Scheduling Accessory Assists Patients with Cognitive Disorders

Originating Technology/NASA Contribution

Neuropsychology is the study of how the brain relates to behavior, emotion, and cognition. Clinical neuropsychologists evaluate the behavioral effects of neurological and developmental disorders stemming from brain injury, strokes, multiple sclerosis, Alzheimer's disease, and Parkinson's disease. Millions of Americans are currently living with these cognitive disorders, including a growing number of veterans returning from Iraq with brain injuries. The disorders often result in cognitive impairments which make it difficult to plan daily activities and stay on task, affecting independence, quality of life, and employment.

In the early 1990s, Richard Levinson, a NASA contractor and senior researcher in Ames Research Center's Artificial Intelligence Research Branch and Autonomous Systems Group, took the science in an entirely different direction when he folded it into his NASA work.

Levinson, who had previously received a Space Act Award for contributing to the development of a prototype autonomous thermal control system for the International Space Station, initially learned about neuropsychology accidentally. Moving into a new apartment in 1986, he received a neuropsychology course program in the mail that was actually intended for the previous occupant. The topic intrigued Levinson, and the pursuit to learn more was on.

As Levinson learned about emerging neuropsychological models of human planning, he continued researching computer models of automatic planning. A central concern for both fields is that plans often change when surprises occur. Neuropyschologists study how this integrated planning and execution breaks down as the result of cognitive impairment, but they do not know exactly how planning occurs in the brain. On the other side, computer scientists can build a planning system, but have a limited understanding of how to integrate planning with execution monitoring and error recovery.

Levinson studied the neuropsychology of human planning and applied this knowledge to his NASA research in order to increase autonomy for spacecraft and robots. Since spacecraft and robots operate in uncertain conditions, they cannot be preprogrammed for every activity, so there are times that they must be responsible for their own "health" and safety. Further, as NASA's missions grow more complex, so does the Agency's need for machines that can exhibit a higher degree of independence and execute improvised actions in novel situations where preprogrammed commands will not work.

In 1995, Levinson published peer-reviewed research papers in computer science and neuropsychology journals, describing an artificially intelligent planning and reaction model founded on neuropsychological theories of human behavior. This planning and reaction model was based on the functioning of the human brain's frontal lobes, which play a part in memory, motor skills, planning, decision making, and socialization, among other functions.

Levinson has since received three patents for the technology, pertaining to activity planning and cueing methods with execution monitoring and error correction.

While Levinson and NASA continue to investigate this advanced computer model for future missions, the technology has already made its terrestrial debut in the form of a powerful cueing and scheduling aid to help people with a wide range of cognitive, attention, and developmental disorders.

Partnership

Levinson received initial funding from NASA and his contracting company, Recom Technologies Inc., of Roseville, California, to research the commercial potential of his artificially intelligent planning reaction model to serve as a tool for helping individuals suffering from various forms and levels of brain impairment. In 1993, the chief of Ames' Artificial Intelligence Research Branch suggested that Levinson contact Santa Clara Valley Medical Center, which hosts a nationally acclaimed rehabilitation and research center that specializes in brain injuries, to see if the hospital was interested in a research collaboration. Levinson heeded the advice and found a valuable partner in the medical center. This partnership led to further development of Levinson's technology and funding to support clinical research from the U.S. Department of Education's National Institute on Disability and Rehabilitation Research.

In 1996, Levinson founded Attention Control Systems Inc., in Mountain View, California, to produce and market this NASA spinoff creation.

Product Outcome

Attention Control Systems now offers people with memory, attention, and cognitive disorders a computerized, personal planning device to help them stay on task by overcoming limitations in planning and fulfilling their daily schedules. The device, called the Planning and Execution Assistant and Trainer, or PEAT, is a pocket-sized PDA, complete with a graphical display, touchscreen controls, an electronic calendar, an address book, and a built-in phone. The functionality of PEAT, however, transcends that of a regular PDA scheduling device. PEAT cues users to start or stop scheduled activities, monitors their progress, and adjusts schedules as necessary in response to delays or calendar changes. It uses the automatic planning model developed for NASA to make automatic adjustments to daily plans when a situation changes. Most PDA systems lack this flexibility, requiring their users to manually re-plan and update schedule data when changes occur.

