Designing a Mobile Survey Application
for People with Cognitive Disabilities

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ABSTRACT

People with cognitive disabilities need careful matching to find appropriate employment. However, it can be difficult for them to articulate their worries and concerns in a timely and useful manner. This work demonstrates how appropriately-designed technology can assist in accommodating cognitive disabilities, providing avenues to assess their concerns about work environments. A mobile application was developed with targeted repeated multimedia surveying to assess work concerns, with temporal- and geo-tagged answers stored for review by a personal assistant, employer, job coach, or person with a cognitive disability. An expert review provided feedback to balance concerns of user population and interface design.

Author Keywords
cognitive disabilities, mobile computing

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Cognitive disabilities—including birth or developmental disabilities, brain injury and stroke, and severe and persistent mental illness—affect tens of millions of people worldwide [5]. Cognitive disabilities can lead to difficulties with memory, attention, problem-solving, and comprehension, and people with cognitive disabilities can become frustrated or overwhelmed in workplace situations. However, appropriate placement in supportive work environments can lead to productive situations, both for the employer and employee.

This paper describes the application development aspects of a joint effort that includes researchers in computer science, cognitive science, and disability advocacy. The community of researchers developing technologies for people with cognitive disabilities has begun to create design guidelines (e.g., limiting text or choices on a screen, providing multiple navigation paths to information, and increasing size of selectable areas on a screen) and to identify interface techniques (e.g., [3]). In our development effort, researchers investigating cognitive disabilities enlighten technology developers about the skills and limitations of, and strengths and challenges faced by, the target user population, and the technology developers lead the exploration of new and emerging mobile platforms, toward identifying a solution of mutual benefit.

The work described here has as its primary focus to develop a mobile questionnaire application for people with moderate to severe cognitive disabilities. These people typically need support in their daily lives, but can become productive members of society through appropriate training on work related tasks, with minimal assistance or supervision in an integrative environment. Specifically, this work seeks to create a mobile application that will ask a set of questions about the work environment to the user in a way that will elicit helpful responses in making an appropriate employment match.

As a secondary purpose, our work seeks to provide a flexible platform for tailoring questionnaires for people of various cognitive abilities. Several configuration files allow a personal assistant, support staff or employer with minimal computer skills to control aspects of the questionnaire such as the questions asked, the content of responses, repetition number and style, delay between presenting of chunks of information, and voice type and content in the presentation of the questions and responses. These factors will allow a personal assistant or employer of people with cognitive disabilities to individualize the questionnaire to meet the strengths of the employee and assess the unique attributes of the job. The application is developed on the Google Android platform and will be available on the Android Marketplace.

The remainder of this paper describes in detail the application that was created, including an architectural overview, a usage walkthrough, and a summary of the expert reviews of the application. We conclude with a view of how we will continue to develop and use the application.

APPLICATION DETAILS

Our mobile application lets people with cognitive disabilities give evaluative feedback via a questionnaire, with results summarized for their personal assistants, job coaches, employers, and themselves. These responses are logged for easy interpretation, so their work environment and situation can be tailored to better fit their needs and abilities.

We targeted an inexpensive solution with sufficient ability to satisfy user goals. As such, we decided to develop a free application for the Android platform—the free development environment and ease of software deployment had great appeal: applications are easily distributable after paying a small one-time fee, and the developer can upload as many applications as desired the Android Marketplace. Any compatible Android device can download and use the application. In addition, Android devices are generally less expensive than other platforms, with a wide range of available devices. For development and testing, we used the Motorola Droid, an older but less expensive device that can still accomplish what we need to do.

While we were designing the application, there were several very important factors that we had to consider. Our target users, people with cognitive disabilities, played a major role in our design decisions. We wanted to keep the application simple and easy to use, both for accommodating cognitive disabilities as well as for accommodating the physical disabilities that sometimes accompany them [2]; hence the use of very large buttons and fonts.

To accommodate literacy limitations, the application reads each answer choice aloud, and both text and images on the buttons reflect choices. These multimedia forms of communication assist the person with cognitive disabilities discriminate button meaning, and prior research has demonstrated increased performance and satisfaction among people with disabilities in testing situations [1]. We also decided to ask one question at a time, important so the user does not have to keep track of and worry about multiple questions at once. Clutter and excessive content represented to the user can be detrimental to the accuracy of the responses.

After all of the questions have been asked, the timestamped, geo-tagged results are displayed and saved in plain text format on the device. The logged responses can then be emailed to another computer or examined on the device.

