The Field Evaluation of a Mobile Digital Image Communication Application Designed for People with Aphasia

MEGHAN ALLEN, JOANNA MCGRENERE and BARBARA PURVES
University of British Columbia

PhotoTalk is an application for a mobile device that allows people with aphasia to capture and manage digital photographs to support face-to-face communication. Unlike any other augmentative and alternative communication device for people with aphasia, PhotoTalk focuses solely on image capture and organization and is designed to be used independently. Our project used a streamlined process with three phases: (1) a rapid participatory design and development phase with two speech-language pathologists acting as representative users, (2) an informal usability study with five aphasic participants, which caught usability problems and provided preliminary feedback on the usefulness of PhotoTalk, and (3) a one-month field evaluation with two aphasic participants followed by a one-month secondary field evaluation with one aphasic participant, which showed that they all used it regularly and relatively independently, although not always for its intended communicative purpose. Our field evaluations demonstrated PhotoTalk's promise in terms of its usability and usefulness in *everyday communication*.

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Authors' addresses: M. Allen and J. McGrenere, Department of Computer Science, The University of British Columbia, 2366 Main Mall, Vancouver, BC, Canada V6T 1Z4; email: {meghana; joanna}@cs.ubc.ca; B. Purves, School of Audiology and Speech Sciences, The University of British Columbia, James Mather 232, Vancouver, BC, Canada V6T 1Z4; email: purves@audiospeech.ubc.ca.

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1. INTRODUCTION

PhotoTalk is an application for a mobile device that allows people with aphasia to easily capture and manage digital photographs in order to support face-to-face communication. Aphasia is an acquired language impairment that can affect speaking, comprehension of spoken language, reading, and/or writing, although the patterns and extent of impairment across these different modalities vary greatly across individuals [National Aphasia Association 2006]. Aphasia, which is estimated to affect one million Americans, is most often caused by a stroke, although other brain damage such as a tumour or traumatic injury can also be the cause [National Aphasia Association 2006].

The incidence of stroke increases with age, so the majority of people with aphasia are older; however, aphasia can affect people of any age. Although people with aphasia often have difficulty communicating with written or verbal language, they generally retain their ability to recognize images [Thorburn et al. 1995]. This retained ability underlies the development of many augmentative and alternative communication (AAC) devices for individuals who have communication impairments; however, such devices typically focus on the expression of basic needs and wants, and always require someone other than the end user to import and organize the contents of the system, such as icons, images, sound, and text (e.g., van de Sandt-Koenderman et al. [2005]).

PhotoTalk supports communication by providing a platform for users to independently capture personally meaningful images and share them with their communication partners. The ease of sharing images allows for communication that would otherwise be more difficult or impossible verbally or gesturally. Someone with aphasia can use PhotoTalk to share important personal information with others, such as photographs of her family, pets or hobbies or to show her husband photographs captured during daily events, taken while he was at work. The ability to share personally meaningful photographs supports a wider range of communication goals, including social closeness [Light 1988], than systems that only support needs and wants.

We used a streamlined design approach with three phases for the PhotoTalk project. The first phase involved participatory design (PD) with two speech-language pathologists (SLPs) who have expertise in working with people with aphasia. Working with experts allowed us to very quickly complete the design phase. In the second phase, we conducted an informal usability study with five participants who have aphasia to identify usability problems and provide preliminary feedback on the usefulness of the application. For the third phase, we conducted two field evaluations of PhotoTalk. Our main evaluation was a one-month field study with two participants who have aphasia. The evaluation was designed to understand how they would incorporate PhotoTalk into their daily

lives. Both individuals used PhotoTalk relatively independently and used it regularly throughout the field study, although not always for its intended communicative purpose. We then ran a second field study with the one aphasic individual who was involved in the four-month ethnographically informed field study and PD of FileFacility, an earlier prototype created by members of our research team, and described briefly later in this article [Davies et al. 2004]. Evaluating PhotoTalk with this individual provided a positive indicator of our team's progress towards the creation of an accessible digital device to support communication: this individual was able to use PhotoTalk completely independently for specific communicative purposes. Overall, our results indicate that PhotoTalk shows promise as a communication tool for individuals who have aphasia.

The contributions from the PhotoTalk research project are: (1) the design of the first application for a mobile device that is *solely* focused on image capture and organization and is accessible to people with aphasia, and (2) two field evaluations with a total of three users demonstrating the application's promise in terms of both its usability and usefulness in everyday communication.[1]

This article extends our previous work that was published at ACM ASSETS 2007, titled "The Design and Field Evaluation of PhotoTalk: A Digital Image Communication Application for People with Aphasia" [Allen et al. 2007]. The main extensions include: results from our secondary field study (Section 5.2), a brief discussion of the issues of adoption (Section 2.5 and Section 6.5), an in-depth description of our design process (Section 3.1), an elaborated discussion of the usability study (Section 4), a brief discussion of the patterns of use (Section 6.2), elaborated discussion of the communication results throughout, and a figure demonstrating access patterns of frequently used photographs (Figure 4).

2. RELATED WORK

2.1 Remnant Book

The PhotoTalk research is being conducted within the Aphasia Project, which is a multi-disciplinary research project with the objective of designing technology to support people with aphasia in their daily lives [Aphasia Project 2007]. A long term goal of the Aphasia Project is to design a digital remnant (life) book. A traditional remnant book is physical in nature, often a three ring binder with pages containing text, images, and other artifacts. The items included are meaningful to the individual and convey information about their past life events [Hux et al. 2001]. The act of sharing this book creates a feeling of closeness between the communication partners. The goal of a *digital* remnant book is to allow the user to collect personally meaningful multimedia files such as photographs, movies, and sound clips that he can share with others on a portable device. Traditional remnant books tend to be static, whereas the digital variant could be considerably more dynamic given the potential ease of

[1]We use the term *everyday communication* to distinguish from communication that can be tested in a usability lab, which is more constrained given the more artificial context.

capturing multimedia data. In addition, a digital remnant book developed for a small mobile device could be significantly more portable than a traditional remnant book.

As a first step towards a digital remnant book, Davies et al. [2004] investigated the feasibility of using a personal digital assistant (PDA), given its portability and cachet. In that ethnographically informed field study, Davies worked with a single participant with aphasia to determine which aspects of a native PDA were most effective and which were most troublesome for the participant, prior to creating an assistive application. They discovered that PDA file access was the most challenging, and together decided to focus on the file system. Using a participatory design (PD) approach, Davies and the participant created a file system called FileFacility, which was designed for this user to manage and access his files. One of the findings from that research was that it remained difficult to manage images in FileFacility. PhotoTalk was designed to address this limitation. In addition, by evaluating PhotoTalk in our second field evaluation with the same participant who worked on the FileFacility, our research program moves one step closer towards achieving a digital remnant book.

