

Running Head: SELF-DIRECTED ACCESS TO ELECTRONIC BOOKS

“Moby Dick is my Favorite:” Evaluating a Cognitively Accessible Portable Reading System for
Audio Books for Individuals with Intellectual Disability

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Abstract

Significant barriers exist for individuals with intellectual disability to independently access print-based content. Regrettably, while the amount of content now available electronically increases, tools to access these materials have not been developed with individuals with intellectual disability in mind. This article reports the results of research evaluating the utility of a Palmtop PC-based application designed to enable individuals with intellectual disability to access electronic books and documents. Participants with intellectual disability were randomly assigned to one of three groups, each group differing in the type of audio player used. Participants who used the specially designed reader made significantly fewer errors accessing electronic books and required significantly fewer prompts than did participants using either of two mainstream audio book readers.

“Moby Dick is My Favorite”: Evaluating the Use of a Cognitively Accessible Portable Reading System for Audio Books by People with Intellectual Disability

Research findings document the potential benefits of computer use by people with intellectual disability for a wide array of outcomes (Wehmeyer, Smith, Palmer, Davies, & Stock, 2004). For example, people with intellectual disability have used computers to acquire skills needed to perform vocational tasks (Riffle, Wehmeyer, Turnbull, Davies, Stock, et al. 2005; Wehmeyer, Palmer, Smith, Parent, Davies, & Stock, 2006), as augmentative communication devices (Hetzroni, Rubin, & Konkol, 2002), to learn functional tasks (Lancioni, O'Reilly, Campdonico, & Mantini, 2001), to engage in anti-victimization training and language acquisition activities (Holzberg, 1994), for menu planning (Stock, Davies, and Ocken, 2001), for independent Internet access (Davies, Stock, & Wehmeyer, 2001), and for decision making support (Davies, Stock, & Wehmeyer, 2003).

One of the most frequently identified barriers to greater independence and integration for people with intellectual disability involves accessing written materials and content. Most people with intellectual disability have difficulty reading. Instruction to promote literacy for this population has predominantly focused on teaching sight-word vocabulary skills (Browder, Courtade-Little, Wakeman, & Rickelman, 2006). Browder and colleagues reviewed 128 studies focusing on literacy for persons with intellectual disability from 1975 to 2003, and found that 80 of these targeted sight word instruction. Fewer (36) focused on fluency and fewer still focused on comprehension (31), phonics (13), or phonemic awareness (5) (Browder et al., 2006, p. 69).

While initiatives like the U.S. Department of Education's Reading First initiative and federal policy detailed by the No Child Left Behind Act and the Individuals with Disabilities Education Act have resulted in a renewed interest in literacy instruction for students with

intellectual disability, efforts which may well provide strategies to achieve greater progress in literacy for people with intellectual disability, it seems likely that many people with intellectual disability will need additional supports to fully access written or text content and use such information to achieve employment, community inclusion, and recreation goals. Providing technology-focused supports and electronic or digital text to enable people with intellectual disability to access written and text content has the potential to provide such support.

Providing access to written content in electronic or digital formats, including audio books, textbooks and other digital materials, holds considerable promise in providing people with intellectual disability the opportunity to engage with print-based information. Electronic or audio versions of a wide array of print-materials currently exist. For example, *Recordings for the Blind & Dyslexic* (RFBDB) reported the availability of over 139,000 books in audio format (RFBDB, 2006), many of which are now available in digital formats for download. Another example is provided by *netLibrary*, a web-based eBook (eBooks may include virtually any text that is in electronic format) repository which includes over 40,000 eBooks and reports that there are now over 54,000 eBook titles available (netLibrary, 2004).

eBooks are currently available as either raw text or binary file format documents. Raw text eBooks are available throughout the Internet (typically HTML formatted versions of books no longer under copyright restrictions from such authors as William Shakespeare, Sir Arthur Conan Doyle, and Lewis Carroll). However, the availability of books in this format is diminishing, as many of these books are being replaced by documents in binary formats. Binary file format eBooks appear to be a much more popular format than raw text books, and this is very likely due to the security and piracy issues with copyrighted material, as well as the portability of having an entire book encapsulated in a single file versus multiple HTML pages.

