). Is flanker-based inhibition related to age? Identifying specific influences

Purpose

The Individual Differences in Performance Technical Group (IDTG) was established to serve human factors and ergonomics professionals who share an interest in any of the wide range of personality or individual differences variables that are believed to mediate human performance. Members of IDTG share a common view that the study of these differences as related to human performance is not only useful, but also may lead to better selection, training, design of equipment and operational environments, and prediction of human task performance.

TG Officers

Program Chair: Jim Szalma

Newsletter Editor: Carryl L. Baldwin

Elections to be held soon for the following positions:

Chair: Your name could be here

Secretary/Treasurer: You?

Webmaster: Your Name Could be Here

Consider volunteering for one of these positions. Contact Carryl or Jim if interested.

(*Featured laboratory, cont.)*
"interdisciplinary."

During my time at Michigan Tech, I incorporated non-psychology majors into the research team, including undergraduate and graduate students in computer science, biology, and electrical engineering. Most of our research pertained to multiple resource theory and used the Multi-Sensory Workload Assessment Protocol (M-SWAP) as a loading task capable of presenting information visually, auditorily, or tactually. We also began developing a multi-modal vigilance task for use in future multiple resource theory investigations. However, my time at Michigan Tech was brief – substantial growing pains associated with space and resource limitations led me to consider other employment options.

The Mechanical Engineering Students from Team Rock working on the LOAD (Linear Oscillating Acceleration Device) . From left to right: Brandon Zoss, Tom Dugan, and Eric Burns.

In the summer of 2009, I once again moved the laboratory – this time to its present location (and what I hope is a more enduring home) at Old Dominion University in Norfolk, Virginia. The ASP Laboratory at ODU features greater capabilities than ever before. The majority of our "start-up" equipment has been acquired, which includes wireless and laboratory grade vibrotactile displays (Engineering Acoustics, Inc.), equipment for tactile display calibration (function generators, oscilloscope, accelerometers), a high-end Tobii eyetracker, spatial audio recording equipment, sound meters, computers equipped with experiment generator software (SuperLab and ePrime) with response boxes, and some physiological recording equipment (J & J Engineering) for measures such as GSR, EEG, EMG, respiration, and ECG.

Upcoming HFES 2010 - We have three paper sessions:

Plan to Attend the IDTG Sessions in San Diego

The IDTG will have three paper sessions at the upcoming Annual Conference in San Diego:

Tuesday September 28th 3:30-5:00 PM

Wednesday September 29th 1:30-3:00 PM

Thursday, September 30th, 3:30-5:00 PM

(featured Laboratory – contd.)

Our space consists of two suites: a five-room suite plus a separate open lab space with an adjoining office/control room. All rooms have cable pass-throughs, access hatches, and one-way mirrors. At present, our efforts will be divided between two seemingly different, though complementary areas of research. One area of research involves multiple resource theory, interactions between multi-modal signals, and cognitive workload assessment. This is the type of research with which I've been involved for the past ten years. The second area of research involves studying responses to motion and its effects on human performance. This research harkens back to my days as a graduate student at the University of West Florida, when I worked at the Naval Aerospace Medical Research Laboratory (NAMRL) at Pensacola Naval Air Station. It represents a long neglected area of research to which I've longed to return. Work on this line of research has been made possible with grant funding through the Virginia Space Grant Consortium New Investigator award.

For conducting motion research, a room is being remodeled to house a custom-built optokinetic drum (OKD). A second room will house another motion device: a Linear Oscillating Acceleration Device (LOAD). The LOAD slowly "rocks" people fore and aft under closed-loop control. It is being designed and manufactured by a team of senior mechanical engineering students under the supervision of Dr. Sebastian Bawab (Prof. of Mechanical Engineering) and myself. The operating frequency range will likely be 0.05 to 1 Hz. The OKD and the LOAD are instrumental to our investigations into sopite syndrome, a response to mild motion characterized by intense drowsiness, difficulty concentrating, malaise, and irritability. One would be hard-pressed to identify a better-suited area for studying individual differences. Susceptibility to motion is highly variable across people. Research in this area requires consideration of past responses to motion, the most accurate predictor of future responses.

