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Assistive Technology in Traumatic Brain Injury

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GENERAL PRINCIPLES

Assistive Technologies (AT) may serve important roles in rehabilitation, community living, education, and employment for people who have survived traumatic brain injuries (TBIs). AT is defined in the AT Act of 2004 as, "... any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities (29 U.S.C. Sec 2202(2))," and includes, "any service that directly assists an individual with a disability in the selection, acquisition, or use of an AT device." So AT can include a wide range of high-tech and low-tech devices and services. Variations on this definition of AT are found in federal laws related to vocational rehabilitation and special education and are relevant in terms of funding AT.

For AT to be adapted successfully, it is important that the user be actively involved in making decisions about AT selection. Not only should the needs of the individual with TBI be considered, but also the needs and preferences of family members or care givers; the "unit" of consideration should be the dyad or even family [1]. Other key considerations are the cognitive and motor prerequisites for use of AT, fatigue, access to technical assistance and even repair after the AT is deployed, and obviously funding is a major issue.

AT needs should be evaluated at differing stages of recovery, ranging from inpatient rehabilitation to outpatient rehabilitation to community re-entry to long-term living. Not only do individual needs change, but options for funding the AT change as well.

In considering AT solutions, we strongly recommend an interdisciplinary approach. Without careful consideration, AT can actually decrease performance on targeted tasks. Thinking through the AT carefully with the interdisciplinary team and individual with TBI is crucial. For example, in considering compensatory strategies in the workplace for memory deficits, a speech pathologist and rehabilitation counselor might consider the advantages and disadvantages of low-tech solutions such as memory books versus more complex AT systems including electronic calendaring.

FUNCTIONAL DOMAINS AND AT

Mobility

Many people who have survived TBI may require mobility aids. We will not discuss these here since the topic is addressed elsewhere (see Chapter 31).

Navigation

People with TBI may have difficulty navigating independently [2]. There are systems in place in many larger communities to provide training in using public transportation, door to door transit, and other options, which people with TBI may use to navigate independently. GPS on hand-held devices may be useful, although some people with TBI find the map interfaces to be too complex and difficult to use in community navigation [3]. Some GPS devices, including those on some smart phones, give voice output related to upcoming landmarks that may be more useful. It is important to not have individuals relying on systems such as looking at screens while walking, which may put them at risk for missing important environmental events and/or cues.

Caregiver Assurance

Some caregivers may be willing to negotiate more community independence for people with TBI if there is a way that they can monitor individuals' locations. Although there are clearly ethical and privacy issues associated with this, we have found that people with TBI are often willing to agree to this, especially if they can turn off the tracking devices. There are a number of commercial systems available, many of which use a standard mobile phone as a location device. Consideration of a backup plan in case the device is lost or loses power is critical; a plan should be in place to assure a way for an individual to "call for help."

Taking Notes

For students in K-12 or postsecondary education, or employees, taking notes is often critical. Unfortunately, because of difficulties with divided attention, people with TBI often say that they cannot take notes and listen at the same time and that they have difficulty taking notes because they cannot discern the salient points in real time. One option is to audio-record lectures or meetings, but audio recordings themselves require a lot of effort to review. A low-tech option is to request a note taker as a reasonable accommodation in class, but even with this, individuals often want to be able to annotate as they go. One option that has been very useful for a number of individuals is the Livescribe®. This system uses a pen to record audio and sync it with handwritten notes. The individual can take very general notes, and then when reviewing the notes, can listen to audio playback corresponding to the time the notes were taken.

Memory Aids

Sometimes the "old way" is the "best way," and memory books ranging from calendars to daily planners to more complex paper and pencil systems have been successfully used for years. The disadvantages of these systems are that users may misplace or lose them, forget to record events or tasks, forget to check the memory book, or may create information overload by inserting numerous "yellow stickies," loose pieces of paper, and so on, so that they are overwhelmed. Electronic devices such as smart phones, tablets, alpha pagers, and computers may be useful. Using electronic devices is easiest for people who

already have experience with them since less new learning is required. It is important to fit the use of any memory device into the day to day routine of the individual, and to the extent possible, the context of their memory needs. Key considerations are:

1. What functions does it perform? Calendar, task list, phone, text, e-mail?
2. Is the visual display easily readable? Is it too cluttered or distracting?
3. Is there speech output?
4. Is the keyboard/text entry usable?
5. Is there voice to text input?
6. Is it compatible with what other family members, friends, or others use at home or at work?
7. How difficult is it to learn to use?
8. Is it redundant—that is, is there back up in case it gets lost, is not charged, or breaks?
9. Is there technical assistance when the user runs into problems?