2.2 Participatory Design with People Who Have Cognitive Disabilities

PD is a mainstream Human-Computer Interaction (HCI) design method in which the target users and system designers work together as equal members of the design team. PD has led to some success in assistive technology research; however, it traditionally relies on strong written and oral communication between the design team members. These abilities cannot be assumed when the participants have cognitive disabilities, necessitating modifications to accommodate their needs. Researchers creating assistive technology for people with cognitive disabilities have successfully modified PD in past projects [Davies et al. 2004; Moffatt et al. 2004; Wu et al. 2004].

When target users have special needs, it is often necessary to include other people in the PD process, such as family members, formal caregivers, and/or clinicians. These individuals may participate in the design process along with target users, or they may act as representatives and participate instead of target users [Boyd-Graber et al. 2006; Cohene et al. 2005; Lumsden et al. 2005]. To clarify, an individual acting as a representative may represent one target user (e.g., their spouse), they may represent many individual target users (e.g., a group they work with), or they may be an expert on a particular area related to the target population as a whole (e.g., speech language pathology) [Allen et al. 2008]. In the PhotoTalk project we involved SLPs and family members.

2.3 AAC Devices

There are many commercially available AAC devices for people who have communication impairments (e.g., Cyrano Communicator [OneWrite Company], Dynavox [Dynavox Technologies]), Gus Communications applications [Gus Communications], and Lingraphica [Lingraphicare]), in addition to a growing number of prototypes specifically for people with aphasia (e.g., Daeman

et al.'s [2007] storytelling application; PCAD, [van de Sandt-Koenderman et al. 2005]. We focus here on two devices that are most similar to PhotoTalk. The Cyrano Communicator is designed to aid individuals with communication impairments to communicate through customized images, text, sound, and synthesized speech [OneWrite Company]. Cyrano is built on the same HP iPAQ model as PhotoTalk and allows users to use the built in camera to take personalized images. Cyrano is not designed specifically for people with aphasia; it is intended for people with a range of communication impairments. Its interface uses considerably more text than PhotoTalk and generally has more complex navigation; both of these design elements can be problematic for people who have aphasia. Additionally, it appears that many people with aphasia would need assistance inputting data. To our knowledge, no evaluations of Cyrano have been reported in the literature.

The portable communication assistant for people with dysphasia[2] (PCAD) is a portable communication device intended for people with aphasia to communicate using pictures, sound clips, digitized and synthesized speech, and written text. A multiple case study involving 22 individuals who have aphasia was conducted. All participants were able to use PCAD in therapy sessions, and 77% used PCAD in a real life situation for a predetermined communication goal. However, it was first necessary for a therapist to customize PCAD for each user by selecting from the seven modules that are provided and inputting a vocabulary of words, images, and sounds. By contrast, PhotoTalk is designed to be used independently and is not intended for therapeutic purposes.

2.4 Field Evaluations of AAC Devices

To our knowledge, very little field work has been conducted to evaluate AAC devices with individuals who have aphasia. The TalksBac [Waller et al. 1998], EasySpeaker [Rostron et al. 1996], and the combined LgLite and ESI Planner II [Boyd-Graber et al. 2006] projects are notable exceptions. An evaluation that compared conversations with and without TalksBac after four participants had been using the device for 9 months showed that the system had the potential to augment the communication abilities of individuals with aphasia who do not already have their own alternative communication strategies [Waller et al. 1998]. EasySpeaker was evaluated with a four-week field study with one participant that showed improvements in the use of EasySpeaker over the study, but only limited use of the system for communication [Rostron et al. 1996]. Finally, the LgLite and ESI Planner II system was evaluated with a four-week field study with seven participants that showed that users were able to use the system, but also highlighted some specific aspects of the system that could be improved [Boyd-Graber et al. 2006]. Although Davies et al. conducted a field study to learn how an individual with aphasia used a PDA, they only did a very preliminary evaluation of their FileFacility prototype in the field [Davies 2004].

[2]The definitions of aphasia and dysphasia differ slightly, however, they are generally used synonymously [AphasiaHelp.Org].

Garrett and Kimelman [2000] describe many studies where participants were able to successfully use AAC systems in therapeutic contexts, but were unable to generalize those skills to other contexts without specific, intensive training [Garrett and Kimelman 2000]. Accordingly, we believe it is important to conduct field studies to assess the usability and usefulness of AAC devices in everyday communication situations.

2.5 Adoption of Assistive Technology by Individuals Who Have Cognitive Disabilities

Adoption is a crucial issue for assistive technology; on average, 33% of all assistive technology devices are abandoned after they are purchased [Lasker and Bedrosian 2000]. Lasker and Bedrosian [2000] proposed an AAC Acceptance Model for adults with acquired communication disorders based on factors related to the milieu, the person (user), and the technology, where acceptance is defined as the degree to which the technology is integrated into the life of the user. The communication partner and funding options are factors related to the milieu, or environment, which affect the acceptance of AAC systems. Attitude, skills, needs, and emotional state are some of the factors related to the user that affect acceptance. Lastly, durability, reliability, ease of use, size, and cost are some of the technology factors affecting acceptance.

Dawe [2006] recently conducted semi-structured interviews with teachers and parents of cognitively disabled students to determine which types of technology the students were using, how they were using it, and what technology they had tried in the past and abandoned. Although Dawe's study focused on young adults with various cognitive disabilities, we believe that many of her findings are likely relevant to people with aphasia. Dawe found that "ease of use", not only of the technology but also of the configuration and documentation, affected adoption. Increased independence, social interaction, and safety were cited as reasons for adopting technology. Dawe found that some level of out-of-the-box usefulness (prior to the configuration), and the ability to back-up, restore, and upgrade the software of an AAC device will maximize the likelihood that the device will be adopted.

3. PHASE ONE: DESIGN AND REQUIREMENTS

3.1 Participatory Design with Experts

The original design of PhotoTalk was achieved through PD done by a team comprising two SLPs and a computer scientist (first author of this paper). We chose to work with experts instead of target users for several reasons. First, recruiting adults with aphasia can be extremely challenging. Since aphasia is most often due to a stroke, many aphasic adults have physical limitations that reduce their ability to participate in research (e.g., reliance on other people for transportation to and from a study held in a fixed location). People with aphasia are often socially isolated, which makes contacting a wide pool of participants difficult. Thus, it can be difficult to include participants with aphasia throughout the design process. Second, the impaired communication

abilities of people with aphasia can make the design process much more challenging; the use of experts in the early stages of research can therefore lead to a more efficient process and is also less likely to overburden the participants with aphasia.

We recognize that there are advantages and disadvantages to working with experts instead of target users. The specific advantages of working with the SLPs were that they clearly understood the goal of the project and were able to use their knowledge of aphasia to contribute strong design ideas. Both SLPs provide speech-language therapy on a daily basis to adults who have aphasia. Thus, they have a broad knowledge and understanding of the needs and abilities of many different adults with aphasia and were able to envision the needs of our target users. The main disadvantage was that we had a hi-fidelity system developed before we tested it with the intended users, introducing the risk that our design vision was off base. We note, however, that this risk was mitigated because PhotoTalk leveraged the FileFacility prototype, which was developed with a participant with aphasia. Nonetheless, assessing both usefulness as well as usability in our field study was crucial.