This allows us to either divide participants into groups based upon susceptibility or to treat susceptibility as a covariate. If insufficiently controlled or accounted, the wide within-groups variability obscures between-groups differences that may, in fact, be present.
Several students have become involved in research at the Applied Sensory Psychology Laboratory at ODU, including two undergraduate psychology majors, a post-baccalaureate psychology student, and the three mechanical engineering students. Next year offers additional opportunities for growth: I have taken on my first PhD student (human factors), a master's student (general psychology), and four of undergraduate research assistants. We look forward to continued growth and a productive research program.

–Dr. Chris Brill

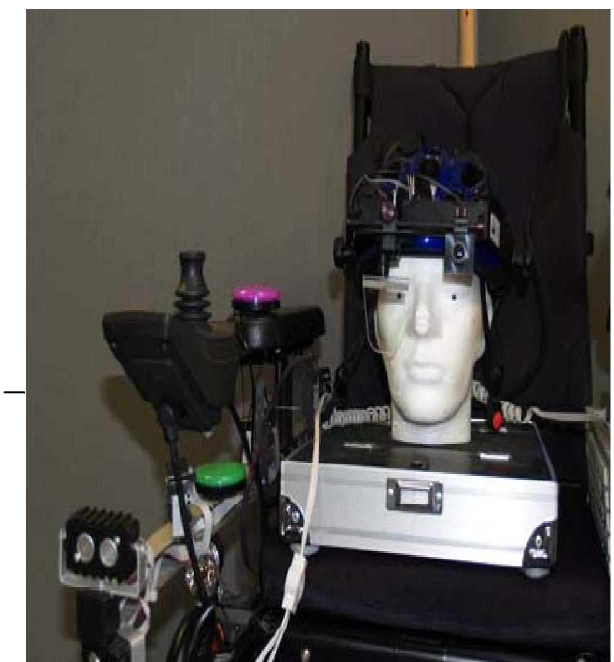
Development of an Automation System Being Adaptive to the Cognitive and Fine Motor Abilities of its User (cont.)

The automation system that we use as a demonstration platform is an electrically powered wheelchair (see Fig. 1), which is an off-the-shelf system and was equipped with additional hard- and software, such that it can be operated on different levels of assistance/automation: It first provides a collision avoidance behavior (see ultrasonic sensors in Fig. 2), which prevents the wheelchair from colliding with static and moving obstacles/humans in the environment. Second, it was enabled to navigate autonomously. If this behavior is active, it allows the wheelchair user entering a desired goal position via a touch-screen and drives the user autonomously to it. Third, the wheelchair system uses a head-mounted eye- and head-tracking system (see Fig. 2) for realizing an intention estimation behavior, which runs on two levels: On the lower level, the user's gaze behavior is analyzed to distinguish movement-relevant and -irrelevant gaze patterns (e.g., searching for an object in the environment). If the gaze behavior is judged as being movement-relevant the wheelchair drives into the user's gaze direction. On the higher intention estimation level, the gaze durations are analyzed and the system aims at identifying the object in the environment, which is the user's current goal. If the system detects such an object, it asks the user whether it really is the desired goal and if the user agrees, it drives the user autonomously to it (for a more detailed description of the system, see Bartolein, Wagner, Jipp, & Badreddin, 2007, 2008).

As this description already demonstrates, the wheelchair system offers different levels of automation. While, in the human factors field, classifying levels of automation (cf. Endsley, & Kaber, 1997; Parasuraman, Sheridan, & Wickens, 2000) is based on the definition of roles, which are either performed by the user or by the automation system, the levels of automation of the wheelchair system are grounded in the recursive, nested behaviour-based control structure (Badreddin, 1989 or 1991), which is a system control structure often used in the field of mobile robotics.

