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Apps as Practical Solutions to Common Cognitive Issues

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Abstract

Cognitive disabilities from brain injuries are a prevalent and serious public health issue resulting in ongoing challenges for millions of individuals with brain injury. The integration of assistive technology for cognition along the rehabilitation continuum provides individuals with brain injury the opportunity for autonomy and independence. We propose a novel application (app) toolbox (BEST Suite app with five tools, Notability and Inspiration Maps) that supports executive function skills and the self–regulation process that can be generalized across contexts. The app toolbox is an essential component of the rehabilitative process for individuals with brain injury due to its ease of portability and accessibility to rehab professionals, patients, and caretakers.

Keywords: Assistive Technology, Smart Apps, Executive Function, Cognitive Prosthetic

Apps as Practical Solutions to Common Cognitive Issues

Cognitive disabilities from brain injuries are a prevalent and serious public health issue resulting in ongoing challenges for individuals with brain injury. Approximately 5.3 million Americans live with a disability related to brain injury (Thurman, Alverson, Browne & Dunn, 2016). Each year 2.5 million people suffer a traumatic brain injury (TBI) in the U.S. of which the majority, 90%, are mild injuries. This number is considered an underestimate as many patients either do not seek medical evaluation or are not diagnosed properly in the emergency department (Pozzato et al., 2020; Prince & Bruhns, 2017). Traumatic Brain Injuries (TBIs) may have a permanent impact on a patient's function regardless of how mild or severe the injury. Contrary to past belief, more than 50% of mild TBI patients have ongoing cognitive issues one year after their injury (Nelson et al., 2019; Pontikas et al., 2020; Theadom et al., 2016). The resulting cognitive difficulties impact the entire community and lead to significant quality of life issues for individuals with brain injury and their family members.

A notable advance in the past 20 years is the incorporation of Assistive Technology for Cognition (ATC) devices as compensatory tools to help individuals with brain injuries (Cicerone et al., 2000; Sohlberg, & Turkstra, 2011). The significance of the use of ATC is underscored by its integration as a practice standard for individuals with mild memory impairments, according to the American Congress of Rehabilitation Medicine (Cicerone et al., 2000; Haskins et al., 2014). Fortunately, with 81% percent of the mobile market using smart devices, it is becoming more common for individuals to have their own (Pew Research Center, 2020). The availability and popularity of mainstream smart devices, and their potential as daily ATC devices, significantly impacts the lives of individuals living with brain injury (Wild, 2012).

ATC includes a range of tools used to provide support for individuals with compromised cognitive ability (Cole, 1999; LoPresti et al., 2008; LoPresti et al., 2004; Michelsen et al., 2020; Sohlberg, M. M., & Turkstra, 2011). ATC resources range from low–tech options (e.g., paper calendars, timers) to specialized high–tech systems (e.g., tablets and smartphones). This popularity, implied normalcy, and sheer volume of mobile applications (apps) associated with the use of mainstream smart devices is quickly changing how

these devices are used and integrated into the rehabilitation community.

Access to and use of technology is no longer a convenience but a necessity. Technology provides an important bridge between what a person wants to do and what they can do (Wehmeyer et al., 2020). Information and Communication Technology–based Assistive Technology (ICT–based–AT) should be recommended for people with prospective memory problems, including those with a brain injury (Brandt et al., 2020). Smartphones have been shown to potentially improve autonomy and independence; however, it is vital for patients to receive support when using them (Wong et al., 2017).

Professionals specializing in the treatment of brain injury play a significant role in the selection and training of devices and apps. It is therefore important for rehabilitation facilities, counselors, therapists, and caregivers to have a working understanding of the devices and apps, in order to support the use of such tools. See Appendix A for sample training practices.

In addition to learning the basic procedures for using an app, individuals need to understand how the app will help them address cognitive challenges and achieve goals that are meaningful to them. The user must know how to implement the app in their daily lives, enabling them to receive the maximum benefit of the ATC (e.g., time, place, and context for app use).

Making Cognitive Connections

Cognitive rehabilitation therapy (CRT) is provided along a continuum of care from the acute inpatient hospitalization to vocational rehabilitation. The goal of CRT is to improve cognitive function, increase patient independence and reduce the impact of the patient's impairment on activities of daily living. In addition to the restorative goals of CRT, compensatory strategies including the use of technology are introduced as workarounds for patients' cognitive deficits. These compensatory strategies allow patients to accomplish more activities of daily living and participate more socially (Koehler et al., 2011).

