Presentation at the National Institutes of Health Neural Prosthesis Workshop
October 13-15, 1992

Computer Software as an Orthosis for Brain Injury

Elliot Cole[1], Parto Dehdashti[1], Linda Ann Petti[1], and Marlene Angert[2]
[1]Institute for Cognitive Prosthetics, 111 Presidential Blvd, Suite 102, Bala Cynwyd, PA 19004
[2]Moss Rehabilitation Hospital, Philadelphia, PA 19141

Introduction

Closed head injury (CHI) leaves many survivors with disabilities to cognitive deficits which are not resolved by rehabilitation; premorbid level of function cannot be achieved, even with existing compensatory strategies. Applying concepts from computer science, a model was developed for computer software to assist CHI survivors with enduring higher level cognitive deficits. Our previous work has demonstrated success in partial restoration of function using highly customized computer software.

Method

Subjects were outpatients one year or more post-injury, and with rehabilitation which failed to achieve functional restoration.

Subjects' enduring deficits included memory, orientation to time, visual scanning, and cognitive flexibility and executive functions -- initiation, organization, planning, attention and concentration, impulsivity. The experimental intervention goal for a subject was a single activity or type of activity chosen from among the activities which the subject was unable to perform without supervision.

Subject behaviors were then analyzed by a team of rehabilitation psychologists and computer scientists to determine which subtasks in the target activity were problematic for the subject. The team then defined software and interface features which were necessary to enable the subject to perform the activity without supervision. Although there was a software system designated a starting point, the intervention system was designed for each subject based on that subject's need. Performance measures for the software and interface included: 1) minimal training time for subject to learn how to use the software; 2) no confusion in use of the software to perform the target activity; 3) self-sufficiency in task completion. Major design decisions were made collectively by the team.

Subjects then participated in software and interface testing and redesign, resulting in more complex designs. Testing involved an analysis of each screen as well as the working system. Sources of confusion were identified, and modifications agreed upon by therapist, patient, and computer scientist. Subjects were invited to choose the colors for the screens used in their systems. When design issues were resolved, subjects were trained on the final system. Computers for two subjects were installed in their home, along with a dedicated phone line for a modem. The third subject used a notebook computer. Software redesign was ongoing.

Results

The study's goals were achieved and exceeded. Because each subject achieved their goal quickly, additional interventions were set and were also achieved. Therapists documented improvements in subjects' targeted activities and goals, as well as other cognitive and affective dimensions. There were no decreases in level of functioning in any dimension of the Saykin Neurobehavioral Activity Scale.

There were major changes in rehabilitation delivery system. Perhaps the most important were remote therapy sessions; the therapist dialed into the patient computer on one phone line, and talked with the subject over a second phone line. Therapists report that this permitted them "to enter the subjects' environment and monitor progress, impose structure, ameliorate problems, provide encouragement and gain a better sense of control over the subjects' treatment."

Subjects and therapists reported that they have become empowered by the computer based cognitive prosthesis technology.

The software development environment exceeded its expectations by being able to deliver a total of 23 software versions. System features and interfaces were different for each of the three subjects.