There is an extensive amount of research going on in the human factors field on when which level of automation should be active (cf. Parasuraman, Bahri, Deaton, Morrison, & Barnes, 1990; Prinzel, Freeman, Scerbo, Mikulka, & Pope, 2000). Criteria, which are applied, are workload (cf. Prinzel, Freeman, Scerbo, Mikulka & Pope 2000) or human performance (cf. Kaber & Riley, 1999). However, individual differences in cognitive or fine motor abilities have hardly been considered as criteria for adapting automation, which is where our research comes in. We would like to enable an automation system to assess the cognitive or fine motor ability of its user and turn automation on/off depending on the ability level.

In order to do so, we (1) demonstrated that individual differences in cognitive and fine motor abilities are predictive especially of the occurrence of safety-critical situations and (2) aimed at identifying behavioral cues, which are indicative about these abilities and which can be measured by a technical system autonomously. For this purpose, we conducted a study during which we asked our participants to drive through a standardized course with our wheelchair system repeatedly – once with each level of automation. While driving, we automatically measured variables such as the route taken, the input signal, the time required to reach a goal position, the velocities driven, or the distances to the objects spread in the environment. These measures were used, amongst others, to calculate individual indices for safety and dependability. After driving, we asked our participants to fill in usability questionnaires and to complete a cognitive ability test and test on fine motor abilities.



Means of operating Wheelchair (Joystick, switches, eye and head tracking system)

With this data base, we investigated in a first step the impact of individual differences in cognitive and fine motor abilities on the safety and dependability while driving through the course. The general linear model analyses we conducted yielded promising results: The cognitive abilities had significant effects on the dependability and safety, as had the fine motor abilities (especially the wrist-finger speed and the precision) (for a detailed description of the results, see Jipp, Bartolein, Wagner, & Badreddin, 2009; Jipp, Wagner, Bartolein, & Badreddin, n.d.). These results demonstrate the importance to automate functions on the basis of the individual ability levels when the safety and dependability is to be increased.

In a second step, we identified automatically assessable variables, which are indicative for these abilities being relevant for the safety and dependability of the user-wheelchair system. For this purpose, we analyzed correlational patterns between the above mentioned fine motor abilities and the velocities, times, routes taken and input signals measured while driving.
These patterns indicate that there are significant correlations especially between the automatically measurable variables and the precision ability. For example, there is a highly significant correlation between the time driven and the precision ability (Jipp, Bartolein, & Badreddin, 2009).

On the basis of these results, we modeled the precision ability with Bayesian Networks in a third step (Jipp, Bartolein, Badreddin, Abkai, & Hesser, 2009). While the inputs into this model are the automatically assessable variables, which are indicative about the user's ability, its output is a vector indicating the probabilities with which a user belongs to a given list of precision ability levels. To validate the Bayesian Network, we conducted validation experiments, which yielded quite positive results: The Bayesian Network can predict the users' precision ability with a level of correctness between 70% and 80%. The probability of a true classification depends on the sample size used for parameter learning. Hence, after having completed this modeling step, we have a method available which allows automatically assessment the users' abilities, which predict the safety and dependability with which a user drives with a powered wheelchair.

Currently we are working on defining the optimal level of assistance/automation depending on a given ability level, such that the occurrence of safety-critical situations is less probable. In the future, we will then implement both, i.e. the automated assessment of the user's abilities and the reasoning on the appropriate level of automation, such that a wheelchair system results, which level of automation is adaptive to the user's individual differences and which will be evaluated, for example, with regard to user acceptance, stability, and dependability.

Not a member? Consider joining. The IDTG is 200+ members strong and dues are just $4 a year. You need not be a member of HFES to join. For more information, contact one of the officers or HFES MemberDesk.

Telephone: 310-394-1811

Till Next time......
Send your News of Note, recent publications pertaining to Individual Differences in Performance and Laboratory spotlights to be featured in the next newsletter to Carryl Baldwin at cbaldwi4@gmu.edu at George Mason University

Hope to see you in San Francisco!
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Carryl Baldwin
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