A Mobile Phone Based Personal Narrative System

Rolf Black, Annalu Waller
University of Dundee
School of Computing
Dundee DD1 4HB, Scotland
+44 1382 386530
{rolfblack, awaller}
@computing.dundee.ac.uk

Nava Tintarev, Ehud Reiter
University of Aberdeen
Department of Computing Science
Aberdeen AB24 3UE, Scotland
+44 1224 273443
{n.tintarev, e.reiter}
@abdn.ac.uk

Joseph Reddington
Royal Holloway
Computer Science
Egham TW20 0EX, England
joseph@cs.rhul.ac.uk

ABSTRACT
Currently available commercial Augmentative and Alternative Communication (AAC) technology makes little use of computing power to improve the access to words and phrases for *personal narrative*, an essential part of social interaction. In this paper, we describe the development and evaluation of a mobile phone application to enable data collection for a personal narrative system for children with severe speech and physical impairments (SSPI). Based on user feedback from the previous project "How was School today…?" we developed a modular system where school staff can use a mobile phone to track interaction with people and objects and user location at school. The phone also allows taking digital photographs and recording voice message sets by both school staff and parents/carers at home. These sets can be played back by the child for immediate narrative sharing similar to established AAC device interaction using sequential voice recorders. The mobile phone sends all the gathered data to a remote server. The data can then be used for automatic narrative generation on the child's PC based communication aid. Early results from the ongoing evaluation of the application in a special school with two participants and school staff show that staff were able to track interactions, record voice messages and take photographs. Location tracking was less successful, but was supplemented by timetable information. The participating children were able to play back voice messages and show photographs on the mobile phone for interactive narrative sharing using both direct and switch activated playback options.

Categories and Subject Descriptors
K.4.2 **[Computers and Society]**: Social Issues – Assistive technologies for persons with disabilities; D.2.2 **[Software Engineering]**: Design Tools and Techniques – User interfaces; H.1.2 **[Models and Principles]**: User/Machine Systems – Human factors; H.5.2 **[Information Interfaces and Presentation]**: User Interface – User-centered design; I.2.7 **[Artificial Intelligence]** Natural Language Processing – Language generation.

General Terms
Design, Experimentation, Human Factors.

Final draft for *ASSETS'11*, October 24–26, 2011, Dundee, Scotland, UK.

Keywords
Augmentative and Alternative Communication (AAC), Personal narrative, Language development, Accessibility, Assistive technology, Disability, Cerebral Palsy, Mobile phone application, Voice output communication aid (VOCA), Speech Generating Device (SGD), User centered design

1. INTRODUCTION
In the "How was School today...?" (HwSt) project we have successfully developed a new personal narrative tool for children with severe speech and physical impairments (SSPI) [1, 2]. HwSt is the first step towards our goal of developing AAC tools that support storytelling and social dialogue. The proof of concept prototype of the system was able to collect sensor data, record voice messages from school staff and use other information, such as the timetable, to generate narratives automatically that children with SSPI could use to talk about their day. The system uses data-to-text natural language generation (NLG) technology to generate the appropriate utterances forming the narrative [3]. A graphical user interface, accessible both directly via touch screen and indirectly via switch scanning access, allowed the children firstly to personalise the stories through editing and then share them with adults and peers. The system was evaluated with three participants but needed substantial technical support to run.

In this paper, we describe key stages in designing and testing a data gathering module in form of a mobile phone application. It is part of a follow-on system that was anticipated to be usable by staff in a special school with limited technical support given over a longer period with several participants. This next generation prototype system uses the mobile phone to facilitate and expand the data collection. Additional data collected include photographs that can be linked to the voice message sets, and the ability to read 2D barcodes and Radio Frequency ID (RFID) tags to identify both interactions and locations. Data collected with the mobile phone are transferred automatically to a remote server, and can be used for the generation of narratives on the child's voice output communication aid (VOCA). School staff and students have both been involved in the design of the system.

At the end of the first HwSt project a questionnaire was given to staff to collect feedback on the use of the initial prototype. Parents were also given a questionnaire with questions about the use of AAC and their expectations on future devices. Feedback indicated the need for: (a) access to older narratives than just the previous day; (b) access to narratives directly after data collection (e.g. to tell the class about an experience after coming back from therapy or a special event); (c) smaller devices with better battery power; (d) the ability to print the generated narratives. In our current 18 months project, we have aimed to address all but the last of these issues.