Each SLP brought a different perspective to the design process. Both see patients who have recently acquired aphasia, but one works in a hospital setting and the other in her patients' own homes. One has a moderate amount of experience designing software applications and was able to use her past experiences to give useful and practical suggestions; the other, by contrast, had never worked with a technology design team before, so she brought a fresh perspective to the design process.

Initially, the PD team met to discuss the high level goals of the project. The computer scientist brought the idea of PhotoTalk to the design team, and the SLPs were enthusiastic that it would be useful for their patients. At first, the team developed the requirements, and then the computer scientist created paper prototypes based on those requirements. The team then evaluated and discussed the paper prototypes and iteratively improved the design of the system. Once the team was satisfied with the paper prototypes, the computer scientist developed a hi-fidelity prototype which the team evaluated. This was followed by another design iteration. At this stage, only minor changes were made, which included changing some of the icons. The PD team met five times over a six week period, with each meeting lasting approximately 75 minutes.

3.2 Requirements

The PD team worked together to determine key system requirements before the detailed design and implementation of PhotoTalk were carried out. At first glance, some people may assume that digital cameras already satisfy the goals we had for PhotoTalk. In our opinion, however, digital cameras only support very limited forms of communication. Users often show recently taken photographs to others, but the inability to manage photographs (such as sorting or grouping) makes it difficult to navigate to a specific photograph, especially one that was not taken recently. Additionally, digital camera screens are usually small, which does not adequately support face-to-face communication, and

further, operations done on photographs (such as delete) are often done through text-based menus. From these considerations, two important aspects of the form factor were identified: (1) it had to be mobile so that users could capture and access their images anywhere; and (2) it had to be implemented on a standard device. Assistive communication devices have traditionally drawn immediate attention to the user's deficit, which may be one reason why some people with communication impairments choose not to use them. The development of PhotoTalk on a standard device ensured that users would be able to use the system without drawing attention to their impairment, and by using cutting-edge technology, subtly demonstrate their significant cognitive abilities despite their difficulty communicating. With respect to tasks, PhotoTalk had to:

(1) support the capture of images such that photographs are automatically imported to avoid the confusion that could occur if users had to import their photographs from the file system;
(2) allow users to sort their photographs into a small number of categories (five or six);
(3) allow users to display their photographs in a sequence of their choice;
(4) allow users to remove photographs from PhotoTalk;
(5) allow users to add captions to photographs.

We specified that the number of stored photographs be limited for both technical reasons (limited storage), and design reasons. Unlimited capacity could lead to a volume of images that would eventually become too difficult or impossible to manage with a simple user interface, negating the communicative purpose of PhotoTalk. To balance flexibility of use with ease of management, we chose 100 photographs as an initial target. We decided to create a folder for each category of photographs. Each folder, except the one which would contain all the newly taken photographs, could be associated with only one screen of photographs to minimize navigation. We did not want to limit the number of photographs that the user could take before sorting, so one folder had to be able to contain more photographs.

PhotoTalk could not contain menus and could only use limited text. Menus were avoided to keep the system as simple as possible; because people with aphasia are often older, they may not have experience with mobile technology and may find it difficult to learn how to navigate through a complex system. Text obviously had to be limited because of reading and writing impairments. We decided to use images in place of text wherever possible because individuals with aphasia often maintain their ability to recognize images [Thorburn et al. 1995].

3.3 Description of the Application

This section describes the PhotoTalk application as it was implemented and used in the field study, which includes small modifications that were made after the usability study (described below). PhotoTalk is built on the HP iPAQ rx3715 Pocket PC with a built-in 1.2-megapixel digital camera and a 240x360

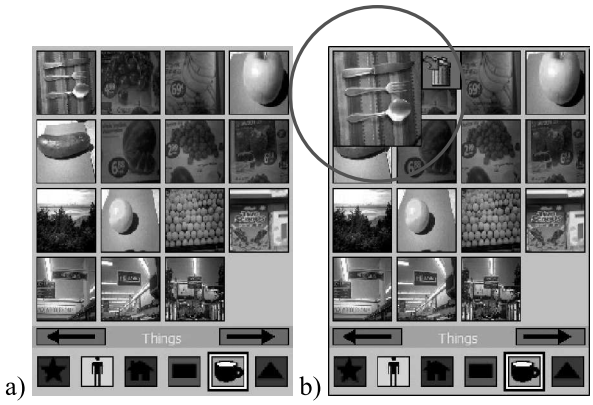

Fig. 1. (a) PhotoTalk, with the Things folder selected (shown with a black box surrounding the orange folder button and an orange bar redundantly encoding the folder colour). (b) on selection, the photo is enlarged and the delete button is shown (circled for emphasis).

pixel screen. PhotoTalk consists of six folders labeled New, People, Places, Events, Things, and Personal (see Figure 1(a)). Newly captured photographs are automatically imported into the New folder, and users may sort their photographs by moving them to another folder if they wish (described below). PhotoTalk is designed to be simple to navigate; the folder buttons are always visible and the user simply taps (using a stylus or finger) to open. In addition, the current folder selection is shown with a black box around the folder button, and is redundantly encoded with a colored bar above the folder buttons.

Each folder, except New, is limited to contain no more than 16 photographs, each 55x59 pixels in size. Sixteen is the maximum number of photographs that can be displayed on the screen simultaneously while keeping the images recognizable. This allows for 80 photographs in the category folders. The New folder supports up to five screens, which contain a total of 72 photographs. Thus PhotoTalk holds 152 photographs.

When a user taps a photograph, it becomes selected and is enlarged to 82x88 pixels. The delete button also appears, shown as a 36x36 pixel trash can (see Figure 1(b)). To delete a photograph, the user must tap the delete button. A full-screen delete dialog confirms the operation with the user (see Figure 2(a)).

Users can control the arrangement of photographs within a folder by moving them within that folder; photographs can also be moved to a new folder. A move operation occurs by dragging the photograph to a new position. Visual feedback is given through an orange bar that indicates the drop target location (within the same folder), or by highlighting the target folder with an surrounding box (different folder).

When a photograph is selected, a user may tap it to bring it to a 240x256 pixel full-screen view (see Figure 2(b)). The user may then add a caption to the photograph by clicking the caption button, shown with an “ABC” icon, in the top left corner. A custom, alphabetic soft keyboard is displayed for the user to enter text (see Figure 3). A custom keyboard with 35x35 pixel softkeys was implemented because the HP default soft keyboard was too small for our user

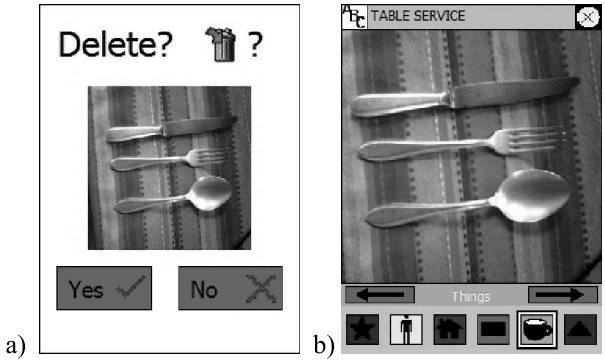

Fig. 2. (a) The full-screen delete confirmation dialog. (b) A photograph displayed in the full-screen view.