There are several binary formats currently in use, including *DigitalWebBook* and *OEB Package Format*, but the most common are Microsoft's *.LIT* format and Audible's *.AA* format. Microsoft, Adobe, and Audible all offer eBook reader software and methods for purchasing and downloading copyrighted material through the reader software. There are numerous web sites available to download and purchase eBooks and many large book distributors, such as Amazon.com, dedicate entire sections of their website to eBook purchases. In fact, many libraries are now providing free download and time-limited use of current books in eBook formats.

The leading eBook reader applications have some accessibility features designed primarily for individuals with physical and visual disabilities, but as is often the case these do not include features designed to make eBooks accessible to individuals with intellectual disability. The interface for selecting and listening to an eBook with these applications requires the ability to read, as well as the ability to navigate through text-based menus for selecting books. In addition, managing playback and navigation of the selected materials is prohibitively complex for individuals with intellectual disability given existing user interfaces.

In this study, we investigated the utility of a simplified multimedia palmtop computer application to enable individuals with intellectual disability to independently access electronic books and documents by listening to recorded or computer-generated speech.

Method

Participants

Study participants included adolescents with intellectual disability recruited from a local education agency's transition program and adults with intellectual disability supported by multiple community-based agencies. All participants were receiving community-based services

and supports across a variety of functional life-activity areas, including employment, academic and daily living skills. A total of 49 participants were involved in the study, 17 of whom were female and 32 male. The average age of participants was 28.47 years ($SD = 10.35$) with ages ranging from 18 to 60 years. The average IQ score for participants was 52.88 ($SD = 8.69$), with a range of 31 to 69. No specific measures of previous comfort level, familiarity or anxiety using computer or technical devices were recorded. Thus, participants were randomly assigned to one of three conditions identified by the type of electronic book reader program they were to use in the study, described subsequently. Table 1 summarizes age and IQ data for participants in each of the three conditions.

Informed consent was obtained from all study participants prior to the start of the study in accordance with the approved IRB procedures for this project. Participants were paid a stipend for their involvement.

Device Design

The software used in this study was a cognitively-accessible software program, called *Rocket Reader*, designed to enable access to electronic books for individuals with intellectual disability. The reading software is operated on the Pocket PC palmtop computer platform. The user interface is highly visual and auditory based and provides consistent feedback and interaction with the user to maximize usability and simplicity. Figure 1 illustrates the book selection interface that is presented to the user immediately after the application is launched. The landscape mode that is available in the Pocket PC 2003 operating system was used for the system, as this orientation provided a more natural interface for holding the unit and navigating through the books with the left and right thumb, as well as for displaying two book images large enough to be recognizable to the user. All hardware buttons on the Pocket PC are automatically

disabled to prevent accidental activation of other programs. When the program first starts (Figure 1), the first two books in the library are presented (in alphabetical order) and an audio prompt instructs the user to select the book to which he or she would like to listen. Additional books are accessed by using arrow buttons on the bottom left and right of the display (Figure 1). These arrows are only visible if the library contains more than two books.

One common barrier to accessibility inherent in mainstream Pocket PC programs involves the use of very small buttons and controls that require precise click actions with a stylus. The cognitively accessible reading system was intentionally designed *not* to require use of a stylus, but rather to allow users to operate the touch screen with their fingers if they chose. For example, in the program the entire circular area surrounding the navigation arrows is the active area, so that these buttons can be easily tapped with a finger or thumb.

When the user taps on the picture of the book he or she wishes to listen to, the book is highlighted (see *Charlotte's Web* in Figure 1), the title and author are displayed, and an audio prompt is played announcing the title of the book, such as "*Charlotte's Web* – to select this book, touch this picture again." Although text is displayed onscreen, users with limited or no reading skills are still able to identify a desired book using the "Button Talk" feature that verbally announces the name of the book when the icon is first tapped. The book is not actually opened until the user taps the book icon a second time to select it. Therefore, nonreaders can sequentially tap each book image and listen to the name until they find the book they are seeking. The audio prompt then instructs users to tap the book a second time if they would like to open that book and begin listening.

The audio prompt that plays when the book is tapped can be customized, including audio recorded by a parent or caregiver, so it can be completely customized to the needs of the user.