Although many smart phones, or even "feature phones" include calendars, we strongly recommend using cloud-based calendars and task lists instead such as Google® or Outlook Exchange®. There are several significant advantages. First, if the phone or tablet or other primary device gets lost, the information remains in the "cloud." Second, the calendar and task lists can be shared with others. This can be a tremendous advantage because trusted family members, teachers, or others can be given access to the calendars/task lists and can ensure that key events or scheduled alarms are set, tasks are broken down into components, and so on.

Note that in many calendar systems, appointments, events, and even steps in tasks that need to be completed may be entered into the calendar and alarms can be enabled. One feature useful for some people is to have alarms set to send a text message reminder to the phone or voice output saying, for example, "appointment with Dr. Gray in 15 minutes," or, "transfer to Bus #2 to hospital in five minutes."

There are also a number of dedicated memory aids, such as key fobs to help remember where one's car is parked and medisets for storing pills that remind the user to take meds.

Many people use e-mail as a form of memory aid. They e-mail themselves, or keep e-mail in their inboxes as reminders. The problem with this for TBI survivors is that they may be overwhelmed with e-mail chaos. We will use the features associated with Microsoft Office Outlook® as examples here, but many e-mail products have similar features. Rules can be set for incoming e-mail. For example, a rule can be established that codes all incoming e-mail from certain people or domains by color, such as "all email from my boss is colored red in my inbox." Alternatively, incoming e-mail can be sorted into different folders. For example, "All email from my instructor is filed in the folder, 'Professor J.'" We recommend that decisions about managing complex e-mail systems be done in consultation with a specialist, such as a speech pathologist or psychologist, so that a balance is struck between reducing the inbox chaos and manageable efficiency.

COMPUTER ACCESS

The whole construct about computer access has changed as the lines between desktop computing, tablets, and mobile devices has blurred. Access to computers includes issues around cognition, vision, seating and positioning, voice, and motor control. We will begin by addressing standard desktop computers or tablets/notebooks set up for use as desktop computers.

Seating and Positioning

Ensuring appropriate seating and access to the computing tasks is critical to minimize fatigue and maximize ability to focus and concentrate, especially for anyone who may have had concurrent orthopedic trauma and/or chronic musculoskeletal pain and fatigue. There are a number of adjustable work surfaces that can be matched with seating schemes, and/or attached to power chairs. Mobile arm supports may be useful to reduce fatigue and improve accuracy of positioning of arm(s). These can be mounted on a power chair, or desktop.

Keyboards

There are a wide variety of off-the-shelf keyboards; individuals may find some easier to use than others. Many people coming through our clinic find that they prefer compressed keyboards, which require less movement to strike keys and can easily be mounted on power chairs, or custom mounted on desktops. For people with difficulty striking a single key, software settings may be set in the "accessibility" settings of the operating system to require that an individual dwell on a key before the stroke registers, or that brief unintentional key strokes are not recorded. Also, within word processing programs, macros can be enabled so that if a person habitually types "rhe" instead of "the," the correct word will be substituted. Alternatively, there are Lucite keyboard covers that have holes through which fingers or pointing devices are inserted to reach keys.

Word prediction may help with text entry as well on several fronts. As one begins to enter the text, the software predicts the intended word and rather than continuing to type, one can accept and move on. Users of mobile phones are familiar with this type of software. On desktop, notebook, or tablet devices, when phonetic spelling is entered, the software will predict the correct spelling. Word prediction software can turn writing into a "multiple choice" task and can be paired with keyboarding.