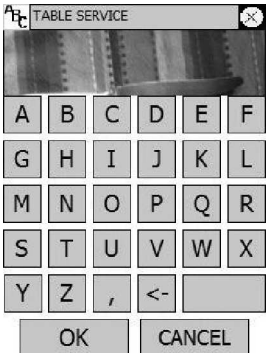

Fig. 3. The custom soft keyboard.

population. As many people with aphasia are older or stroke survivors, they often have motor impairments that make selecting small targets difficult. The custom softkeys are approximately four times larger than the softkeys on the default soft keyboard.

PhotoTalk has built-in logging to capture user interactions. It logs when a photograph is taken, moved (and where it is moved to), deleted, when navigation is performed, and when captions are created or changed. The log does not store the actual photograph for privacy reasons; the usage data is solely associated with the image filename. This logging was developed to enable rich and objective data about system usage during the planned field evaluation.

4. PHASE TWO: USABILITY STUDY

We ran an informal study to identify usability problems, as well as assess the perceived usefulness of PhotoTalk before conducting our field study. In this section, we describe the study and explain the changes to PhotoTalk that arose from this study.

Five adults over the age of 50 who have aphasia participated in the usability study. Four were male (P1, P2, P3, and P4) and one female (P5). All

participants acquired aphasia because of a stroke at least two years prior to the study[3] and all were recruited through stroke and aphasia groups with the assistance of the group facilitators. All participants regularly used computers prior to their strokes, but only P3 continued to use computers (including a PDA) regularly, both for communication and other purposes. P3 had participated in the ethnographically informed field study and participatory design (PD) of the FileFacility (described in Section 2.1). Participants were paid $10 for their time.

Each participant met with the experimenter once for up to one hour at a place convenient to the participant. The participant was asked to sign an aphasia friendly consent form that contained images throughout, which were also explained verbally in detail. The experimenter asked the participant some brief questions about his or her technology use, both pre- and post-stroke, and provided a short explanation of the goals of PhotoTalk and a quick demonstration of the software.

The experimenter then went through a series of tasks with the participant: taking a photograph, moving a photograph within the same folder, moving a photograph to a different folder, adding a caption to a photograph, changing the caption of a photograph, and deleting a photograph. Each task was first explained and a brief demonstration was given. The participant was then asked to perform the task. If the participant made a mistake, the experimenter intervened with a suggestion of how to complete the task successfully. Participants continued until they were successful or it became clear that they would be unable to perform the task. Before introduction of the caption tasks, participants were asked if they were comfortable spelling; those who were not, were not asked to perform those tasks to minimize any feeling of embarrassment.

After participants finished the tasks, the experimenter asked questions probing their opinions of PhotoTalk, including what they liked best, what they liked least, and how, if at all, they thought they would use PhotoTalk in daily life.

No major usability issues were discovered in this study. All of the participants were able to successfully complete all of the tasks with one exception. P1 had not regained his ability to spell since his stroke and was not asked to perform the caption tasks. Despite successful completion, it was clear that the move interaction sequence was overly challenging. Thus we changed move to its current drag and drop style from the previous style, which required an initial button press.

P1 was the only participant who suggested modifications to PhotoTalk. All of his suggestions involved making parts of the interface bigger which was not surprising, given that P1 has large hands and preferred interacting with his fingers rather than the stylus.

Participants had different and interesting ways that they envisioned using PhotoTalk. P1 thought he would use it to take pictures of his garden and P2

[3]The first year following a stroke is generally considered to be the period of greatest language recovery, although some improvement may continue over many years.

thought he might use it to work on his language skills by taking photographs and using the captions to practice his spelling and pronunciation. P3 thought he might use it to help him remember the names of his co-workers because remembering names was difficult for him since his stroke. P4 thought he would use it to take pictures of items while he was shopping to bring home and show his wife. Finally, P5 thought she would use it to ask for directions (e.g., show the image of the female symbol when asking for help locating the restroom).

Based on the results of the usability study, we were confident in the basic usability of PhotoTalk and were able to move forward with the planned field study.

5. PHASE THREE: FIELD STUDIES

5.1 Primary Field Study

The main goal of our field study was to learn how and if individuals with aphasia would incorporate PhotoTalk into their daily lives. We chose the field study format to discover actual use of the system, rather than anticipated use, which was gathered in our usability study. We chose a one-month duration to balance the need for our participants to have sufficient time to identify key strengths and weaknesses of PhotoTalk with our expectation that further design iteration would be required before investing the resources required for a longer study.

We expected the field study to reveal that our participants would use PhotoTalk independently, incorporate it into their lives to some extent, and use it for some aspects of communication. We were particularly interested to learn if the participants would use PhotoTalk on a regular basis, and for what purposes they would use it.

5.1.1 *Participants.* We recruited two individuals from the usability study (P1 and P2) to be the two primary participants in the field study; the remaining three participants from the usability study were not able to participate in this longitudinal field study, although P3 later participated in a secondary field study (see Section 5.2). A close family member of each participant was also recruited to attend a small subset of the meetings. PhotoTalk was designed to be used independently; however, given that communication naturally occurs between at least two people, we anticipated learning additional information about use of PhotoTalk as part of each participant's communication strategies by including a family member. The aphasic participants and their family members were each paid $75 and $25 respectively for their time.

A certified speech-language pathologist (the third author) administered the Western Aphasia Battery (WAB) to each participant. The WAB is a standardized assessment that is widely used to assess language impairments in aphasia [Kertesz 1982]. Abilities are assessed in the areas of speech, auditory comprehension, reading, and writing.

We also administered the Quality of Communication Life Scale (QCL) [Paul et al. 2004] at the end of the field study to gain a deeper understanding of

Table I. Western Aphasia Battery (WAB) Scores for P1 and P2

	P1	P2
Speech	severe	moderate
Auditory Comprehension	moderate	moderate
Reading	moderate	mild
Writing	severe	moderate

the impact of P1 and P2's aphasia on their quality of communication life. The QCL is an 18 item scale completed by the person with aphasia; each item is presented visually, and we helped the participants understand the questions. An example item in the QCL is "Even though I have difficulty communicating, I like talking to people". Each item is scored from 1-5 where 1 corresponds to *no* and 5 corresponds to *yes*.

P1 is an adult male (approximately 65 years old), who, as a result of a stroke approximately 10 years ago, is nonfluent, unable to speak more than a very limited number of single words, and able to write only partial single words. His WAB results showed that in addition to these severe speech and writing impairments, he has moderate impairment of auditory and reading comprehension, demonstrating difficulty, for example, in understanding complex or paragraph-length information (see Table I; levels of impairment are based on mean scores of subtests within each category and are relative to a standardization sample of people with aphasia). P1, who was unable to return to his consulting business following his stroke, lives with his wife and spends a lot of time with their two adult children and many close friends. Despite P1's significant communication impairments, he is comfortable performing many activities independently; for example, he goes to the grocery store, the bank, the doctor, and the coffee shop by himself. He uses his limited speech, gestures, props, drawing, and occasionally notes written by his wife to communicate in these situations. P1 attends a stroke club once a week.