2. BACKGROUND

Augmentative and Alternative Communication (AAC) technology can help individuals without speech to communicate with their environment. Since its early days in the 60s and 70s, AAC has seen dramatic changes in the technology used – from letter and phrase boards to gaze controlled computer access[1] or mobile phones with dedicated AAC software[2], both with natural sounding voice output technology [4]. However, most commercially available technology has been designed mainly to support transactional communication such as voicing needs and wants ("I am thirsty") and computing power is mainly used to enable physical access (e.g. to support eye gaze) or to improve voice output (via Text-to-Speech technology). Word selection and phrase construction, the storing and retrieving of content with all their associated cognitive requirements are still mainly left to the user [5].

For human beings, personal narrative is one of the main ways to access social communication. When we talk about our experiences we translate the things we know into narratives [6] which can help us to shape our language development [7]. Additionally, the telling and re-telling, structuring and re-structuring of our personal stories, enable us to reflect on our life and helps us to develop a sense of self [8]. Through the sharing of stories we make new friends and sustain current relationships.

Some AAC research projects have developed prototype systems which attempt to facilitate personal narrative, e.g. by providing users with fixed conversational utterances that can be selected with some support for conversational moves and spoken using synthesised speech [5, 9, 10]. However, these systems all need to be authored ahead of any conversation by the user (or their carer) in a laborious time consuming process.

Other research systems use Natural Language Processing technology to provide users with computer generated messages and support in accessing and selecting appropriate messages [11, 12]. However, these systems tend to be literacy based and are not necessarily appropriate for children or non-literate users.

Current commercially available VOCAs or AAC software applications for mainstream technology only partly support personal narrative interaction. Most devices allow the user or carer to save collections of utterances about personal experiences on the device for later retrieval. However, the process of organising the storage (in folders or so called 'notebooks') is left to the user or the user's carers and there is little support to edit the stories on the fly to accommodate interactive narrative where communication partners alter their stories to suit the conversation.

As an example, devices without a graphical interface such as sequential voice recorders (e.g. Step-by-step[3]) allow the user to record voice message sets which can be accessed sequentially or individually to talk about an experience.

A common way to enable users with a VOCA with graphical interface to speak about a personal experience is creating a photograph album with added annotations which the user can play back as a slide show. Photographs can also be used as visual scene displays by adding hot-spots with individual messages to the image. However, devices usually require advanced programming of the device in order to allow the user to access utterances other than the initial captions of the photograph[4].

All currently available applications have to be updated manually, i.e., the user or carer needs to decide what narrative to store on a device [13]. There is little or no opportunity to edit a story interactively during narration, and there is no support in retrieving situation or interaction appropriate stories. Technical abilities of new mainstream hardware, such as GPS for location detection on the iPhone and other smart handheld devices have been used to support retrieval of situational vocabulary, but the use of this technology has been limited, to date, to needs based communication such as ordering a meal at a restaurant[5].

3. USER CENTRED DESIGN PROCESS

Developing systems and interfaces for assistive technology is particularly challenging from an HCI perspective. What would work for a general population cannot be assumed for the intended user groups. It is particularly important to work with the users and their carers to develop something that works for them.

Several information gathering methods were used during the design of the original proof of concept (PoC) prototype [1]: (a) interviews were conducted and informal feedback gathered from speech and language therapist/pathologists, teachers and parents; (b) an ethnographic study over two weeks was conducted, shadowing the three participating children throughout their day to collect information about daily activities, interaction with staff and peers and the location of the children; (c) further information such as the children's timetable, lunch menu, current use of AAC equipment, literacy/symbol use and access methods were noted [14].

This information was used, together with ongoing feedback during the iterative design process, to ensure the development of a system that would fit into the school environment. The evaluation of the original PoC prototype showed that the system's output successfully supported personal narrative for the participating children. However, using the system was not practical on a day to day basis by staff without extensive support from the researchers (e.g. staff were unable to update the system, several hardware components had to be mounted and un-mounted on the user's wheelchair on a daily basis).

The follow-on project is set in a different special school. This school has less experience in AAC than the original school and therefore needed more input from the research team on the use and concept of supporting personal narrative of children with severe speech and physical impairments.

In the next sections, we describe the user-centred design process from information gathering to evaluations of the mobile phone prototype.

3.1 Information gathering

The researchers spent several weeks at the new special school to establish routines and identify possible participants for the evaluation.

The school caters for children with social, emotional and behavioural difficulties, profound or complex learning needs and physi-

[1] See http://cogain.org/ for examples

[2] E.g. http://www.proloquo2go.com/

[3] Trademark of http://www.ablenetinc.com/

[4] E.g. http://dynavoxsys.custhelp.com/ci/fattach/get/536/, retrieved 11 August 2011

[5] E.g. http://myvoiceaac.com/ or http://locabulary.com/

cal and sensory impairment and has about 60 pupils in nursery, primary and secondary classes. About half of the pupils are non-speaking and many use a combination of un-aided AAC (such as Makaton[6]) and 'low-tech' AAC (such as symbols or photographs) for communication. 'Low-tech' VOCAs are used for curriculum support, but are not widely used for communication support.

