The Design and Field Evaluation of PhotoTalk: a Digital Image Communication Application for People with Aphasia

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ABSTRACT
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 3 phases: (1) a rapid participatory design and development phase with two speech-language pathologists acting as representative users, (2) an informal usability study with 5 aphasic participants, which caught usability problems and provided preliminary feedback on the usefulness of PhotoTalk, and (3) a 1 month field evaluation with 2 aphasic participants, which showed that both used it regularly and fairly independently, although not always for its intended communicative purpose. Our field study demonstrated PhotoTalk's promise in terms of its usability and usefulness in *real life* situations.

Categories and Subject Descriptors
K.4.2 Computers and Society: Social Issues – Assistive Technologies for Persons with Disabilities; H5.2. Information Interfaces and Presentation: User Interfaces – Evaluation/Methodology, Graphical User Interfaces, Prototyping, User-Centered Design

General Terms
Design, Human Factors.

Keywords
AAC devices, aphasia, cognitive disability, participatory design, evaluation, field study, mobile technology.

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 which can affect speaking, comprehension of spoken language, reading and writing, although the patterns and extent of impairment across these different modalities vary greatly across individuals [2]. Aphasia, which is estimated to affect 1 million Americans, is most often caused by a stroke, although other brain damage can also be the cause [2].

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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 [17].

There are many augmentative and alternative communication (AAC) devices for individuals who have communication impairments; however, they 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., [18]).

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 [11], than systems that only support needs and wants.

We used a streamlined design approach with three phases for the PhotoTalk project. We used participatory design (PD) with two speech-language pathologists (SLPs), clinically trained experts in aphasia, to very quickly complete the design phase. We then conducted an informal usability study with 5 participants who have aphasia to identify usability problems and provide preliminary feedback on the usefulness of the application. Finally, we ran a 1 month field study with 2 individuals who have aphasia to understand how they would incorporate PhotoTalk into their daily lives. Both individuals used PhotoTalk fairly independently and used it regularly throughout the field study, although not always for its intended communicative purpose.

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) a 1 month field evaluation with 2 users demonstrating the application's promise in terms of both its usability and usefulness in *real life* situations.

2. RELATED WORK
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 [1]. 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 [9]. 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 they 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 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. investigated the feasibility of using a PDA, given its portability and cachet. They performed an ethnographically informed field study with a single aphasic user to determine which aspects of a native PDA were most effective and most troublesome for the participant [7], prior to creating an assistive application. They discovered that file access was the most challenging, and together decided to focus on the file system. Davies and the participant used participatory design (PD) to create 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 as a further step towards a digital remnant book.

Participatory Design with People who have Cognitive Disabilities: PD is a mainstream HCI design method in which the target users and system designers work together as equal members of the design team. PD has begun to see 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 [7, 13, 20].

When target users have special needs, it is often necessary to include other people in the PD process, such as loved ones, caregivers, and 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 [4, 5, 12]. In the PhotoTalk project we involved SLPS and family members.

AAC Devices: There are many commercially available AAC devices for people who have speech impairments (e.g., [14]); we focus here on 2 devices that are most similar to PhotoTalk. The Cyrano Communicator is a device designed to aid individuals with speech impairments to communicate through customized images, text, sound and synthesized speech [14]. 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 speech impairments. Its interface uses considerably more text than PhotoTalk and generally has more complex navigation, both of which 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.

PCAD is a portable communication device intended for people with aphasia to communicate using pictures, sound clips, digitized and synthesized speech, and written text [18]. 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 pre-determined communication goal. A therapist must 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.

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 [19], EasySpeaker [16], and the combined LgLite and ESI Planner II [4] projects are notable exceptions. An evaluation compared conversations with and without TalksBac after 4 participants had been using the device for 9 months [19], while both EasySpeaker and the LgLite and ESI Planner II system were evaluated with 4 week field studies [16, 4]. Although Davies et al. conducted a field study to learn how an individual with aphasia used a PDA, they only did a very preliminary and casual evaluation of their FileFacility prototype in the field [6].

Garrett and Kimelman 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 [8]. Accordingly, we believe it is important to conduct field studies to assess the usability and usefulness of AAC devices in real life situations.

3. PHOTOTALK

The original design of PhotoTalk was achieved through PD done by a team comprised of two SLPs and a computer scientist (first author of this paper). We recognize that there are advantages and disadvantages to working with experts instead of target users and we refer the interested reader to the first author's thesis [3] for a more in depth explanation of our design method.