The version of PhotoTalk that P1 used during the field study was slightly modified from the system described earlier. Some minor suggestions that P1 made during the usability study were implemented specifically for him before he began the field study. We modified PhotoTalk to have larger pictures in the folder view and some larger buttons, both needed to support interaction with his fingers. P1's version of PhotoTalk only displayed nine photographs per folder, allowing 76x80 pixel photographs instead of the default size of 55x59 pixels. P1's version of PhotoTalk also had only five folders so that the folder buttons could be larger and easier for P1 to press; the Personal folder was dropped because we, the researchers, deemed it the least important. The size of the delete button was increased from 36x36 pixels to 60x60 pixels and the caption box height was increased from 24 to 40 pixels.

P1's wife (P1_w) also participated in the field study. She works part-time and is quite busy with her job and household responsibilities. Both P1 and P1_w spend a lot of time working on their substantial and well cared for garden.

P2 is an adult male (approximately 75 years old) who had retired several years before he had a stroke 2.5 years prior to participating in our study. P2 speaks in full sentences at a fluent pace, but often makes word-choice errors.

Most often, he mistakenly says another word with the same first letters as the target word. Sometimes he recognizes that he has made a mistake and continues to try to say the target word until he is successful or until his listener guesses what word he is trying to say. At other times, he does not notice that he has made a word-choice error and so continues with his sentence. P2's WAB results showed that in addition to word-finding errors he has moderate impairment of writing, making frequent spelling errors; auditory comprehension is also moderately impaired. Reading comprehension, though substantially better than auditory, is mildly impaired (see Table I), with occasional errors in answering inferential questions about paragraph-length material. P2 lives with his adult daughter; his wife has lived in a long-term care facility for many years. P2 visits his wife three times a day for meal times; these daily visits keep him very busy. He is comfortable performing many activities independently; he goes shopping and performs other activities by himself. He uses speech, gestures, writing, newspapers, and other written materials to communicate in these situations. He also attends a stroke club once weekly. P2 used the version of PhotoTalk that was described earlier without any personal modifications. P2's daughter (P2_d) participated in the field study. She is quite busy with full-time work as well as regularly scheduled activities during most evenings.

Despite the differences in both the nature and the severity of P1 and P2's aphasia, they each scored 3.75 out of 5 on the QCL. Given that 5 indicates a positive attitude to aspects of communication, and 1 indicates a negative attitude, these scores indicate that both have a relatively high quality of life with respect to communication.

5.1.2 *Procedure.* The researcher met with each aphasic participant twice per week for 4 weeks during the field study. The family member was involved in the first and last meeting, and one midway through. We planned a large number of meetings in order to maintain awareness of the study progress, to allow us to quickly fix any software or hardware problems should they occur, and to collect log data throughout the study mitigating the potential of total data loss.

At the first meeting, lasting approximately 60 minutes, the particular communication skills and strategies of the person with aphasia were discussed with the aphasic participant and the family member. To refresh each participant's memory, the researcher also re-taught PhotoTalk to the person with aphasia using a *demonstrate followed by user trial* approach that was used in the usability study. Both participants quickly remembered how to use each feature. Participants were also told that their interactions with PhotoTalk would be logged by the system but that none of the images would be collected.

At each subsequent meeting, the researcher asked the person with aphasia questions about how they had been using PhotoTalk since the previous meeting. These discussions often involved looking at captured images. The participants were aware that the researcher could be viewing their images at each meeting and could delete any images in advance. Participants were also asked if they had experienced any problems, and the researcher briefly

Table II. Quantitative Usage Results from the Primary Field Study

	P1	P2
Field study duration (in days)	28	30
Days PhotoTalk was used	20	21
Meetings with researcher	9	8
Photographs taken	151	218
Photographs deleted within PhotoTalk	64	101
Photographs deleted in other software	30	42
Photographs remaining at end of study	57	75
Delete operations cancelled	6	4
Full-screen mode enabled	59	243
Different photographs shown in full-screen mode	39	91
Captions entered or changed	1	117
Photographs moved within the same folder	13	66
Photographs moved to a different folder	63	125

looked at the log data, before creating a backup copy. These meetings lasted approximately 30 minutes each.

As one of our research goals was to see how these two individuals would decide to use PhotoTalk, we did not dictate how or when they should use PhotoTalk. We told the participants to use PhotoTalk whenever and however they wanted and not to feel obligated to use it. The researcher did however ask each participant on two or three occasions about specific situations, such as "Would it be useful for you to take PhotoTalk to your stroke club?"

At the last meeting, we conducted a semi-structured interview with both the aphasic participant and the close family member. The planned questions for the interview were:

—If you could keep using PhotoTalk, would you? For what purposes would you continue to use it?

—What was the most useful feature of PhotoTalk?

—What was the most frustrating feature of PhotoTalk?

—What feature of PhotoTalk did you like the best?

—What feature of PhotoTalk did you like the least?

5.1.3 *Results.* We first describe the quantitative usage results. This is followed by the qualitative findings from the interviews, which augment the quantitative data and reveal the purposes for which the participants used PhotoTalk. Finally, we describe the usability problems uncovered.

The quantitative usage results captured from P1 and P2's logs are given in Table II. The data show that both participants used PhotoTalk regularly during the study and on approximately half of the days that they did not meet with us. Each participant encountered a problem when their New folders became full and the most recent photographs were not automatically imported into PhotoTalk. When this happened, we assisted each participant in deleting some photographs using software other than PhotoTalk (File Explorer or HP Image Zone, the built-in photo viewing software on the iPAQ). Due to a software limitation discovered during the field study, photographs taken when the New folder was full could never be accessed via PhotoTalk. P1 and P2 each

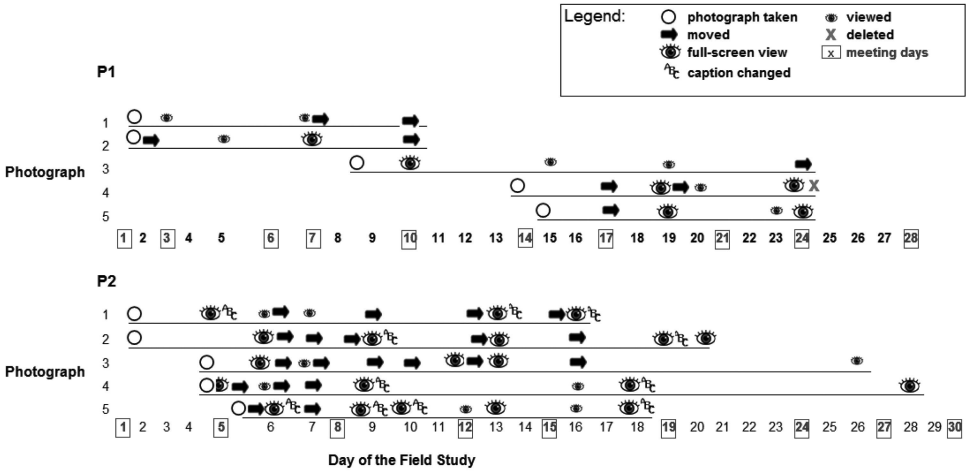

Fig. 4. A timeline of the accesses and manipulations for the five most frequently used photographs by each of P1 and P2.