For example, an audio prompt could say, “Click on this picture again to read your favorite story.” Once the user locates the book he or she is looking for and taps it to hear the name of the book, tapping a second time opens the book and begins an audio output of the book. Figure 2 illustrates the screen after a user selected “*A Wrinkle in Time*.” If this is the first time the book has been opened, the audio is started at the beginning of the book. If the book has been listened to previously, the system opens the book and picks up the audio presentation where the user left off the last time. For feedback purposes, an animated icon of a speaker is displayed on the left side of the screen to denote that the book is currently being played. Below the speaker icon is a progress meter that shows the relative location in the book. On the right side of the screen is the book cover. The available buttons on the screen, from left to right, are an orange *Restart* button, a red *Stop* button, and a *Read/ Pause* button (green and blue respectively). The *Restart* button will allow the book to be restarted from the beginning. The *Stop* button will stop the book and immediately return to the book selection screen, and *Read/ Pause* will allow the book to be paused and played again, and will change appearance based on the current play state, as illustrated in the second panel of Figure 2.

The user’s current location within a book is always saved on the Pocket PC. If the user turns off the Pocket PC while the book is playing and turns it on again later, the book will resume where it left off. If he or she stops the book, the location is saved and when the user returns to the book, it will resume a few seconds before the saved point, to lead the listener back into the story.

In summary, then, the cognitively accessible audio player was designed for use by individuals with intellectual disability and provides a simplified interface, a limited number of large easily selectable buttons, and uses both visual and audio cues and instructions to help the

user operate the system. The system includes a number of user customization options that allows the interface to be customized according to the needs of the user. For example, for users who want more complexity, the personal library can be organized into categories with a picture or icon representing the category (e.g., Mystery books using a magnifying glass for an icon) that, when selected, can display as many as eight book covers on the display at a time, with the navigation arrows then taking the user to more books in the selected category. Alternatively, for users who desire less complexity, another interface option that is even simpler displays only one book image at a time and each time the navigation arrow is pressed, the next book is displayed and the name of the book is announced with an audio message. This approach provides the simplest operation for selecting books and can also be used by users with visual impairments who need to step through the books one at a time and hear the title before selecting the one they desire.

Procedure

The study compared the degree to which participants were able to independently and accurately utilize the audio reader designed specifically for use with people with intellectual disability (Rocket Reader) with similar indicators with two other commercially available audio players: the Audible® Player and Microsoft® Reader. The Audible® Player is available from audible.com® and is designed to play digital files in multiple formats, including eBooks. Microsoft® Reader is the eBook player designed for use on Pocket PCs and often bundled with the Windows Pocket PC operating system. Participants were randomly assigned to one of the three groups as determined by which audio player was utilized, with 17 participants in the Rocket Reader group, and 16 in each of the Audible® Player and Microsoft® Reader groups.

The study took place over a four-week period. Data were collected on two dependent measures of utility: accuracy and independence. Accuracy was defined as the person's ability to select a book and operate the system using the playback procedures, and independence referred to the number of prompts a participant needed to complete a testing session. In addition, there were two equivalent book selection scripts that were randomly selected for use during the person's test session. Each player was loaded with the same eight audio books. Each script required users to select four different books to listen to, to close each book when instructed, to return to the book selection screen, and to return to the books and continue reading at the previous location. Table 2 provides one of the two book selection scripts with specific verbal instructions that were provided and associated timing for presentation of the instructions. The second book selection script was identical, except for the specific books that that user was directed to open and listen to. Finally, the three player applications were presented using two of three different Pocket PCs; a Dell Axim X50, a Toshiba E-400, and an Asus MyPal Pocket PC (e.g., each audio player was presented to participants on at least two different Pocket PC devices). Each Pocket PC ran the Pocket PC 2003 operating system.

