

Making software accessible to people with severe memory deficits

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Good interface design must take into account limits on the users' short-term memory. With conditions such as dementia, the working (short-term) memory can be so impaired as to be virtually non-operative. This presents a significant challenge in designing interactive systems for people with this condition. If the difficulties can be overcome, however, such systems offer the possibility of improving the communication abilities of people with dementia, and eventually providing them with satisfying activities that can carry out unaided. We report on a project that has developed a hypermedia based reminiscence aid for older people with dementia, which has been designed to be usable by people with short-term memory deficits. The system has proved remarkably effective in supporting the communication of people with dementia.

Dementia, Alzheimer's disease, working memory, short-term memory, multimedia, hypermedia

1. DEMENTIA AND WORKING (SHORT-TERM) MEMORY

Dementia consists of a group of symptoms involving progressive impairment of cognitive abilities. The two major causes of dementia are Alzheimer's disease, which is a progressive loss of nerve cells, and vascular dementia, which is loss of brain function due to a series of small strokes. The gradual loss of working (short term) memory is often the first symptom of the disease to be noticed.

Caring for people with dementia will be a major challenge in all countries of the world in the 21st century. The number of people with dementia is projected to increase due to demographic changes which are taking place worldwide, with the number of older people proportional to the younger population growing steeply. The percentage of the population with dementia increases from the age of 65 to reach 25% of people over 85 [1].

The loss of working memory in elderly people as a result of dementia is a very serious problem for the person and for their family and carers. Many social activities and interactions become increasingly difficult as the condition progresses, since they depend on short term memory for effective participation. As a result people with dementia can become socially isolated and deprived of the range and variety of social interactions that characterise everyday life for unimpaired people. This can have a profound effect on their mental wellbeing, and put severe strains on family and carers.

The potential of using computers as cognitive prostheses would seem to be well worth exploring. If a way could be found for a person with dementia to be able to interact with a helpful computer system, this may have a significant impact on the quality of their lives, and that of their carers. Systems might then be developed to assist the person with dementia in carrying out conversations with others, and to provide them with stimulation, entertainment, and other types of computer-based support. None of these interventions would be expected to offer an improvement in the dementia itself. But they would enable the person to maximise their positive skills, empower them, and restore to a degree their participation in social life.

As a starting point in creating a range of systems which are usable by people with short-term memory deficits, we have developed a hypermedia conversation support system based on reminiscence that can be used by a person

with dementia along with a carer. Our plans are to follow this work by devising ways in which the person with dementia could themselves take direct control of navigating through such a system.

2. THE DIFFICULTY OF COMMUNICATION WITH DEMENTIA

Everyday conversation is fundamental to human social interaction. Through conversation we learn to talk, we are socialised, we make friends and form lifelong partnerships, and we establish ourselves in the social hierarchy. We in fact create our sense of identity and sense of self worth primarily through our conversational interactions with others [2].

Holding a conversation is very difficult without a correctly functioning working memory. People with dementia will often repeat what they have only just recently said, and can give the appearance of not listening to what others are saying. This can be disempowering for the person and distressing for relatives and friends.

Ways of structuring conversations have been investigated, for instance with the use of specially prepared memory books that contain autobiographical material, daily schedule information, and problem resolution information. When such material is individually prepared, and when staff are trained in using it, communication improves between the carers and people with dementia [3].

Reminiscence sessions are also a useful way to structure interaction so as to maximise the positive contribution that can be made by a person with dementia. Although their working memory is impaired, the long term memory of a person with dementia is often still functioning even at the latter stages of the disease. By guiding and supporting the person to take advantage of long term memory they can be helped to take a more active part in conversations [4,5,6,7,8]. While very valuable, reminiscence activities involve prior planning and gathering of material, which is time consuming for busy relatives and carers. Also the process of conducting these sessions entails a great deal of effort. Reminiscence sessions can be pleasurable and empowering for the person with dementia, but the experience for the carer is far from a relaxed natural interaction.