viewed a variety of photographs in full-screen mode suggesting its utility. P2 made extensive use of captions, while P1 only used this feature once. Both participants relied heavily on the move operation, both within a folder and between folders. Figure 4 shows accesses and manipulations of the five photographs that P1 and P2 used most often on unique days. This figure provides a visual indicator of how P1 and P2 used PhotoTalk differently, as we elaborate on below. Overall, the log data suggest that PhotoTalk was used considerably by both participants and regularly throughout the study. It is too soon to use the numbers in Table II as metrics in any way, however, they should provide baseline data for similar future studies investigating image capture devices that support communication.

The interviews provide significant insight into the logging data. P1 only used the folders when we recommended he do so, usually because his New folder was almost or completely full. P2, however, regularly and independently sorted his photographs into folders. Neither participant used the folders exactly as we had anticipated. P1's version of PhotoTalk had five folders and he kept photographs of his garden in both the Events and Things folders, photographs of people in the People folder; the Places folder was empty and the New folder was used for all the unsorted photographs. P2's version of PhotoTalk had six folders and he used the Places folder for photographs of places, the Things folder for photographs of produce, and both the Events and People folders for household items; the Personal folder was empty and the New folder contained all other photographs. Within the New folder, P2 had organized a tools section by moving all the photographs of tools to the first screen and the rest were unsorted.

Both participants reported using PhotoTalk to communicate. P1 and P1_w reported that P1 used PhotoTalk about three or four times per week to show P1_w what he had done in the garden while she was at work or something that

still needed to be done with a specific plant. P1 also took PhotoTalk to his stroke club once, and was able to show the other members of the group photographs of his garden, which he had never done before. This communicated something about a significant part of his life that had previously remained hidden from other stroke club members. P2's use of PhotoTalk for communication was more limited than P1's. P2 used PhotoTalk once towards the end of the study to ask for a specific tool in a hardware store. P2 also took PhotoTalk to his stroke club to share his photographs with the group. When asked at the end of the study "What was most the most useful feature of PhotoTalk?", both participants identified communication: for P1 it was his ability to show P1_w photographs of the garden, and for P2 it was his use of a photograph to ask for the tool in the hardware store. We note that neither of these uses was suggested to the participants by the researcher.

When asked, P1 said that he would continue to use PhotoTalk in the same way he used it during the field study, P2's response was more mixed, requiring some interpretation. He said that at this time, he would not continue to use PhotoTalk, although he thought that PhotoTalk could be "tremendous." He felt that given how busy he was, he did not have time to use it to work on his language. P2 had spent considerable time taking pictures, especially of produce and other household items, and entering captions. P2's comments suggest that this was with the aim of improving his language skills, so that he used PhotoTalk predominantly as a language rehabilitation tool. This was not surprising given that he commented in the usability study on the potential for Phototalk to facilitate working on his spelling and pronunciation of particular words; however, we had been optimistic that he would also find PhotoTalk useful for communication.

A few usability problems were uncovered during the field study. Both P1 and P2 had suggestions for the improvement of the form factor of the iPAQ and the design of PhotoTalk. Both participants mentioned that the most frustrating aspect of the study was that it was hard for them to hold the camera steady. This often resulted in fuzzy photographs that had to be retaken. The high number of retakes accounts for many of the photographs that were deleted for both participants. P1 would have preferred a slightly bigger device (1-2 inches wider and longer), although we have been unable to locate any commercial devices of this size. P1 also commented that it would have been easier to use if the on-screen buttons were bigger, indicating that our modifications for him may not have been sufficient.

Both participants got confused if they accidentally ran other built-in software on the PDA, for example if they restarted the iPAQ or pressed one of the soft buttons on the initial screen before starting PhotoTalk. Occasionally, the iPAQ would make a sound as if it had recognized a tap, but PhotoTalk did not react to the tap, which caused confusion for the participants. We were not able to determine whether the unrecognized taps were a hardware, HP software, or PhotoTalk issue. P1 had more difficulties with unrecognized taps than P2 did. Both participants had to be reminded how to move photographs at least once during the study, although they remembered how to use all the other features of PhotoTalk. Finally, the software limitation that prevented photographs

from being imported when the New folder was full is an obvious usability problem.

5.2 Secondary Field Study

After completing the primary field study we conducted a less formal, secondary field study in order to get feedback from a particular participant.

5.2.1 *Participant.* The participant, P3, was involved in the 4-month ethnographically informed field study and participatory design of the FileFacility [Davies et al. 2004]. P3 also participated in the PhotoTalk usability study. We chose to run an additional study with this individual because he has had considerable involvement in previous Aphasia Project research, which brings a unique perspective to the evaluation of PhotoTalk. Additionally, since P3 was involved with the FileFacility project, he would be able to comment on our team's progress towards the goal of a digital remnant book.

P3 is an adult male (approximately 55 years old). He speaks very few words, but is an expert communicator. He uses a variety of strategies to communicate including writing single words, gesturing, using props, sharing digital photographs, and email. P3 regularly uses a PDA and a laptop computer, and many of his communication strategies involve some type of technology. P3's extensive experience with technology also provided a different perspective to the evaluation of PhotoTalk, since neither P1 nor P2 regularly use technology.

We administered the Quality of Communication Life Scale (QCL) [Paul et al. 2004] at the beginning of the field study (the QCL is described in detail in Section 5.1.1). P3 scored 4.18 out of 5 on the QCL which indicates that although he is aware of his communicative difficulties, he has a fairly high quality of communication life. We did not administer the Western Aphasia Battery [Kertesz 1982].

We did not involve any of P3's family members in this field study. The researchers are all familiar with P3 and felt confident that they could communicate effectively with P3, and therefore would not gain any additional knowledge from interviewing a close family member. Also, we were confident that he would be able to use PhotoTalk completely independently and would not benefit from a family member who was familiar with the system.