Prior to beginning the book selection scenario, a training script was used to illustrate correct task performance by first demonstrating book selection and playback to the participant. This demonstration was followed by having participants use the player application to select and playback a book on their own, then to return to a bookmarked location to pick up listening where they left off. This training activity was designed to teach participants how to operate the specific player for his or her experimental condition. Each training session was conducted individually for each participant immediately prior to the start of the individual's experimental session. Following this training period, the participant was requested to use the player to select a series of

books and to begin listening to them. The two book selection scripts required the user to select a book, begin listening for a period of time, then close the book and select a new book. Four different books were opened during the testing period and three books were required to be opened twice so that the user could demonstrate his or her ability to return to a book that had been opened previously and continue listening from where they left off. Each script required a total of 12 separate book selection tasks (see Table 2). The duration of test sessions for each participant ranged from approximately 15 – 30 minutes, depending upon the person's speed at performing the tasks.

Test Procedures and Experimental Variables

Data collection forms were used to record errors and prompts during each experimental session. An error was recorded: 1) if the user did not perform the step correctly; 2) if the user skipped the step completely, or 3) if the user initiated an action that did not have the intended result, such as attempting to tap a button but missing it. A prompt was recorded: 1) if the user specifically requested help, or 2) if a prompt was necessary to correct an error prior to proceeding to the next step.

Two data collectors scored the all participants in parallel to allow for inter-rater reliability measures to be obtained. Inter-rater reliability of ratings for recorded errors was 98% and for recorded prompts was 96%. The ratings made by the two raters were averaged to then provide a single error and prompt score for each participant for data analysis. In addition, there was room provided on the data collection forms to record additional observations as well as statements made by participants during the test sessions.

Data Analysis

A one-way analysis of variance (ANOVA) procedure was conducted to evaluate mean differences between the three experimental conditions (Rocket Reader, Audible® Player, and Microsoft® Reader) for each dependent measure *Mean Errors* and *Mean Prompts*. Data were analyzed using SPSS 13.0.

Results

Table 3 provides means and standard deviations by experimental condition and dependent measure. There were significant differences on univariate ANOVA tests between groups for both average number of errors [$F(2, 46)=6.725, p < .003$] and average number of prompts [$F(2, 46)=5.817, p < .006$]. Table 4 summarizes the results of the ANOVA tests. Results from post hoc analyses, using Tukey's HSD test, are provided in Table 5. For average errors, which was a measure of subjects' ability to correctly operate the three different player applications, pairwise comparisons showed no differences when participants used the Audible® Player ($Mean = 12.59, SD= 12.92$) in comparison to when subjects used Microsoft® Reader ($X = 14.15, SD= 13.33$). However, when using Rocket Reader ($Mean = 1.67, SD= 2.39$) participants made significantly fewer errors when compared to the Audible® Player ($p=.014$), as well as significantly fewer errors when compared to Microsoft® Reader ($p=.005$).

For the average number of prompts provided to participants while performing the book selection tasks during the experimental sessions, pairwise comparisons showed no differences when participants used the Audible® Player ($Mean = 13.56, SD= 12.51$) in comparison to when subjects used Microsoft® Reader ($Mean = 14.65, SD= 12.95$). However, when using Rocket Reader ($Mean = 3.26, SD= 4.54$) participants required significantly fewer prompts to complete the book selection and playback tasks as compared to when using the Audible® Player ($p=.021$) as well as significantly fewer prompts as compared to when using Microsoft® Reader ($p=.010$).

Discussion

The findings from this study demonstrated that an audio eBook reader designed with features that promote cognitive access can be used by people with intellectual disability with greater accuracy and increased independence than standard, commercially available eBook audio readers. When using Rocket Reader, 76% of study participants with intellectual were able to complete the 12-step book selection scenario with one or fewer errors. When using the Audible Player only 25% were able to access the book selection scenario with one or fewer errors and similarly, while using Microsoft Reader, 25% were able to access the book selection scenario with one or fewer errors.

There are a number of limitations that must be taken into account when considering these results and that limit generalization. First, although participants were randomly assigned to groups that differed according to the audio reader software used, the size of each group was relatively small and replications are needed with larger samples. Second, because of the limited number of Palmtop PCs with which to conduct the study, it was necessary to have participants come to a central location and use the device there. This provided a relatively short time during which the software use could be evaluated and, as such, we were not able to examine more than basic device use features. As such, this study focused on limited variables (i.e., ease of use, accuracy) and did not address impact on variables such as motivation for reading and reading comprehension. Future research is needed to examine longer-term use and its impact on issues such as literacy and comprehension, as well as the impact of access to eBooks on quality of life. Finally, the centralized testing location cannot be equated with environments in which people might typically use such devices, including in their homes, on buses, during a workout, and so forth. Ease of use needs to be evaluated in environments that are more ecologically valid. Given

these caveats, we believe that the study illustrates the potential benefit to people with intellectual disability of having access to cognitively accessible electronic and information technology.