In collaboration with staff at the school, eight possible participants were identified on the basis of their communication and/or intellectual impairments; some of the children exhibited a desire to share their experiences, for others it was felt by staff that the children might benefit from participation. A bigger pool of potential participants allowed us to prepare for drop-outs due to illness or other issues (such as key staff leaving) which are common when working with individuals with severe disabilities. After drop-outs, we continued the evaluation with two children with very diverse profiles in particular in terms of mobility and age (See Section 5.1 for a description of our participants).

3.2 Workshop sessions at the school

A major factor for the successful use of a narrative tool using voice recordings which was identified in the original PoC project was staff experience and skills in using VOCAs to support personal narrative. The collaborating school in the current project had only one 'high-tech' AAC user at the time and used voice recording devices mainly to support curriculum activities rather than communication. To address the issue of building up skills on how to use AAC devices to support narrative, the research team, together with Nicola Grove[7], led a workshop on personal narrative for individuals with learning disabilities over two evenings for the teachers at the school. During the workshop, staff were encouraged to express expectations and possibilities for supporting personal narrative for the students at the school.

In order to support the data collection using the system, a further workshop on the use of voice message recording AAC devices (such as Step-by-Step voice recorders) was held as part of an in-service training day at the school.

3.3 Hardware Requirements

The following requirements list for the portable data gathering device was compiled from information gathered during the project and from feedback from the previous project:

(a) Accessible to individuals with reduced dexterity;

(b) Remotely accessible for individuals using switch access, e.g. via cable or Bluetooth;

(c) Audio recording and playback capabilities with sufficient playback volume;

(d) Inbuilt camera accessible for photograph taking and barcode detection;

(e) Data transfer via Wifi or 3G (UMTS) mobile phone network;

(f) Running Windows for mobile operating system to be able to run Wifi tracking client (we used a Windows Mobile based commercial system, see Section 3.4.3);

(g) Sufficient battery life, i.e. at least 2 days stand-by with active Wi-Fi and 3G network to avoid running out of battery during data gathering.

At the time, the most suitable device appeared to be the HTC Touch2 mobile phone with a touch screen. The choice was justified by the fact that this device would support all technical requirements mentioned above. The touchscreen would allow switch-like access for users with reduced dexterity by creating whole screen buttons and Bluetooth keyboard support would allow remote switch access for head switch users via adapted Bluetooth keyboards. Later, we had to switch to a Nokia 6212 Classic due to hardware as well as software implications described in Section 3.4.2.

3.4 Data collection trials

Interface design scenarios based on the information gathering described earlier were drawn up to inform the design of a PowerPoint mock-up graphical user interface (GUI). The mock-up interface could run on the HTC Touch2 for initial user feedback.

The interface mock-up allowed for recording sets of voice messages (similar to Step-by-Step voice recorders), taking photographs (e.g. to accompany the recordings), or detecting barcodes for interaction tracking.

3.4.1 Voice recording trial

A first working prototype running on the touch screen mobile phone (HTC Touch2) was set up to allow recording of voice messages only, and feedback was collected for the ease of input and the user interface. During a data gathering trial, researchers trained staff in the use of the device. Advice was given on strategies for recording voice messages designed to support interactive narrative. This advice included: dividing stories into several recordings to facilitate interactive conversation (i.e., time for the communication partner to comment and ask questions), using statements that will prompt comments or questions by the communication partner which can be anticipated and reacted to by the subsequent recording (e.g. "*I played some music.*" would probably result in the conversation partner asking "What did you play?". Even if the question were not asked, the subsequent message would make sense, "*I played the drums!*"). Staff at that point were not routinely using voice message recording devices. Voice recordings were taken by both researchers who shadowed children during the day and staff under the instruction of the researchers.

After a day of recording, messages were transferred from the phone to a laptop, transcribed and played back to the children, using a Text-to-speech (TTS) engine reading the transcripts. The participating children were able to access the messages using a single switch for sequential playback. The mobile phone was used for very limited playback since none of the identified participants had enough dexterity to be able to access the phone via the touchscreen in a meaningful way. Playback via TTS using the transcription of the audio recordings meant that the utterances from voice recordings and the automatically generated messages by the system would all be spoken in the same voice (we aim to address this in a future project). Recordings were used for the design of the narrative structuring algorithm used for automatic narrative generation [15].