5.2.2 *Procedure.* The researcher met with P3 five times over a seven week period. The study was initially planned as a one-month field study so as to be consistent with the primary field study, but it was extended because P3 became unexpectedly unavailable for several weeks in the middle of the study. At the first meeting, the researcher taught P3 how to use PhotoTalk with the same *demonstrate followed by trial* approach that was used in the usability study and the primary field study. Since P3 regularly uses a PDA and participated in the usability study, he quickly remembered how to use all the features of PhotoTalk. At each subsequent meeting, the researcher asked P3 about how he had been using PhotoTalk. At the final meeting, the researcher and P3 discussed his opinions of PhotoTalk, including his thoughts about

Table III. Quantitative Usage Results from the Secondary Field Study

	P3
Field study duration (in days)	48
Days PhotoTalk was used	9
Meetings with researcher	5
Photographs taken	43
Photographs deleted within PhotoTalk	13
Photographs deleted in other software	0
Photographs remaining at end of study	30
Delete operations cancelled	6
Full-screen mode enabled	64
Different photographs shown in full-screen mode	26
Captions entered or changed	8
Photographs moved within the same folder	4
Photographs moved to a different folder	17

PhotoTalk in relation to FileFacility [Davies et al. 2004] for managing and sharing images.

5.2.3 *Results.* The quantitative usage results are presented in Table III. P3 did not use PhotoTalk regularly throughout the field study, but this is largely because of the unexpected circumstances that arose midway through the study.

Additional information was obtained during the interviews with P3. Not surprisingly, he was easily able to learn how to use PhotoTalk and used PhotoTalk completely independently throughout the field study. Although P3 did not regularly use PhotoTalk, he did find it useful for two specific purposes. P3 took photographs of his damaged motorcycle and found PhotoTalk useful for sharing these photographs. P3 also used PhotoTalk to share photographs of his pets.

P3 suggested including the captions in the folder view (see Figure 1(a)) in addition to showing them in full-screen mode (see Figure 2(b)). He also mentioned that it is difficult to take photographs with the built-in digital camera if the lighting is not ideal.

P3 said that he preferred using PhotoTalk for photographs to FileFacility [Davies et al. 2004]. His main reason for preferring PhotoTalk was because the resolution of the photographs was higher, and therefore, the photographs were of better quality. PhotoTalk is implemented on more recent hardware than FileFacility, so it is not surprising that PhotoTalk produced better quality photographs. When asked, P3 said that he also preferred the PhotoTalk software for managing and accessing his digital photographs. This is an indicator that our research team has made positive progress towards the photo capturing element of a digital remnant book.

P3 said that if he had continued access to PhotoTalk, he would continue to take it with him on a daily basis as long as he was carrying a backpack. If he was not carrying a backpack, he would only carry PhotoTalk in his pocket on days when he was specifically planning on using it. In particular, he

thought that PhotoTalk would be useful for capturing and sharing photographs of vacations.

6. DISCUSSION

Our results indicate that PhotoTalk is a promising tool for people with aphasia, but that the hardware form factor and design of PhotoTalk need further improvement. Here we discuss the findings of the field study and briefly reflect on the research process that we used.

6.1 Merit of Concept

P1 and P3 used PhotoTalk for its intended purpose, that is, to support face-to-face communication. P2 primarily used PhotoTalk as a language rehabilitation tool, and only once to support communication in a hardware store, although at the end of the study P2 indicated that its communication potential was PhotoTalk's most valuable aspect. All three participants were able to use PhotoTalk quite independently and to incorporate PhotoTalk into their daily lives to some extent. All the participants were able to use PhotoTalk in a meaningful and personal way, which shows that the tool provided some benefit to these individuals. Although none of the participants used the folder-category mapping that we had designed, they were all easily able to create their own folder-category mapping based on their photographs, showing the flexibility of the design.

In the spirit of rehabilitation, P2 took many photographs so that he could practice his spelling and pronunciation with the captions rather than just taking photographs that he was planning to use to meet specific communication goals. By contrast, P1 and P3 used it exclusively to capture images to communicate. This could be due to differences not only in the nature and severity of their word-finding problems but also in the differing lengths of time they have been coping with their impairment. P1 and P3 have had aphasia for ten and five years respectively, and have well-developed coping and communication strategies. P2 has only had aphasia for two and a half years and is still working on rehabilitating his language skills. P1's well-developed coping strategies are a likely explanation for why he only used PhotoTalk for a very specific communicative purpose when he was at home. He already had a well-established pattern of communication with his wife, and identified PhotoTalk's potential to enhance that pattern by communicating specific information about the garden to her. P3's excellent communication skills are likely why he also used PhotoTalk for only a specific communicative purpose. P2, however, with his active focus on rehabilitating his language skills, was excited to incorporate PhotoTalk into his language practice.

Overall, our findings suggest that the concept of easily capturing and managing photographs using a mobile device has merit for people with aphasia, who may find different uses for it that are influenced not only by the nature of their aphasia, including both the pattern and relative severity of impairments, but also by their personal circumstances and communicative goals. Clearly, further study will be required to assess the extent of its usefulness.

6.2 Patterns of Use

Although each of the three participants found PhotoTalk useful for a particular communicative purpose, P1 and P2 used PhotoTalk far more regularly than P3 (see Table II and Table III for more information). We believe that this is because P1 and P2 were exploring different scenarios of use, while this was not necessary for P3 because of his previous experience using a mobile device with a digital camera [Davies et al. 2004]. P3 had already explored different scenarios and knew prior to participating in the PhotoTalk study the communicative situations in which PhotoTalk would be most useful for him. This may indicate that once a user is familiar with PhotoTalk, its use becomes less time-consuming because he or she is aware of the situations in which it will be useful.

6.3 Customizability

Several issues that emerged from the field study could be rectified with customizable options. P1 wanted almost all elements of PhotoTalk to be bigger, including the PDA, the photographs, and the buttons, but P2 and P3 were happy with the elements' default sizes. The different preferences could easily be accounted for if the size of the GUI elements in PhotoTalk was customizable. P1 had more difficulty with the screen-sensitivity than P2 and P3. This indicates that a customizable level of screen-sensitivity would be useful (although this is not possible on the current iPAQ hardware). P2 created captions on 73% of the photographs that remained at the end of the field study, and P3 created captions on 33% of his photographs, while P1 only created one caption. The caption feature should be customizable so that if captions are not desired the extra screen space could be devoted to photographs. P3 suggested including the captions in the folder view as well as in full-screen mode, but this was not desired by P1 or P2. The presence of captions in the folder view is another feature that could be customizable. In order to keep the use of PhotoTalk as simple as possible, these customizations should be made before the user receives the system, possibly with a simple text-based configuration wizard that a family member could complete. Even very simple customizations could complicate PhotoTalk, however, so we would have to carefully consider the advantages and disadvantages of customization prior to adding this functionality.

6.4 Improvements to Phototalk

We found problems with the form factor and design of PhotoTalk during the field study. Some of the problems mentioned in the Results section could be easily avoided. PhotoTalk should prevent users from starting native Pocket PC applications to alleviate the confusion that the participants faced when they accidentally started software other than PhotoTalk. Also, the iPAQ is designed to be used by a right-handed user; for example, the button used to take a picture is positioned optimally for a right-handed user. Many people with aphasia have motor impairments in their right arm and hand (hemiparesis), which makes physical operation of the PDA challenging. Left-handed models would be a significant improvement to PDA accessibility.