Wehmeyer and colleagues (2004) documented that in too many cases, issues pertaining to the characteristics of people with intellectual disability are ignored in the design of technology. Of particular importance in such designs are features like flexibility, simplicity, and tolerance for error that enable 'cognitive access.' For example, devices like the one used in this study ensure flexibility in use by providing options that accommodate for users' accuracy and precision, and adapt to a user's pace. Eliminating the need for a stylus and the concomitant requirement for accuracy and, instead, designing a broader 'active button' area that can be selected using one's finger, as was done with the accessible reader, is one example of design features ensuring flexibility, as well as simplicity. Simplicity and intuitive use are important design elements for people with cognitive disabilities. Many devices, particularly software, tend toward greater complexity as a market-driven feature and in so doing limit the device's use by people with cognitive impairments. Cognitively accessible devices and programs address this by allowing the set up of the program to vary according to complexity based upon the user's needs. As few or as many buttons or icons can be shown as needed; buttons can include both text identification and audio instructions identifying their use; and having buttons fade or disappear after their function has been activated and may not be needed any longer (e.g., direction arrows) all provide a simpler and more intuitively used device. Finally, tolerance for error is an important feature. In many devices, a mistake results in the termination of the session or results in the unsuccessful use of the device in some way. So, for example, with the accessible reader hardware buttons on the Pocket PC are automatically disabled when running to prevent accidental activation of other programs and, consequently, termination of the audio book reading session.

Notably, participants both reported and demonstrated their enjoyment with their success in using the system to be able to access audible books. Participants commented on the ease of use of the accessible reader (“It’s pretty easy, I like this;” “This is a piece of cake;” “It’s easy to use. It reads to you.”), and their general satisfaction with using a palmtop PC when using any of the three readers (“I like those little computers;” or “I’d like to get one of these for Christmas.”). Mainly, though, when asked to comment on the process, what participants referred to was not the device or the software, but the fact that it opened the door to literacy for them. Participants observed: “I like the stories and the music.” “I love stories.” “That is a good story,” and “Moby Dick is my favorite.” One participant observed that he could listen to the books on the bus, since it took him “forever” to get home.

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Table 1

Participant Demographic Characteristics by Experimental Condition

Experimental Condition	N	Age: Mean	Age: SD	IQ: Mean	IQ: SD
Rocket Reader	17	26.47	8.23	49.13	8.20
Audible Player	16	27.19	8.89	55.56	8.87
Microsoft Reader	16	31.88	13.15	53.94	8.16
Total	49	28.47	10.35	52.88	8.69

Table 2

One of Two Book Selection Scripts Used with Subjects in Each Experimental Condition

1.a	OK, now I'm going to ask you to use the little computer to pick a book to listen to. The first book I'd like you to find and open is "Charlotte's Web." Then after you find it, go ahead and start listening to the story. (Listen for approximately 1 minute)
1.b	OK. Stop the story now. How do you like that story so far?
2.a	Now let's find another book. Find and open "Treasure Island." Then after you find it, go ahead and start listening to the story. (Listen for approximately 1 minute)
2.b	Good. Now stop the story. How do you like that story so far?
3.a	Now let's find another book. Find and open "Call of the Wild." Then after you find it, go ahead and start listening to the story. (Listen for approximately 1 minute)
3.b	Good. Now stop the story. How do you like that story?
4.a	Now let's return to the first book and pick up where you left off. Go ahead and find "Charlotte's Web" again and start listening where you left off before. (Listen for approximately 1 minute)
4.b	OK. Stop the story now.
5.a	Now let's find another new book. Find and open Moby Dick." Then after you find it, go ahead and start listening to the story. (Listen for approximately 1 minute)
5.b	Good. Now stop the story. How do you like that story?
6.a	OK, now find and open the book "Treasure Island" and start reading where you left off. (Listen for approximately 1 minute)
6.b	OK. Stop the story now.