We considered three platforms for PhotoTalk: polaroid cameras, digital cameras, and a PDA. We chose a PDA because polaroid cameras are too cumbersome as they are bulky to carry and create physical photographs that must be organized and are also bulky to carry in any number. Digital cameras are too difficult to navigate for many individuals with aphasia and their small screens do not adequately support face-to-face communication.

3.1 Requirements

The PD team worked together to determine key system requirements before the detailed design and implementation of PhotoTalk were carried out. 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. 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 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. Users had to be able to sort their photographs into a small number of categories (five or six) and display them in a sequence of their choice, as well as remove them from PhotoTalk and add captions.

We limited the number of stored photographs 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; New, People, Places, Things, and Events were suggested by the SLPs later during detailed design. Each folder, excepting New 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 New had to be able to contain more photographs.

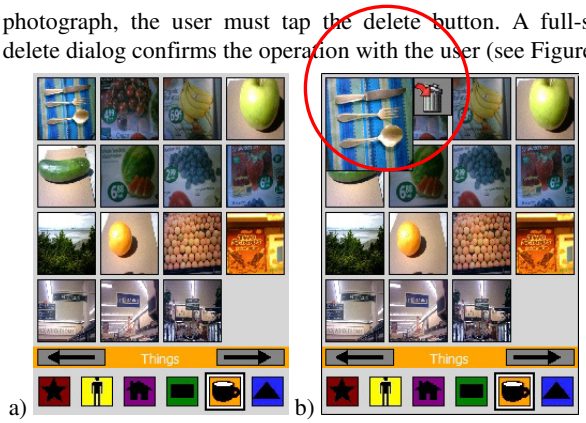
PhotoTalk could not contain menus and could only use limited text. Menus were avoided to keep the system as simple as possible; because people with aphasia are often older, they may not have experience with mobile technology and may find it difficult to learn how to navigate through a complex system. Text was obviously limited due to reading impairments. We used images in place of text wherever possible because individuals with aphasia often maintain their ability to recognize images [17].

3.2 Description of the Application

This section describes the PhotoTalk application as it was 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 pixel screen. PhotoTalk consists of six folders labelled New, People, Places, Events, Things, and Personal (see Figure 1a). Newly captured photographs are automatically imported into the New folder, and the user may sort her photographs by moving them to another folder (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 coloured 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 5 screens, which contain a total of 72 photographs. Thus PhotoTalk holds 152 photographs.

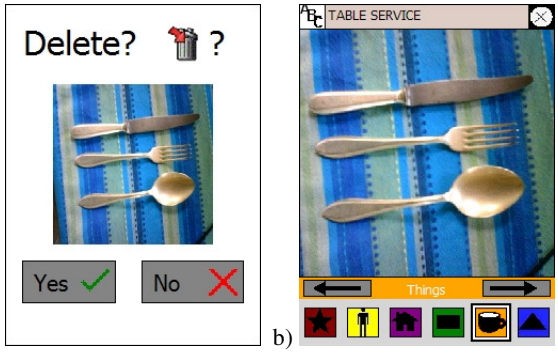
When a user taps a photograph, it becomes selected and is enlarged to 82x88 pixels. The delete button also appears, shown as a 36x36 pixel trash can (see Figure 1b). To delete a photograph, the user must tap the delete button. A full-screen delete dialog confirms the operation with the user (see Figure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



a) b)

Figure 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).

Users can control the arrangement of photographs within a folder by moving them within that folder; photographs can also be moved to a different 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 (within the same folder), or by highlighting the target folder with an orange box (new folder).



a) b)

Figure 2. a) the full-screen delete confirmation dialog. b) a photograph displayed in the full-screen view.

When a photograph is selected, a user may tap it to bring it to a 240x256 pixel full-screen view (see Figure 2b). 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. A custom keyboard with 35x35 pixel softkeys was implemented because the HP default soft keyboard was too small for our user 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 study.

4. USABILITY STUDY

We recruited 5 aphasic adults to participate in an informal study to identify usability problems, as well as assess the perceived usefulness of PhotoTalk before conducting our field study. The study tested the basic functionality of PhotoTalk, including 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, and deleting a photograph. We also asked questions probing each participant's opinions, including how he thought he would use PhotoTalk in his daily life.