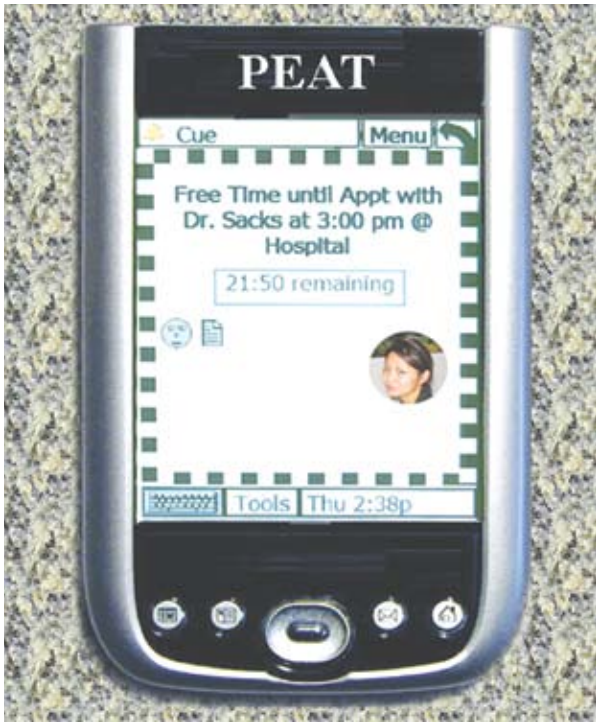
While daily routine activities come naturally to most, individuals with memory, attention, and cognitive impairment may struggle to remember that they have to perform certain tasks. Those with severe impairment to the point where independent living is a challenge are affected most, as they may not only forget to perform tasks, but forget how to perform them.

Whether individuals are mildly or severely impaired, PEAT makes it easier for them to get through their planned schedules by providing cues for task completion and adjusting for unplanned schedule conflicts. PEAT can automatically shift flexible tasks that do not require an exact start time in order to keep the prioritized, scheduled events on track. For example, an individual using PEAT wakes up to a preplanned day that consists of having breakfast with a family member from 9:30 to 10:30, followed by stopping at the bank, and then seeing a 12:00 matinee show with a friend (the individual receives cues from PEAT to inform him/her of all of these scheduled tasks). This agenda was preprogrammed in the user's device (either programmed by the user or by a caregiver, depending on the degree of impairment), with breakfast and the movie being the top-priority scheduled tasks, and the bank trip being a secondary, unscheduled routine task.

Not everything goes as planned, however. It turns out that breakfast takes longer than the scheduled hour, so the user does not have time to stop at the bank before the movie. Since the bank trip did not require an exact start time, it is a task that PEAT can automatically shift to another available time. This way, the task, though delayed, is not ignored and will not be forgotten, and the individual's priority tasks—breakfast and the movie—are not interrupted.

The automatic cues that PEAT delivers to its users to start and stop activities can be in the form of customized voice recordings, sounds, and pictures; extra large text and pictures help users with visual and motor problems. Cueing continues until the user responds. Additionally, users can program customized scripts (activity sequences) for breaking large tasks into multiple, small tasks. This feature is especially helpful for highly impaired users who may find difficulty completing tasks such as getting dressed in the morning or fixing themselves a meal.

PEAT's Cue Card display provides a countdown timer until the next scheduled event and cues the user to start or stop at the scheduled time. Highly impaired users may be locked into this Cue Card section, which means they will only see reminders for one event at a time. This mode keeps the reminders simple and does not create unwarranted confusion for these users. Other users with less impairment may have the option to override cues by starting and stopping them early, and can delay, skip, reschedule, or altogether cancel the cues. The device keeps a log of all of these actions, so that the caregivers and family members can evaluate how well a user is adapting to the technology and accomplishing real-world tasks. For the user, the accomplishments boost independence and confidence, and diminishes cost of care.



PEAT is a powerful cueing and scheduling aid to help people with a wide range of cognitive, attention, and developmental disorders.

"PEAT can be simplified by hiding features so that highly impaired users will use a system with far less features than higher-functioning users," stated Levinson. "We start off simple with each user and add options over time. In some cases, a caregiver or therapist sets up the schedule and the user must only respond to cues, while PEAT monitors their progress and automatically adjusts the schedule as necessary," he added.

PEAT is sold as a complete system that includes software, hardware, documentation, and technical support. In addition to the flagship Pocket PEAT device, there is PEAT Phone: software that runs on cellular phones; PC PEAT: software that runs on desktop and laptop PCs, where the larger screen and keyboard may be used to configure the system, enter data, train users, and back up data; and PEAT Link: software that links the Pocket PEAT device to PC PEAT for software copying and data transfer.

PEAT is currently providing planning and execution assistance to patients at Department of Rehabilitation facilities in 25 states, Santa Clara Valley Medical Center, the U.S. Department of Veterans Affairs' Palo Alto Health Care System, and to school districts and assistive technology centers.

At the Palo Alto hospital's Polytrauma Rehabilitation Center, Dr. Harriet Zeiner, lead clinical neuropsychologist, has developed treatment protocols for troops returning from overseas with mild traumatic brain injuries from improvised explosive devices, as well as for soldiers with post-traumatic stress disorder. Zeiner's treatments include using the PEAT device as a memory prosthesis.

Meanwhile, clinical studies of PEAT continue at Santa Clara Valley Medical Center. Levinson also foresees the technology he first developed for autonomous robotic planning to have "spin-in" application for NASA's astronauts. ❖

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