One hypothesis of this research is that suitably presented hypermedia can be helpful in supporting people with dementia in taking part in conversations. An obvious advantage of a computer based system over using traditional materials is the bringing together of the various media into one easily accessible system. But we also wanted to explore ways in which the hypermedia could in some way mimic the way memory is used in conversations. It is inherently plausible that the associative links in memory [9,10] and in free-flowing conversation [11] could be roughly modelled with hypermedia links. We have developed a hypermedia-based system that takes this approach.

3. A SUPPORT FOR COMMUNICATION BASED ON HYPERMEDIA AND REMINISCENCE MATERIAL

It is unrealistic to expect people with dementia to acquire new skills, as their working memory problems normally preclude this. For the current generation of older people, therefore, using a mouse to interact with a system (or a keyboard, if the person has not been a typist) would not be suitable. A touchscreen, however, has proved to be a suitable input device for an application such as this. It is intuitive to use and does not require fine muscle control to operate. Previous work, by ourselves and others, has established that people with dementia can usually manage to make use of touchscreens. The direct sense of manipulation they provide seems to offer enough affordance that, with encouragement, they work very well even with people who have fairly severe dementia [12,13].

Because of potential vision problems with elderly people, and since the display was to be shared during a reminiscence session it was decided to use the largest available (21") flat panel touchscreen. This size of screen was also chosen to create a more engaging experience than that offered by standard TV screens, but still staying on the table top, with a screen that suggested active use, and not just passive viewing of a large public screen on the wall. Sound output was provided using a standard computer sound card together with speakers.

3.1 Prototype development

An iterative design approach was used to develop the first prototype. Forty people with dementia were identified who expressed an interest in helping us to design and evaluate the system. Thirty relatives and carers also agreed to take part as advisors and evaluators for the project. As a first step, we asked the group to comment on suitable content for the system. Ideas for themes the system might include (such as national events, local industries, street life, celebrations) were suggested by means of high quality photographs. Using the photographs as prompts, discussions were held with people with dementia and their carers to help decide on the best choices for content for the system.

The system was developed using Macromedia Director. Director was chosen because it is a cross-platform development package that allows rapid development of complex multimedia systems. It also has its own programming language which allows it to be interactive and to be connected to a database. The completed system was given the name CIRCA, standing for Computer Interactive Reminiscence and Conversation Aid.

3.2 Description of the interface

Consultation with experts on dementia had indicated that the interface would need to be as simple as possible while still appearing attractive and encouraging interaction. One problem that people with dementia have is an inability to cope with too many items that compel attention. In this state the user often will focus on one item and stay with it, not being able to scan easily over the other possibilities. To cope with this, we designed the interface so that the background and navigation features are in muted colours. In most cases only one item of interest is shown at a time. In this way, even a black and white photograph stands out clearly as the point at which the user's attention should be directed. In order to keep the navigation process as simple as possible it was decided to have just three themes to choose from, and for each theme to have three media types that could be chosen. Each theme is associated with a different colour scheme. When a theme is selected the background colour and colour of all the buttons are changed to reflect the selected theme. When the carer or the person with dementia selects one of the three themes, they are then offered a choice of photographs, video or music.