Voice Commands

Text may also be entered using voice commands with software built into the operating system (e.g., in Apple, Android, and Windows devices) or via standalone programs such as Naturally Speaking. Modern voice recognition software requires that text be entered as continuous speech for best recognition. To attain this, it is necessary to dictate at least whole phrases without pauses or incidental sounds such as "uhmmm." People with dysarthria or accented English often get very poor recognition. With Naturally Speaking for Windows products, the individual can speak into a digital recorder and then transcribe that using the software. This is sometimes an advantage because the user isn't viewing the text as it

is generated, which can be confusing and distracting. Voice recognition built into the operating system is often "user independent," but more sophisticated systems such as Naturally Speaking require that the user train the system to have the best results and often we have found that without adequate training and consultation, voice recognition software is not adequately integrated and used. Although one can use voice recognition software to manage computing "hands free," many people find that they are much more efficient if they can combine voice recognition with some key strokes or use of pointing devices.

Pointing Devices

Pointing devices, such as the computer mouse, can be challenging for people with motor deficits. It may be difficult to reach the target, and/or to click once the target is acquired. It may also be difficult to see and/or follow the tracking motion on the display. In the settings of the operating system, the sensitivity of the pointer may be set to either speed it up or slow it down. The image of the pointing device can also be changed to make it bigger and easier to see, and to provide a "tail" so one can view the movement more easily. Alternatives to conventional mouse pointers include joy sticks. The advantages of a joy stick is that when the user stops applying pressure, the pointer stops, as opposed to devices like a track ball where the pointer often moves off target. The disadvantage is that use is considerably slower. Touch pads may also be preferable for some users. In general, mouse clicks may be separated from pointers or used independently of pointers with independent switches, such as "big red" or micro-switches activated by electromyographic input (EMG). Individuals can also use a variety of pointing devices, such as mouth-operated joy sticks or even eye gaze, to enter text using on-screen keyboards and to manipulate computer actions.

Viewing the Screen

People may have difficulties with vision, including converging on the image, double vision, and field cuts. Some of these may be addressed by manipulating the size of the display, positioning the display to maximize vision, increasing image size, or using software for people with reading disabilities (see Reading Software in the section which follows). Displays come in all different sizes and the new LCD displays are light enough to allow for creative mounting and positioning. Tablets can be mounted to a variety of devices using Velcro, although it can sometimes be difficult to maximize both visual access and text/data entry. Screen enlargement options and changes in contrast can be found in the accessibility features or general display settings of operating systems. Alternatively, there are dedicated software packages such as ZoomText®, which enlarge all images on the screen, read the text to the user, and have advanced features. One point to keep in mind is that using these features may increase cognitive load. For example, as one increases the size of text, one reduces the amount of information available on the screen, and for people with cognitive difficulties, it may be difficult to keep track of where text is, and to move to text that is now off screen due to enlargement.

Reading Software

Reading text from a computer screen can be difficult for people with TBI. For some, having concurrent text to speech can help. There are lightweight options

such as ReadPlease®, which will read highlighted text to the user. There are more sophisticated packages designed for people with reading disabilities such as Kurzweil®, which import text in a variety of formats including PDF, highlight a portion of the text, such as a sentence, in one color, and the word being read in another color, and provide a selection of reading voices. These more elaborate systems may be useful for people with field cuts that are resolving, or difficulties sustaining attention. For example, we have had professionals use these systems to read professional journals while they were still in the healing process.

ENVIRONMENTAL CONTROL AND HOME AUTOMATION SYSTEMS

Managing the environment at home and at work may increase independence. Integrated environmental control systems have become ubiquitous and can be purchased at many big box stores and online. These systems can control heating, lighting, and so on, and the interfaces can be voice activated or switched. There are also a number of systems available to manage audio–video entertainment. Devices such as robotic vacuum cleaners should not be ignored either since they may provide additional independence. Of course, cost will always be a factor.

KEY POINTS

- Technology should be considered as an adjunct to other interventions for people with TBI.
- The relative value of technology should be weighed against potential negative consequences since technology may add to cognitive load.
- An interdisciplinary approach to technology and TBI is strongly advised.
- Consider physical/built environment and social context in which technology will be deployed.

ADDITIONAL READING

Electronic References

AbleData is a data base of tools and technologies to improve independence for people with disabilities: http://www.abledata.com/.

Alternative Finance Programs provide low cost loans for the purchase of AT: http://www.resnaprojects.org/allcontacts/allafpcontacts.html.

Statewide AT Act Programs provide demonstration and loan of AT: http://www.resnaprojects.org/allcontacts/statewidecontacts.html.

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