3.4.2 Barcode interaction tracking using the HTC Touch2

Initial trials with the HTC Touch2 suggested that using QR code technology for barcode detection was unreliable, with at best 10%

[6] Makaton uses signs together with symbols and speech to support communication for individuals with communication and/or learning difficulties. http://www.makaton.org/

[7] Nicola Grove, Director of the Openstorytellers, a professional group of storytellers with learning disabilities

of barcodes being recognised. Users had to take several photographs before the software would recognise the barcode, often with no reliable readings, due to the low resolution available to the program written in Java. It was decided to change data collection to RFID sensor technology which worked reliably in the previous project. The only phone with an inbuilt RFID sensor available on the market at the time was a classic keypad phone, the Nokia 6212 Classic.

3.4.3 Location tracking using Wifi tracking with EKAHAU Wifi tracking software

In order to detect the location of the user we experimented with Wifi tracking software. In order to keep software development efforts to a minimum, we trialed an 'off-the-shelf' system that used extrapolation of readings rather than simple triangulation to avoid 'ghost' errors. The software is functional and the technology is rapidly maturing; however commercial solutions, e.g., EKAHAU, are intended to locate items (or staff members) for security applications or for periodic location updates. The data density and reliability required in this context is at the very limit of current technology. A practical application usable in a school environment did not seem achievable during this project and it was decided to explore other location tracking methods (See Section 4.1).

4. THE HwSt-itW MOBILE PHONE

In this section we describe the motivation and functionality of the mobile phone used to collect data.

The original HwSt PoC prototype allowed for the recording of voice messages onto the child's VOCA. These messages successfully augmented the narratives generated from on the sensor data. However, access to the narratives was limited due to (a) message generation only at the end of the day and (b) the nature of VOCAs taking a long time to boot up and set up at home or in school. Alternative 'low-tech' and 'mid-tech' communication aids, such as Step-by-step (SBS) voice recorders, are recommended as quickly accessible alternatives for situations where a VOCA is impractical [16]. However, messages used on an SBS are limited and usually replaced by newer messages; older messages are therefore not available for long term use. Using a mobile phone for data collection would allow for quick access to all voice recordings independent of the child's VOCA. This supports spontaneous narrative interaction. The phone can also wirelessly transmit the collected data to a remote database for automatic story generation on the user's VOCA.

4.1 Data collection methods

Different methods for data collection (interaction with people and objects, location data and voice recordings) were trialed:

4.1.1 Tagging of objects, people and locations using 2D barcode (Quick Response, QR) stickers

Sufficient camera resolution using the Nokia 6212 Classic allowed for reliable use of 2D QR barcodes (See Figure 1). These were mainly used to identify any unexpected locations of the participants. Staff took a photograph ("New picture" option, see Figure 2) of a QR code on an A4 poster located in every room of the school when the participant was in this location, if it conflicted with his/her timetable's location (e.g., the participant went to the hall for a theatre presentation rather than staying in class for the timetabled lesson). The QR codes contained a unique 2-digit decimal or 8-digit hexadecimal code and a text string with type of interaction information (object, person, location) for database retrieval.

Figure 1. QR barcode, encoding the text "15:object".

4.1.2 Tagging of objects, people and locations using Radio Frequency Identification (RFID) tags

Objects that were regularly used by the participants were tagged with near field communication (NFC) tags; these are RFID tags which can be detected by the Nokia 6212. Staff cards with NFC tags were prepared for teachers, Special Learning Assistants (SLA) and other people the participants were likely to interact with (e.g., kitchen staff, visitors or friends). The tags contained information about the nature of the tagged object (person, object or location) which was registered by the phone together with the tag's 8-digit unique hexadecimal code for identification via database entries.

4.1.3 Voice recordings

The mobile phone's interface allowed for multi-part voice message recordings (voice message sets). Feedback from staff using both the initial "voice recording" application on the mobile and Step-by-Step AAC devices was used to design an interface that allows for: (a) sequential recording of voice messages; (b) playback and limited editing of message sets (adding to or deleting of recordings of an existing set); (c) adjusting the timestamp of a recording for recordings taken at the end of the day; (d) adding a photograph to a recording.

4.2 Equipment setup

A Nokia 6212 classic is used for data collection by staff, carers and parents. The 6212 is a classic design with a 16-key keypad, additional navigation keys and colour screen, equipped with a front and back camera and an RFID/NFC sensor (see Figure 2). Communication with the system server runs via a 3G network[8].

Interaction and location data are acquired by (a) holding the inbuilt sensor at the top end of the phone to an NFC tag or (b) taking a photograph of a QR barcode using the camera mode (New Picture Menu, see Figure 2). Both tags and QR code stickers were attached to objects, location posters or a person's name badge.