A critical aspect of CRT is "Making Cognitive Connections," an approach designed to help those with brain injury learn to use technology, while becoming aware of the cognitive skills (e.g., attention to detail, critical thinking, etc.) involved in learning the technology (Wild, 2012). For example, becoming aware of and focusing attention on the cognitive skills involved in learning to use devices and/or apps can provide a foundation for learning other types of technology. In addition, this approach can help provide insights into how those same cognitive skills can be applied in other less technological aspects of life. Of note, CRT is most successful when patients, family members and caretakers all understand the benefits of ATC during the rehabilitation process.

Cognitive Skills and Generalization

Executive Function

Executive function is a set of cognitive skills that includes planning, initiation, monitoring, problem solving, metacognition and inhibitory control (Cicerone et al., 2000). Impaired executive function is the most persistent, prevalent, and debilitating result of a TBI (Haskins et al., 2014) and leads to a wide range of impaired cognitive abilities including organization, decision making, time management, goal setting, and self–regulation. These deficits have a profound impact on quality of life and social independence (Pettemeridou et al., 2020).

Executive function skills are often addressed in therapy via paper–pencil exercises which are typically not engaging and do not easily generalize to everyday life. The Making Cognitive Connections approach encourages the use of technology to address challenges of executive function and self–regulation. We pro-

pose the use of technology that explicitly teaches executive function skills and the self–regulation process that can be generalized across contexts.

Self–Regulation

Self–regulation is a cyclic process of planning, monitoring, and evaluating one's behavior in order to learn from and optimize end results over time. The *planning* phase allows individuals to consider the various aspects of a situation and establish a plan. The *monitoring* phase allows one to check their progress on a task and the quality of their performance as plans are implemented. *Evaluation* requires gathering the information from the planning and monitoring phases so that future plans may be modified as necessary. The evaluation phase is imperative to prevent individuals from repeating a plan with unsuccessful outcomes.

The entire self–regulation process can be difficult for individuals following brain injury, who may encounter difficulty at any one of these steps (Kennedy & Coelho, 2005; Kennedy, 2017). The development of this skill requires practice, prompting, and consistency in the rehabilitation environment.

Generalization

When using ATC in the rehabilitation environment, it is important that treatment be contextualized in a manner that can be generalized to day–to–day life. Individuals with brain injury, for example, often have the problem of transferring and generalizing skills learned from one environment to another (Togher et al., 2014). ATC should adapt both to the individual's needs as well as support planning activities useful in rehabilitation (Jamieson et al., 2020). Identifying and teaching cognitive skills while the survivor is learning and using technology is both practical and effective. ACT can be used as a compensatory tool in everyday life allowing for greater understanding and generalization opportunities.

App Toolbox

Although there are thousands of high–quality apps available, they are typically designed for the general population or for use in a specific therapy specialty (occupational or speech/language pathology). These apps are often not meant to be used outside of the therapeutic environment and as a result are not always helpful in the everyday life of the survivor.

A significant challenge is when working with individuals with brain injury is that they have complex needs, yet due to the very nature of their disability (cognitive deficits), they require solutions that are designed with their deficits in mind. Solutions need to be easy to use, accessible, convenient, and not visually overwhelming. In addition, the inclusion of a consistent user interface reduces or eliminates confusion.

Here, we propose a novel app toolbox to address the unique needs of individuals with brain injury as they engage in CRT and transition to their new normal. A toolbox, limited to four or five practical apps, is less overwhelming for individuals with brain injury and makes it easier for them to learn/relearn when app updates inevitably occur. It should include apps that are versatile and can be used for a variety of purposes. This engages individuals with brain injury and serves as a practical application of CRT. For these reasons, we recommend the following apps: the BEST Suite, Notability, and Inspiration Maps (see Table 1).

Table 1: Recommended App Toolbox

APP	PURPOSE
BEST Suite (5 tools in 1) – $9.99	
PaceMyDay	Plan and monitor energy and time
ReachMyGoals	Set and monitor SMART goals
StrategizeMyLife	Document, track, and rate strategies
CompleteMyToDos	Track and monitor productivity
CueMyList	Create checklists and prompt moving from one task to another
Notability – $8.99	Take notes with linked recording
Inspiration Maps – $9.99	Create graphic organizers/mind maps for organizing of ideas

App Toolbox Components

BEST Suite. The BEST Suite includes five tools in one. It is designed specifically for the brain injury community; however, it has been found to be beneficial for other populations dealing with cognitive challenges. Its primary purpose is to help with executive function skills and to help individuals with brain injury develop awareness, self–regulation, and insight.

The tools within the BEST Suite interact with each other and share information reducing frustration and the potential for entry errors. Although information is shared across the tools, each tool has a different emphasis.