Table 3

Mean and SD by Experimental Condition and Dependent Measure

		N	Mean	SD	SE	Min	Max
<i>Average Errors</i>	Rocket Reader	17	1.67	2.39	.57	0	9
	Audible Player	16	12.59	12.92	3.23	0	33
	Microsoft Reader	16	14.15	13.33	3.33	0	41
	Total	49	9.31	11.90	1.70	0	41
<i>Average Prompts</i>	Rocket Reader	17	3.26	4.54	1.10	0	16.5
	Audible Player	16	13.56	12.51	3.12	0	32
	Microsoft Reader	16	14.65	12.95	3.23	1	41
	Total	49	10.34	11.65	1.66	0	41

Table 4

Analysis of Variance results

		Sum of Squares	df	Mean Square	F	Sig.
<i>Average Errors</i>	Between Groups	1538.90	2	769.45	6.725	.003*
	Within Groups	5263.43	46	114.42		
	Total	6802.34	48			
<i>Average Prompts</i>	Between Groups	1315.24	2	657.62	5.817	.006*
	Within Groups	5200.35	46	113.05		
	Total	6515.60	48			

Table 5

Tukey's HSD Post-Hoc Tests for Group Difference

Dependent Variable	(I) Reader	(J) Reader	Mean Differ	SE	Sig.
<i>Average Errors</i>	Rocket Reader	Audible Player	-10.91	3.72	.014*
		Microsoft Reader	-12.47	3.72	.005*
	Audible Player	Rocket Reader	10.91	3.72	.014*
		Microsoft Reader	-1.56	3.78	.910
	Microsoft Reader	Rocket Reader	12.47	3.72	.005*
		Audible Player	1.56	3.78	.910
<i>Average Prompts</i>	Rocket Reader	Audible Player	-10.29	3.70	.021*
		Microsoft Reader	-11.39	3.70	.010*
	Audible Player	Rocket Reader	10.29	3.70	.021*
		Microsoft Reader	-1.09	3.75	.954
	Microsoft Reader	Rocket Reader	11.39	3.70	.010*
		Audible Player	1.09	3.75	.954

* The mean difference is significant at the .05 level.

Figure Captions

Figure 1: Book selection interface for cognitively accessible reader

Figure 2: Playback interface for cognitively accessible reader

Initial book selection screen	Second book selection screen (after pressing the right arrow from the first screen).
 <p>ROCKET READER 1.0</p> <p>MADELEINE L'ENGLE <i>A Wrinkle in Time</i></p> <p>CALL WILD JACK LONDON</p> <p>Please select a book.</p> <p>➔</p> <p>The initial book selection screen displays two book covers: 'A Wrinkle in Time' by Madeleine L'Engle and 'Call of the Wild' by Jack London. A prompt 'Please select a book.' is centered below the covers, with a right-pointing arrow button to its right.</p>	 <p>ROCKET READER 1.0</p> <p>Charlotte's Web E. B. White</p> <p>ADVENTURES OF HUCKLEBERRY FINN Mark Twain</p> <p>← Charlotte's Web → E. B. White</p> <p>The second book selection screen displays two book covers: 'Charlotte's Web' by E. B. White and 'Adventures of Huckleberry Finn' by Mark Twain. The 'Charlotte's Web' cover is highlighted with a red border. Below the covers, the text 'Charlotte's Web' and 'E. B. White' is displayed, flanked by left and right arrow buttons.</p>

Playback display (book playing)	Playback display (book paused)
<p data-bbox="219 493 771 525">A Wrinkle in Time by Madeleine L'Engle</p>  <p>The interface for 'A Wrinkle in Time' features a large speaker icon on the left, a progress bar in the center, and three control buttons at the bottom: a yellow repeat button, a red stop button, and a blue pause button. The book cover is displayed on the right.</p>	<p data-bbox="852 493 1404 525">Call of the Wild by Jack London</p>  <p>The interface for 'Call of the Wild' features a large speaker icon on the left, a progress bar in the center, and three control buttons at the bottom: a yellow repeat button, a red stop button, and a green read button. The book cover is displayed on the right.</p>