To support immediate story sharing the phone is connected to a small external battery powered loudspeaker which can be used when accessing voice recordings stored on the phone. Stories, which consist of a voice message set, are selected by staff and can be played back either using the large centre key on the navigation keypad (see Figure 2) or using a modified NFC card connected to a switch. Pressing the switch closed the circuit of the tag antenna

[8] The used phones contain a pay-as-you-go SIM card for network access. Data transfer is minimal and during the whole project not more that £1 of the SIM card balance was used up (Three.co.uk Network).

which had the same effect as swiping the tag on the phone (see Figure 3).

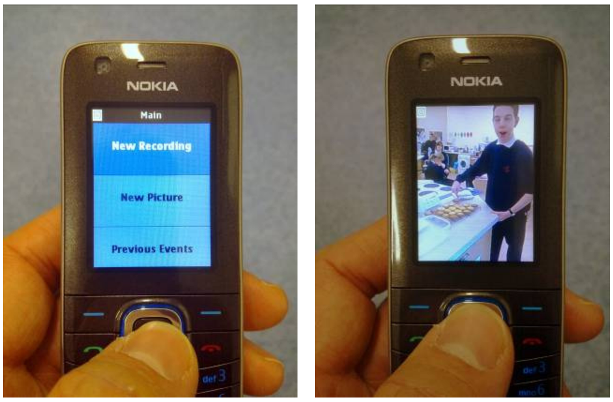

Figure 2. Main mobile phone interface with links to voice recorder, camera, and collected data (left). Photograph display during voice recording playback (right)[9].

Future systems will allow users to select a story themselves without support. However, many of the anticipated users will have some degree of learning disability which means they will need carer's support when choosing a story.

Figure 3. Modified tag attached to mobile phone cradle with connected switch (left). NFC tag with attached cable for switch connection (top right) and original tag (bottom right).

The mobile phone automatically sends all collected data to a remote server, checks for successful data transfer and attempts to resend in case of connection failure. A particularly pleasing use of this functionality occurred when one of our participants went on holiday abroad – the pictures were sent on their return to the UK.

5. EVALUATION AND PRELIMINARY RESULTS

The prototype system was implemented in the collaborating school to assess if it could be used for collecting and telling stories under realistic school conditions. Teachers and other school staff were equipped with NFC staff cards for interaction tracking. All locations/ rooms accessible to the students/ participants were tagged with a location poster (A4 size) containing the symbol used in the school for this location and a QR code image. Objects used regularly by the participants (phonic book, computer, standing frame, etc.) were also tagged using NFC stickers for interaction tracking.

All staff were introduced to the mobile phone and a researcher was with staff for the first two weeks to train them in using it. One-page manuals were handed out to the class explaining the handling of the phone. Participants took their phone home with them to play back and record new messages about interesting events at home. So, parents of the participants were also trained in the use of the phone for recording and playback of messages.

5.1 Participants

Two participants in two separate classes were equipped with a mobile phone and the appropriate accessories. Both used home/school diaries routinely for information transfer between school and the parents. The mobile phone was handled by staff (teachers and special learning assistants) for data collection and selection of voice message sets for playback.

5.1.1 Peter[10]

Peter was a student at primary four class. At the beginning of the project he was 10:2 (years:months) old and had been at the school since nursery.

Peter has athetoid cerebral palsy. He is not ambulatory and is not independently mobile in the school. He arrives in a manual wheelchair which he is not able to wheel himself and is transferred into a special chair for class. He has very little functional speech. Peter is a friendly boy and is easy to engage with in interaction. He uses gestures and head pointing in his environment for communication as well as an E-Tran[11] folder for aided communication. The vocabulary folder (in symbols) is prepared by class staff. He has some emerging literacy, being able to recognise whole words and letters. Peter can work on a computer using his hands to select up to two switches for binary access using a combination of ballistic and fine motoric movements. He can only use this access method very ineffectively. Peter is in a class with five peers. Three of his class peers have no functional speech and two are not ambulant.

As part of the HwSt project Peter was equipped with a Step-by-Step device to support personal narrative for six months prior to the mobile phone prototype use. He used the device enthusiastically with recorded messages from both school and home.

For the evaluation, Peter used the mobile phone with the cradle (see Figure 5) mounted on his tray (attached to his standing frame or wheelchair). He was able to play back messages pre-selected by staff by pressing the switch attached, but he was unable to navigate to the messages by himself.

5.1.2 Martin

Martin is a student in his final year at the special school. He is a 17:0 year old teenager who has been at the school since nursery.