Even though P3 was consistently able to move photographs, both P1 and P2 needed reminders, which indicates that despite our redesigning this feature after the usability study, it still requires improvement. A simple solution could be to add a visual reminder that photographs are moved by drag and drop, such as a drag handle in the corner of each photograph.

6.5 Adoption

Although adoption is a key issue for assistive technology, it was not a core goal at this stage of the PhotoTalk project; the current software is far too young to be adoptable as a shrink-wrapped application. However, based on the AAC Acceptance Model developed by Lasker and Bedrosian [2000] for adults with acquired communication disorders, we are encouraged that PhotoTalk has many of the attributes that suggest its eventual likelihood for adoption: PhotoTalk is relatively simple, provides a platform for increased independence and social interaction, and is small and portable. Although our field studies were short and provided support to the participants, we are cautiously interpreting P1 and P2's regular use of PhotoTalk and P3's expressed desire to continue using PhotoTalk as positive indicators for future adoption. A longer field study with less regular support from the researcher would be required to identify whether or not users will be willing and able to adopt PhotoTalk and continue to use it for an extended period of time.

Due to shifting demographics, a larger percentage of older people, and therefore, a larger percentage of people acquiring aphasia, will have prior experience with PDAs. This is another factor that should positively influence the adoption rate of a PDA-based application like PhotoTalk.

6.6 Research Process

Conducting the informal usability study before running the one-month field study caught basic usability problems before our field study participants invested a month of their time using the system. The additional usability problems that emerged in the field study, however, may have been caught had we run an additional usability study first.

Although we were able to recruit five participants relatively easily for the one-hour usability study, it was extremely challenging to recruit any aphasic individuals for the field evaluation during the relatively short time period in which the first author was doing her master's degree research. We learned that research projects requiring longitudinal field work with individuals who have disabilities may be more appropriate for researchers who have flexible research deadlines, as recruiting challenges can cause significant delays.

The field study format worked reasonably well. The frequent meetings ensured that we were constantly aware of the study progress. We discovered one bug in P1's version of PhotoTalk which was quickly fixed. Working with just two participants in the primary field study yielded informative results from this initial evaluation of PhotoTalk. The involvement of the close family members was most beneficial at the outset of the study; the participants seemed more comfortable knowing that their family members would be present to

assist in communication with the researcher if necessary. Once the participants and the researcher gained more familiarity with one another, the family members had significantly less involvement in the discussions. (Both family members were extremely busy and hardly spent any time interacting with P1 and P2 and PhotoTalk.) Conducting the secondary field study with P3 was an effective way to evaluate our team's progress towards the goal of creating a digital remnant book. Overall the basic framework of our field study methodology worked reasonably well. We expect that it would be appropriate for other investigations of assistive devices that are designed to be used by relatively independent individuals.

We did, however, discover one glitch with our field study protocol at the end of the primary field study. Each participant had used PhotoTalk for communication, but despite being asked about their use at every meeting neither participant mentioned their communication usage until the last meeting. At the meetings throughout the study they typically described when and of what they had taken pictures. It was only at the end that they both mentioned communication as being PhotoTalk's most useful feature. Although the communicative exchanges they described were exactly what we had in mind when designing PhotoTalk, the participants apparently did not at first consider these uses to be significant enough to mention, perhaps because our usage instructions at the outset were intentionally vague. Another possibility is that the participants' communication impairments were a barrier; P1 and P2 may not have completely understood the researcher, although, during the earlier meetings it seemed otherwise. This raises the concern that we may have missed other pertinent information because of unknown difficulties communicating with the participants. This confusion highlights the challenge of performing field evaluations with people who have communication impairments. In comparison to laboratory studies, field evaluations do not have prescribed tasks that we can use to measure participants' performance. In field evaluations, we do not necessarily know what the users intended task is, and it is difficult to have the participant clearly communicate their task in order for us to analyze his or her usage.

Finally, all three participants have relatively high QCL scores, which could be one of the reasons that they each used PhotoTalk only for a very specific purpose. Because they were both reasonably confident in their coping strategies and their ability to communicate, they may have had a lesser need for an AAC device. We speculate, however, that it may be challenging to recruit users with low QCL scores because they may be more socially withdrawn.

7. CONCLUSION

The results of our field studies indicate that we were largely successful in meeting our goals. We designed an application for a mobile device that allows people with aphasia to independently capture and manage digital photographs to support face-to-face communication. All three field study participants found PhotoTalk useful for a specific type of face-to-face communication, while one participant also identified further potential for its use in language

rehabilitation. Even though neither P1 nor P2 regularly used computers before the field study, and neither had ever used a PDA before, they were both able to learn how to use PhotoTalk and had positive impressions of the software. Due to his prior experience with PDAs, P3 was easily able to learn how to use PhotoTalk. However, as both P1 and P2 needed reminders of how to use it throughout the study, a modest amount of support would be necessary to continue using the tool in its current form. Fixing the basic usability problems and making the application more customizable should lead to greater independence. Creating an accessible, image-based application that supports communication is one of the contributions of this research.

To our knowledge, little field work has been done to evaluate AAC devices with individuals who have aphasia. Although conducting field studies with aphasic participants is challenging, it is important to evaluate AAC devices in everyday communication situations, albeit not completely intervention free, instead of solely in therapeutic or laboratory settings. We recognize that our frequent meetings with the participants may have influenced their use of PhotoTalk. Frequent meetings were necessary given that PhotoTalk was in prototype form and that successfully communicating with the aphasic participants was challenging. Our field evaluation of PhotoTalk is an important first step in measuring real life use and an additional contribution of this work.

The PhotoTalk project was a positive step towards the Aphasia Project's goal of creating a digital remnant book. PhotoTalk could be a base for a digital remnant book once its usability problems are rectified; additional functionality, such as digitized speech and support for multimedia files, could be added. This would necessitate considerable design work and naturally shift the application in the direction of some of the more complex AAC devices (e.g., [OneWrite Company]) that cannot be used independently by the person who has aphasia. The tradeoff between the power of the application and the user's ability to independently operate the application would need further consideration.

The next steps for the PhotoTalk project involve further development and evaluation, especially given the diversity of patterns of impairment associated with aphasia. We plan to investigate customizability broadly, using GUI element size and caption bar presence as our starting points. Eventually, we hope to compare PhotoTalk to Cyrano Communicator. Based on the findings of the current study, we hypothesize that, people with moderately or severely impaired comprehension (such as the two participants in the current study) may require the simplicity of PhotoTalk, while those with word-finding problems but with relatively good comprehension may prefer the power of Cyrano Communicator. If this proves true, we could create a more complex and powerful layer within PhotoTalk, providing a full-featured system that allows users to choose the layer they will work with. Again, the balance between power and independent use will be a design factor.

Longer term, we expect to conduct another field study to determine how individuals with aphasia will integrate PhotoTalk into their daily lives over a period of six months or more. Many social interactions occur infrequently and a longer field study would span more events in our participants' lives and provide opportunities to explore further how PhotoTalk can accommodate

different patterns of impairment. Such a study would shed significant light on the level of support necessary for PhotoTalk's independent operation as well its overall potential for adoption.

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