No major usability issues were discovered. All the participants were able to successfully complete all the tasks (except our first participant, P1, who was not asked to do either caption task because he indicated at the outset that he was no longer able to write). 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.

Each participant had a different and interesting way that they envisioned using PhotoTalk. For example, P1 thought he would use it to take pictures of his garden and P2 thought he might use it to work on his language skills by taking photographs and using the captions to practice his spelling and pronunciation.

5. FIELD STUDY

The primary 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 1 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 regularly, and for what purposes they would use it.

5.1 Participants

We recruited two individuals from the usability study to be the two primary participants (P1 and P2) in the field study; the remaining three participants from the usability study were not able to participate in the longitudinal field study. 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 pairs of people, we anticipated learning additional information about its use and each participant's communication strategies by including a family member. The participants and their family members were paid $75 and $25 respectively for their time.

A certified speech-language pathologist 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 [10]. Abilities are assessed in the areas of speech, auditory comprehension, reading, and writing.

We also administered the Quality of Communication Life Scale (QCL) [15] at the end of the field study to gain a deeper understanding of 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 ten 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. 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 (larger pictures in the folder view and 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 deemed it the least important. The delete button was increased in size from 36x36 pixels to 60x60 pixels and the caption 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 due to 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 ago. 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; his auditory comprehension is also moderately impaired. Reading comprehension, though substantially better than auditory, is mildly impaired. 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 at 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 which indicates that although they are aware of their communicative difficulties, they both have a relatively high quality of communication life.

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

At the last meeting, we conducted a semi-structured interview with both the aphasic participant and the close family member.

As one of our research goals was to see how these two individuals would 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?".

5.3 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. Further results, including P1 and P2's access patterns for regularly used photographs are available in the first author's thesis [3].

The quantitative usage results captured from P1 and P2's logs are given in Table 1. 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. Photographs were deleted by both participants outside of PhotoTalk (using File Explorer or HP Image Zone, the built-in photo viewing software on the iPAQ), when their New folders became full and the most recent photographs were not automatically imported. 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 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. Overall, the log data suggest that PhotoTalk was used considerably by both participants and regularly throughout the study.

Table 1. Quantitative usage results from the 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

The interviews provide significant insight into the logging data. P1 only used the folders when we recommended he do so; he needed to sort his photographs 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, 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 a large part of his life that had previously remained hidden from the stroke club. 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 work on his language in this manner. 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 his comments in the usability study; 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 by 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.

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.

Merit of Concept: P1 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. Both participants were able to use PhotoTalk quite independently and incorporate PhotoTalk into their daily lives to some extent. Both participants were able to use PhotoTalk in a meaningful and personal way, which shows that the tool provided some benefit to these two individuals. Although neither participant used the folder-category mapping that we had designed, both participants were 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 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 has had aphasia for 10 years and has well developed coping and communication strategies. P2 has only had aphasia for 2.5 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 has 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. 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.

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 was 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. 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, while P1 only created one caption. The caption feature should be customizable so that if captions are not desired the extra space

could be devoted to photographs. 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 wizard that a family member could complete.

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. 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.

Both participants needed reminders of how to move photographs, which indicates that this feature 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.

Research Process: Conducting the informal usability study before running the 1 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 another usability study first.

Although we were able to recruit 5 participants relatively easily for the one-hour usability study, it was extremely challenging to recruit any aphasic individuals for the field study 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. Two participants were sufficient to get 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.)

We discovered a glitch with our field study protocol at the end of the month. Each participant had used PhotoTalk for communication, but despite being asked about their use at every meeting neither participant mentioned this until the last meeting. At the meetings throughout the study they typically described when and what they had taken pictures of. It was only at the end that they both mentioned communication as being PhotoTalk's most useful feature. Although the communicative exchanges they described are exactly what we had in mind when designing PhotoTalk, perhaps because our usage instructions at the outset were intentionally vague, the participants did not consider these uses to be significant enough to mention earlier on. 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.

P1 and P2's relatively high QCL scores could be one of the reasons that they both used PhotoTalk only for a very specific purpose. They are both reasonably confident in their coping strategies and ability to communicate, so they may have a lesser need for an AAC device. We speculate, however, that it may be hard to recruit users with low QCL scores because they may be more socially withdrawn.

7. CONCLUSION

The results of our field study 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. Both 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 had never used a PDA before, they were both able to learn how to use PhotoTalk and had positive impressions of the software. However, as they both 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 increase 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 *real life* 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., [14]) 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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