[9] The authors have permission from the participating children's parents and staff to show their photographs.

[10] All names mentioned have been changed to ensure anonymity.

[11] Eye-Transfer (E-Tran) systems are "low tech" AAC devices using eye pointing for spelling or access to words and phrases. The user first selects one of 4 or 6 color coded groups and selects the item with a second gaze at the appropriate color.

Martin has a chromosomal disorder. He is ambulatory and is independently mobile in the school. He has no functional speech with some single words and a mild movement disorder which results in an uncoordinated walking gait and reduced dexterity. He can use a computer using a touch screen. Martin is a friendly teenager and is easy to engage with in interaction. He sometimes displays behavioural difficulties which usually result in physical contact against weaker peers. He uses Makaton gestures and pointing at his environment as well as visual supports (photos and symbols) for communication. Martin has a GoTalk 9+[12] `mid-tech' VOCA. However, in the past he only used the device for accessing requests and answers to curriculum questions, and then only very ineffectively. He preferred using a BigMAC single message voice recording switch which he sometimes took home to bring back messages from the weekend. Martin was in a class with five peers. Three peers are ambulant with functional speech. Two peers need a wheelchair for getting around and have no functional speech.

As part of the HwSt project Martin had been equipped with a Step-by-Step (SBS) device. When Martin had an accident at school resulting in a black eye, he used his SBS for several days when asked about the story behind his disfigurement: "Guess what happened to me. Look! – I tripped over my big feet and hurt my elbow my knee and my eye. – I had to go to the nurse and get an ice pack. But it wasn't too sore."

For the evaluation, Martin either carried his mobile phone which was attached to a lanyard around his neck or the phone was carried by the school staff who were supporting him. He was able to play back messages by pressing the centre navigation button on the phone, but had little concept of navigating to the messages by himself and needed support from staff to select stories he might have wanted to tell.

5.2 Example datasets

5.2.1 Voice recordings from school

Staff in the classes of both participants ensured that the mobile phone was always with the participants during the school day. Tables 1 and 2 show examples of multi voice messages from both participants.

Table 1. Voice Recordings for School, Martin

#	Photographic Image	Voice Recordings
1	No image.	Message 1: "I was so excited when I got into class today." Message 2: "Because Ms ____ (class teacher) was back."

5.2.2 Voice recordings from home

Both participants took their mobile phone home during term time and holidays to collect stories to tell when back at school. Parents of the participants were given a short training session on what kind of stories to record and on how to illustrate them with photographs which they could take after recording a story. The following examples (Tables 3 and 4) show multi voice messages from both participants.

[12] The GoTalk 9+ can store 12 voice recordings that can be accessed by pressing a symbolised button for each message on the device.

Table 2. Voice Recordings from School, Peter

#	Photographic Image	Voice Recordings
1		Message 1: "I have just come back from swimming this morning I had good fun." Message 2: "I started off getting weights put on my legs so I could practice walking in the pool" Message 3: "Then I get the helmet on and the weights are taken of and some floats so I can swimming on my own which I like doing. Message 4: "When I was swimming so first of all the funniest thing of the day was when _____ (peer) came over and tried to give me a big kiss."

Table 3 gives examples of voice recordings by Martin's parents with and without photographs taken. Martin lives on a sheep farm, and he sometimes stays in respite care over night or during the weekend. The first example recording was taken during the Easter holidays, the second one before a weekend in respite care. Messages were not always about Martin's experiences, but to inform staff and the research team about use of the system (see Table 3, Example 3).

Table 3. Voice Recordings from Home, Martin

#	Photogr. Image	Voice Recordings
1		Message 1: "Guess who I like feeding on the Farm!" Message 2: "Yes, you've guessed it, the little lamb."
2	No image	Message 1: "Guess where I 'm going tonight!" Message 2: "I'm going to ____ Cottage – for the weekend. I'm quite excited."
3		Message 1: "Dad says he's going to have to phone Rolf because he can't hear my messages from school. He thinks the speaker's not working."

Example 1 and 2 in Table 3 use the pattern of building up anticipation by asking a question and giving the answer in the following message. This was a pattern demonstrated during the introduction of the mobile phone and Step-by-Step devices as an example of how to support an interactive conversation using sequenced voice recordings. Any recording should aim to make it easy to predict the response by the conversation partner. This way following messages can be recorded to help the conversation flow because they can respond to the predicted communication partner's response of the conversation. However, the use of photographic images makes this more difficult because in many cases the image already contains the answer to a question (Example 1).

Recording 3 is an example of using the voice recordings for messages to the carer or parent that would usually be given by a home/school diary entry.