PaceMyDay. The PaceMyDay tool is designed to help users plan and monitor their energy as they work on tasks throughout the day, helping them develop insight and manage neurofatigue. It encourages users to plan their day each morning after waking and assessing their overall sleep, fatigue and energy levels, helping them learn to be more realistic about what they may be able to accomplish. In addition, users monitor their physical and emotional well–being by responding to specific questions both before initiating a task and after the task is attempted. The information gathered can be used to help identify appropriate amounts of time to work on tasks and potential physical and emotional triggers that may impact individuals with brain injury on a daily basis.

ReachMyGoals. The ReachMyGoals tool helps users set SMART (specific, measurable, attainable, relevant, timely) goals. It allows users to create goals using a step–by–step guide, goal templates, or manually. Users can track their progress and monitor successes and challenges by completing a weekly check–in, which generates journals that can be shared with others to help with accountability.

StrategizeMyLife. The StrategizeMyLife tool provides a reliable place where individuals with brain injury can document, track, and rate the effectiveness of strategies introduced in therapy and/or those used in their daily lives. Strategies can be grouped and tagged so they are easy to find when needed. In addition, strategies can be rated based on their individual effectiveness so individuals with brain injury know which strategies are most helpful and reliable.

CompleteMyToDos. CompleteMyToDos is a task management tool designed to help users track tasks and projects. It helps users focus their attention on those tasks due ‘today’ rather than being distracted by all tasks on their list. It also allows users to track the number of times a task is worked on before being completed.

CueMyList. CueMyList serves as a tool to create simple checklists. It includes the ability for users to assign a duration per item and receive a prompt to move to the next item when the time expires. It allows users to create, organize, and reorder checklist headings and corresponding items, making it helpful for all kinds of lists (e.g., shopping, routines).

Note the similarity in interfaces among the tools in the BEST Suite (see Figure 1).

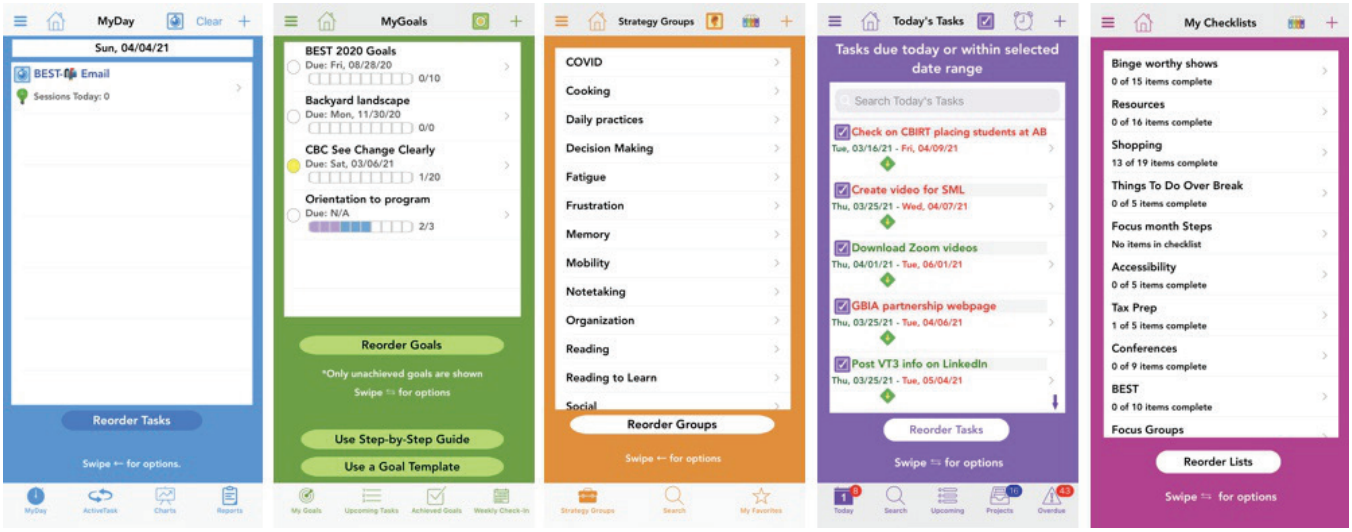

Figure 1: BEST Suite Tool Screens

Notability. Notability is a notetaking app designed for the general public that allows users to take typed or handwritten notes (e.g., during a lecture or doctor's appointment) and record audio at the same time. The audio recording is timed to the notes entered for quick and easy access to specific information. In addition, handwritten notes can be converted to text. Notability includes the ability to add photos and images, including hand–drawn images, and to organize notes, making it a great app for a variety of daily activities. Applications may include taking notes and recording lectures, securely storing and organizing passwords, tracking and organizing job search and interview activities, documenting and recording information received during medical appointments, and documenting information related to medications (see Figure 2).