The application is highly configurable. It is easy for a non-technical person to alter the questions, the spoken responses, delays between the reading of responses, and the images that are displayed. This configurability allows an assistant or employer to tailor the application to the skills and abilities of the target users, and to create a usage environment that makes the user more comfortable; e.g., the developer can include faces or voices that match the gender or ethnic demographic of the person taking the survey.
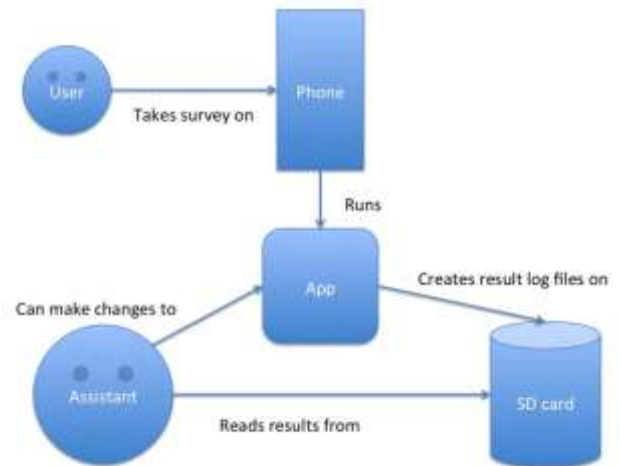

Figure 1. Overview of the major components and interactions of the mobile application targeted use

ARCHITECTURAL OVERVIEW

The major components reflecting the use of the mobile interface include: the user, the personal assistant, the mobile interface (or application), and the file system (see figure 1). The next few paragraphs describe each of these components in detail and then demonstrate the interactions that occur between them.

The user is the person who will be taking the survey. In most cases, the user is a potential employee with cognitive disabilities ranging from moderate to severe. The mobile interface collects information about their current employment situation through a survey application. The interface is intended to be used at the job site, hence the need for a mobile platform.

The user takes the survey on a mobile device that is running the application. This application will cycle through all of the questions that the employer or caretaker has prepared. The questions are presented to the user one at a time and the user is then able to select a response that best corresponds to his or her feelings. In order to account for a wide range of cognitive disabilities, the application leverages multiple types of media. The questions are presented textually and by voice, and possible responses are represented by text (e.g., like, OK, don't like), visual symbols (e.g., faces), and voice readings with highlighting for each response. If the user needs help, a "speech" button will read and re-read the question and the possible answers aloud while highlighting them.

Once the user has finished answering all of the questions in the survey, the results are stored as a text file on the device memory card so the assistant can analyze the survey results. The file contains the questions and responses, timestamps for each question, and geo-tags indicating the location where each question was answered. The geo-tag uses the Android latitude/longitude coordinates to be able to distinguish between, e.g., several different rooms in the

workplace. (Increasing granularity of GPS technology makes this increasingly useful.) These data allow an assistant to reflect on how long the user took to answer each question, where within (or outside of) the workplace the user answered a question, and how long it took the user to answer all questions.

The final component is the personal assistant: a caretaker, job coach, employer, or the person taking the survey who is responsible for and capable of assessing the survey responses. The application is designed to help them understand how the users feel about their current employment situation. They need to know about the user's needs and capabilities so they can best make the necessary accommodations. As described previously, the personal assistant is able to view the survey results that get stored on the micro-SD card. Because there are many employment situations that the user may be in, it is important for the assistant (or multiple assistants, including caretakers, job coaches, potential employers) to tailor the survey to specific circumstances. Therefore, the mobile interface must be highly configurable. Since it is unreasonable to assume that these assistants are highly technical and know how to program, the application is designed to be easily modified by someone with no programming skill via an editable xml file on the mobile device. (We plan to make future versions even easier to configure via a web-based interface.)

The ease of configuration of the application is achieved by separating the programming logic (or code) of the app and its resources (or content). While the programming logic will always remain the same, the personal assistants/employers can easily change the content that is displayed by the mobile interface. This includes the audio that is read, the text of the questions, the number of questions, the text of the responses, and the image associated with each response. All of these items can be easily modified so that the survey can accommodate any user and any employment situation.

APPLICATION WALKTHROUGH

The user is presented with the survey questions as soon as the application is opened. The first question is displayed in large font at the top. The user now has the option of choosing to respond to the question by clicking on one of the response buttons. If the user needs additional help, he or she can click on the speech button. This will initiate a process that reads aloud the question that is being asked and the possible answer choices. For each reading, the text or response button that is being read will be highlighted (see figure 2) to replicate scanning techniques used by augmentative or alternative communication systems. There is also a five-second delay between each reading. This pause aids comprehension and ensures that the users with cognitive disabilities can understand and differentiate the question being asked and the responses that are available.

Once the user has selected a response to the question, the application will automatically display the text for the next question, repeating the process until all questions are answered. Survey results can be displayed on screen, with a more detailed log (with full timestamp and geo-tag data) in a file on the device's memory card.