The first voice recording in Table 4 illustrates the learning process for the person making the recordings. Messages should be recorded as if they were spoken by the user. The example is the first message recorded by Peter's uncle which became one of Peter's favourite messages.

The recording time (which is displayed on the mobile phone with each recording) indicated that this recording and other similar recordings were recorded in the morning after the event before setting off to school.

Table 4. Voice Recordings from home, Peter

#	Photogr. Image	Voice Recordings
1	No image	Message 1: "Hey, Peter got home . I got home and I . eh . met my uncle and ma mum and ma wee sister and ma big sister . eh (short laugh, then giggling by two people)"

5.3 Example interaction

Martin is using the mobile phone at home to tell his parents about a stray cat that had been at the school. The phone displays a photograph of the cat at the window during message playback.

```
M - participant Martin
P - voice recording in phone accessed by Martin
Mum - Martin's mum
RA - researcher
[] - parallel events
{} - non verbal
(...) - unintelligible
M:    Hoooo
P:    I went to Mr ____ for Eco . and we went out-
      side to clear the tubs . then I saw a cat
      from the neigbourhood and I chased it
Mum:  Ooooh Martin you didn't chase the pussycat
M:    Hoooo
Mum:  you would as well cause he chases anything
      that moves
RA:   ah
M:    hoo
      (interruption of conversation)
Mum:  What else did you do with Mr ____?
M:    {turns to his mum, shakes his head} hoohooo
      {folds his arms}
Mum:  Were you taking all the roots out of the
      tubs {gestures pulling roots out of tubs}
Mum:  Gettin them ready for plantin up in the
      spring
M:    Huhoo {points at biscuit box and signs food}
Mum:  No . no more biscuits . You're maybe gettin
      one later . don't tell you've had a biscuit
M:    {shakes head, signs - index finger on side
      of palm: television} hooo
Mum:  I'll put the telly on for you in a wee
      minute
M:    {turns to RA, presses play button, turns
      back to mum,
M:    [{signs "home"}
P:    [Then I was told by Mr ____ and Mrs (...) to
      leave the cat alone and carry on with the
      gardening
Mum:  Listen . did you get a row for chasing the
      cat (phone rings)
M:    {nods, signs "phone"}
Mum:  Dad's gettin it through there
```

6. NEXT STEPS

The mobile phone currently allows the staff, and to a limited extent the children, to access the stored voice recordings and photos for personal narrative interaction. However, the main functionality of the mobile phone is to collect data that can be used a) to automatically generate utterances to augment the voice messages and b) to identify interesting stories and allow computational support to the user when searching for stories they want to tell. We had partly realised these aims in our original PoC prototype [17]: the system created messages such as "Martin was there" from interaction data and was able to recognise exceptions and use them to identify interesting stories (e.g. from location data and timetable information: "I went to the hall this morning during English class").

We have now set up the automatic generation of narratives on the participants' PC based VOCA systems (DynaVox Vmax and Tobii C12[13]). The data recorded by the phone is automatically transferred to a remote server linked to a database. All the data sent are encrypted and identified with unique identifiers. That way, even if the data were to be intercepted and decoded, most of it would not be intelligible. The database saves all interactions logged by the phone. These include location, object and people interactions (both 2D barcodes and RFID), voice recordings (single, multi-part) and photographs (stand-alone or associated to voice recordings).

Early trials used The Grid 2 VOCA software[14] to display and access messages and recordings which were manually transferred onto grid pages. Figure 6 shows the interface for Peter, a page to access the messages of a specific event (green fields, from top left): location message ("I was in the gallery"); people interaction message ("Peter, Paul and Mary were there"); object interaction message ("I used my reading book"); and four voice messages, labelled with photographs taken at the time of recording. The page also contains evaluation messages (such as "I liked it") and buttons for navigation ("back to day overview", top left), editing ("hide this event", middle left) and link to the user's regular AAC method (bottom left). Martin tried a similar setup but had difficulties navigating and preferred using a single switch for accessing stories as sequentially played back messages to selecting individual messages via the touchscreen.

A Java programmed interface which used automatic transfer to the VOCA system was trialled. This interface was adaptable to the

[13] http://dynavoxtech.com/, http://tobii.com/

[14] http://sensorysoftware.com/thegrid2.html

user skills and allowed access to narratives from the current and previous days. Results from the evaluation of this trial will be published in a separate paper.

There are plans to implement search algorithms to present a personalised selection of narratives such as the most told narratives ('Favourites') or include links to related narratives that have an overlap in content (e.g. in the given example the system would present other stories containing the gallery, any of the people or the objects interacted with) [18].