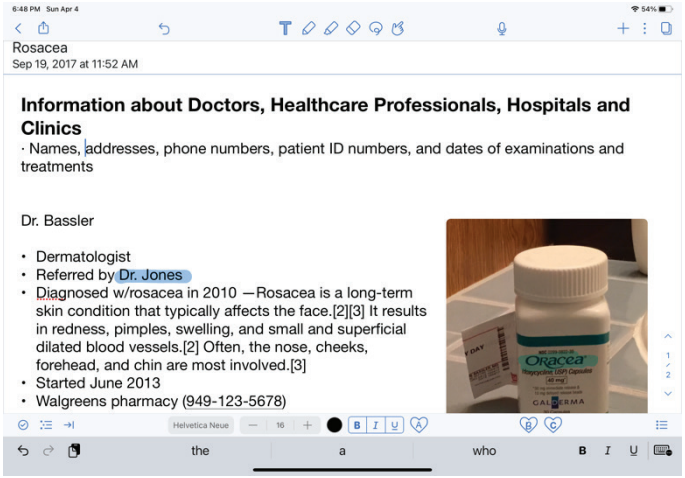

Figure 2: Notabilty Medication Example

Inspiration Maps. Inspiration Maps is a mind–mapping app designed for the general public. It allows users to add words, images, and graphics to the screen and move them around to organize them. Information entered can be rendered as either mind maps or outlines for maximum flexibility. It can be used in a variety of ways both during rehabilitation and in everyday life. Applications may include brainstorming, essay planning and organization, and party planning (see Figure 3).

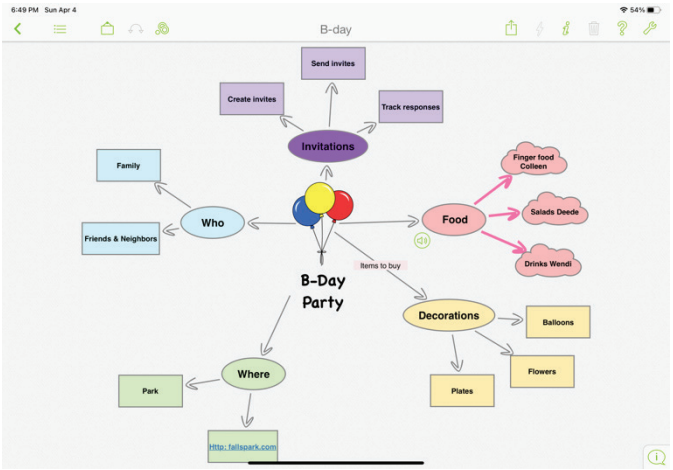

Figure 3: Inspiration Maps Party Example

Discussion

ATC devices such as smartphones and a variety of apps that are widely used by the general population are now being integrated into the therapeutic process and applied as compensation for cognitive limitations. As these devices and apps become more readily used by individuals with brain injury in the brain injury community, it is important for rehabilitation facilities, counselors, therapists, and caregivers have a working understanding of their benefits and support the use of such devices.

Although sometimes underutilized by clinicians, these tools are an asset to individuals with brain injury in their recovery and rehabilitation post–injury. Inexperience or discomfort with technology may con-

tribute to their lack of implementation in the rehabilitation process. An extensive review of the literature has considered the barriers and aids to successfully using technology in TBI rehabilitation (Brunner et al., 2017). Barriers can be reduced or eliminated by making appropriate devices and apps available in the clinical rehabilitation setting along with training. Therapist input into app development and an increase in evidence–based research would add to clinical acceptance (Seifert et al., 2017; Widehammar et al., 2009).

Brain injury professionals play a significant role in the selection and training of devices and apps, and often rely on their peers for app recommendations (Seifert et al., 2017). The app toolbox we present here addresses the unique needs of individuals with brain injury in the cognitive rehabilitation continuum and their transition to day–to–day life. The "Making Cognitive Connections" approach facilitates learning the technology while focusing on the cognitive skills required to use the device. This approach teaches the executive function skills and the self–regulation process. These same cognitive skills can be applied to everyday life making this approach practical, concrete, relevant and transferrable.

Author Note and Conflict of Interest Notice

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Appendix A: Best Practices in App Training

- Step–by–step instructions with screen captures to help orient users to app screens
- Review of training materials (written and videos) as often as needed to learn the apps
- Learning to use apps independently, from user's own computer
- Learning to troubleshoot problems before they happen
- Practicing each skill learned by completing exercises, activities and projects
- Integrated "Making Cognitive Connections" activities
- Training environment that remembers where users left off
- Short video trainings
- Screenshots and step–by–step instructions
- Give It A Try exercises to provide practice in applying newly learned skills
- Quizzes to help test app knowledge
- Troubleshooting scenarios integrating app–related problems with practical solutions
- Putting it All Together projects to practice the integration of all features learned

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