Because the users might be in many different scenarios, the caretakers have the ability to modify certain aspects of the application. The caretakers/employers who use this application can configure the following items: number of questions, content of questions, audio speech for the answer responses, images displayed for each answer response. The contents of each question can be found in the strings.xml file. Each question is surrounded by the tags <item> and </item>. To change the content of a question, modify the text inside the item tag. To add a new question, make another item open/close tag and place the question content inside the tag.

Audio and image files can be exchanged to match the demographics of the target user population, as this has been shown to result in improved performance for people with cognitive disabilities [4]. The mp3 audio files and button images, along with the survey questions, are found in resource folders on the mobile device. An assistant can exchange them for alternate questions, voices, or icons (e.g., using a young person's voice, or a Hispanic face) to best match the demographics of the survey taker.

Once the user has selected a response to the question, the application will automatically display the text for the next question, repeating the process until all questions are answered. Survey results can be displayed on screen, with a more detailed log (with full timestamp and geo-tag data) in a file on the device's memory card.
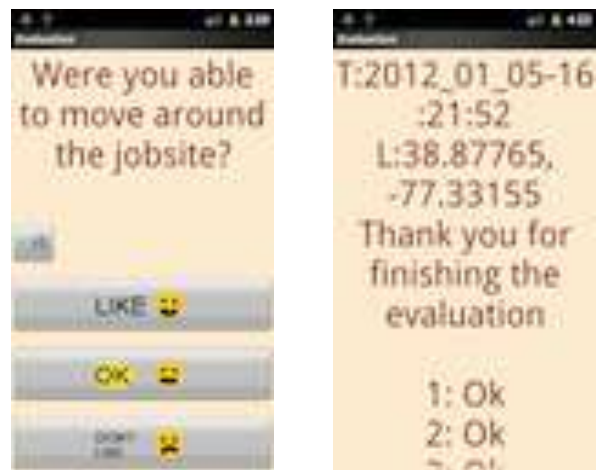

Figure 2. A screenshot from the mobile application (left) showing one of the responses highlighted, as occurs when the responses are being verbalized to assist in comprehension; and a timestamped and geo-tagged results page after the survey has been completed (right) with a more detailed view available on the device for the assistant

EXPERT REVIEW

Development of this application was guided by a series of expert evaluations by three evaluators: an interface design expert, a computer scientist with expertise in cognitive science, and an expert in cognitive disabilities. The designer provided them with prototype materials and applications, and they met in groups of two or three to review the provided information and give feedback.

Simplicity is important in the design of applications for people with cognitive disabilities [2]. The expert review was helpful in identifying not only appropriate language for the questions, but in making decisions on button size, centering of text, the length of time between the reading of responses, and the use of voice cues. Many of the design decisions that were made differ from those for other user populations; for example, the application pauses for five seconds between reading each option, text on the buttons was limited to at most two words, the number of options from which the user could choose was limited to three, and text for the questions is centered instead of left-justified. For other populations, these choices might be viewed as redundant at best, and hindering or distracting to the user in some cases. However, they were deemed vital for the successful completion of a survey when used by people with moderate-to-severe cognitive disabilities (our target population).

Key aspects of the design—like the ability to match the demographics of the target users to the faces and voices featured in the application—emerged from the expert review as well. While the use of icons to represent the answers is used as the generic solution, the application is easily customizable to allow any voice or face (from established symbol/voice sets or taken by the assistant of people familiar to the user) to be used. The current design has three voice sets to choose from—matching the most common gender and race demographics of the users—though it is expected that more might be needed. It is our expectation that this growing level of flexibility will enable the application to be used not only for the targeted population of people with moderate-to-severe cognitive disabilities, but with other populations as well.

Certainly we acknowledge that deployment to our target user population is necessary to judge its success. However, the confluence of expert opinions allows us to move forward with greater confidence in our design—particularly important given the limited availability of the target population. Our next steps will be to use the application with small groups of users to further assess areas for change and opportunities for broader use in schools and vocational training settings.

CONCLUSIONS AND FUTURE WORK

This paper describes the development process and results of a job questionnaire application for people with cognitive disabilities. The mobile application described here was targeted for young people with moderate to severe cognitive disabilities who need a straightforward way to provide feedback about a workplace environment when exploring different employment options or environments. The feedback will help assistants and employers tailor a job that matches each person's skills. Application deployment is planned within local communities for the near future.

As follow-up work, we plan to make the application even more configurable. This includes more ease and flexibility in survey creation—in switching voices, in making available demographically appropriate vocabularies for questions and responses, and in changing the number and type of available responses. As technology improves, we anticipate being able to include more detailed location information so that the assistants can distinguish between different rooms or sectors in the workplace, thus allowing them to understand better what aspects of the workplace are most appealing. In addition, the application will be deployed via the Google Marketplace and advertized through several channels, with the expectation of use across many populations.

ACKNOWLEDGMENTS

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