Figure 6. Wizard of Oz VOCA Interface using The Grid 2 software to display and access recordings and automatically generated massages based on collected data.

7. ACKNOWLEDGMENTS

The authors would like to thank the children, their parents and school staff, who participated in this study and who so willingly gave us their time, help and support. We would also like to thank Steven Knox and Alan Clelland for their work on programming the mobile phone application.

We would like to thank DynaVox Inc. for supplying the Vmax communication devices to run our system on and Sensory Software Ltd for supplying us with The Grid 2 VOCA software to enable the manually prepared access to the narratives.

This research was supported by the Research Council UK's Digital Economy Programme and EPSRC (Grant numbers EP/F067151/1, EP/F066880/1, EP/E011764/1, EP/H022376/1, and EP/H022570 /1).

8. REFERENCES

[1] Reiter, E., et al., *Using NLG to Help Language-Impaired Users Tell Stories and Participate in Social Dialogues*, in *ENLG2009*. 2009, Association for Computational Linguistics: Athens, Greece.

[2] Black, R., et al., *"How was School Today…?" Evaluating the Personal-Narrative-Telling Prototype: Preliminary results*, in *Communication Matters Symposium 2009*. 2009, Communication Matters: Leicester.

[3] Reiter, E. *An Architecture for Data-to-Text Systems.* in *ENLG-2007*. 2007.

[4] Vanderheiden, G.C., *A journey through early augmentative communication and computer access.* Journal of Rehabilitation Research and Development, 2002. **39**(6): p. 39-53.

[5] Waller, A., *Communication Access to Conversational Narrative.* Topics in Language Disorders, 2006. **26**(3): p. 221-239.

[6] McCabe, A. and C. Peterson, *Getting the story: A longitudinal study of parental styles in eliciting narratives and developing narrative skill*, in *Developing narrative structure*, A. McCabe and C. Peterson, Editors. 1991, Lawrence Erlbaum Associates: Hillsdale, NJ. p. 217-253.

[7] Quasthoff, U.M. and K. Nikolaus, *What makes a good story? Towards the production of conversational narratives*, in *Discourse Processing*, A. Flammer and W. Kintsch, Editors. 1982, North-Holland Publishing Co.: Oxford.

[8] Polkinghorne, D.E., *Narrative configuration in qualitative analysis*, in *Life history and narrative*, J.A. Hatch and R. Wisniewski, Editors. 1995, Routledge: London. p. 5-24.

[9] Todman, J., et al., *Whole utterance approaches in AAC.* Augmentative & Alternative Communication, 2008. **24**(3): p. 235–254.

[10] Todman, J. and N.A. Alm, *Modelling conversational pragmatics in communication aids.* Journal of Pragmatics, 2003. **3**: p. 523-538.

[11] Dempster, M., N. Alm, and E. Reiter, *Automatic generation of conversational utterances and narrative for Augmentative and Alternative Communication: a prototype system.* , in *Proceedings of NAACL-10 Workshop on Speech and Language Processing for Assistive Technology*. 2010: Los Angeles, USA.

[12] McCoy, K., C. Pennington, and A. Badman, *Compansion: From research prototype to practical integration.* Natural Language Engineering, 1998. **43**(73-95).

[13] Beukelman, D.R. and P. Mirenda, *Augmentative and Alternative Communication: Management of Severe Communication Disorders in Children and Adults*. 3rd ed. 2005, Baltimore: Paul H. Brookes Publishing Co.

[14] Black, R., et al., *Tell me about your day: creating novel access to personal narrative*, in *Communication Matters Symposium 2008*. 2008, Communication Matters: Leicester.

[15] Reddington, J. and N. Tintarev, *Automatically generating stories from sensor data*, in *Proceedings of the 16th international conference on Intelligent user interfaces*. 2011, ACM Palo Alto, CA, USA.

[16] Musselwhite, C., K. Daswick, and S. Daswick. *Self-Constructed Scripts*. Tip of the Month 2005 [cited 2010 8 February]; Available from: http://www.aacintervention.com/selfconstructing%20scripts.pdf.

[17] Black, R., et al., *A New Tool to Support Interactive Narrative Experience for Children with Communication Disorders*, in *14th Biennial Conference of the International Society for Augmentative and Alternative Communication*. 2010, International Society for AAC: Barcelona, Spain.

[18] Black, R., et al. *Using NLG and Sensors to Support Personal Narrative for Children with Complex Communication Needs.* in *First Workshop on Speech and Language Processing for Assistive Technologies (SLPAT), Human Language Technologies: The 11th Annual Conference of the North American Chapter of the Association for Computational Linguistics*. 2010. Los Angeles.