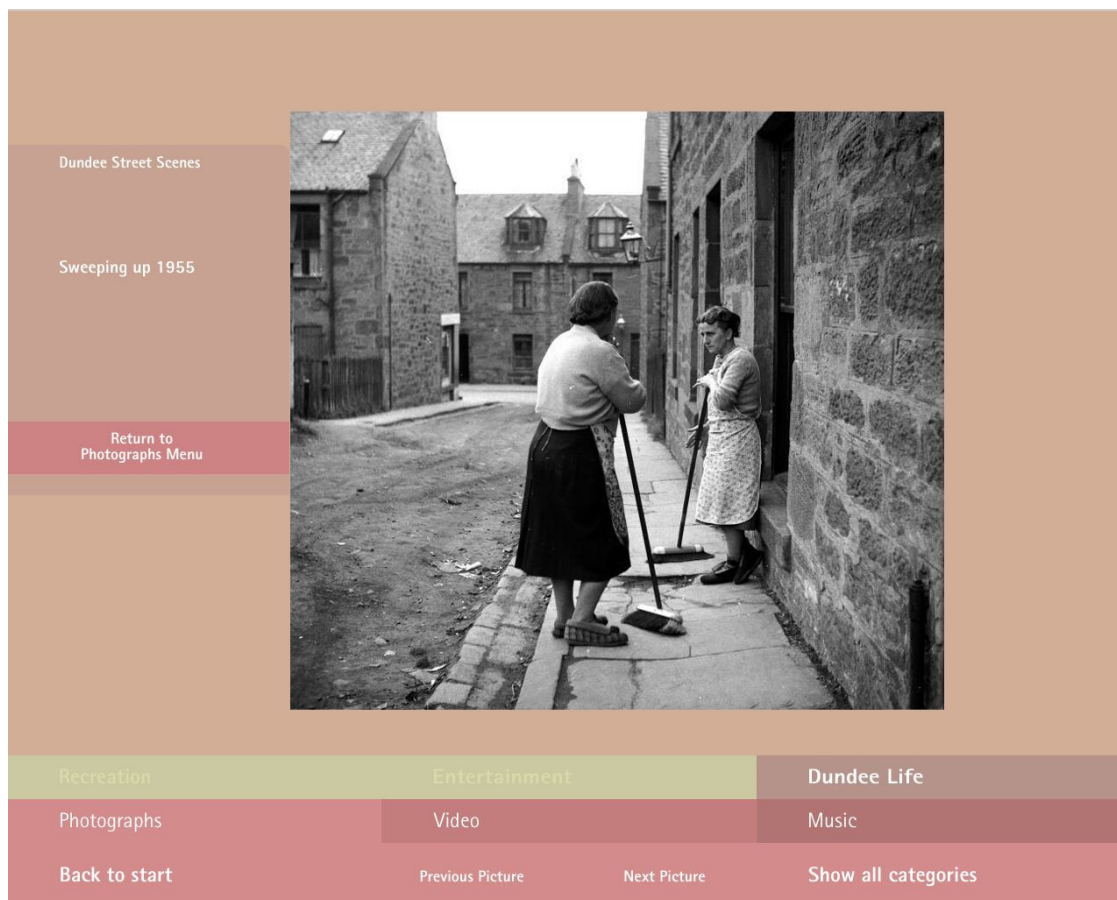


FIGURE 1: . Screen shot of the Photographs section in the Dundee Life theme. A title and brief description are given as a help to the carer, who might not recognise what is shown. The menu bars of the touchscreen are at the bottom for easier reaching for older users. Visible are the three themes, the three media choices, and simple navigation buttons.

3.3 Media content of the system

Based on feedback from our user population, the three themes chosen for the prototype were; Recreation, Entertainment and Dundee Life. The Recreation theme focused on UK material with an emphasis on Dundee and Scotland. The Entertainment theme contained both US (movies and music) and UK material (TV and music). The Dundee Life theme focused on local material. In total the system contained 80 photographs, 10 videos, and 23 music items.

Photographs are often used in reminiscence sessions as they are relatively easy to source. There are many photograph archives and library available, covering many themes and time periods. It was therefore relatively easy to add a large number of photographs to the prototype. As it is usual to view photographs in short sequences, the photographs within each theme are grouped into categories. Two navigating buttons, "Next picture" and "Previous picture" are provided for stepping through the photograph sequences (see Figure 1).

The system allows the users to select and play video clips related to the theme selected. People with dementia may not be able to follow a long video clip because of their working memory problems. The video clips have a short duration for this reason and also because they are intended to act as conversation prompts and not be too immersive. The system allows the users to select and play music related to the theme selected. Rather than simply having a static screen while the music plays, a display is presented of the type of device that particular music would normally be coming from. A record player, radio or tape recorder is displayed depending on the theme selected, as shown in Figure 2. This representation of the music producing device can also act as a conversation prompt in itself.

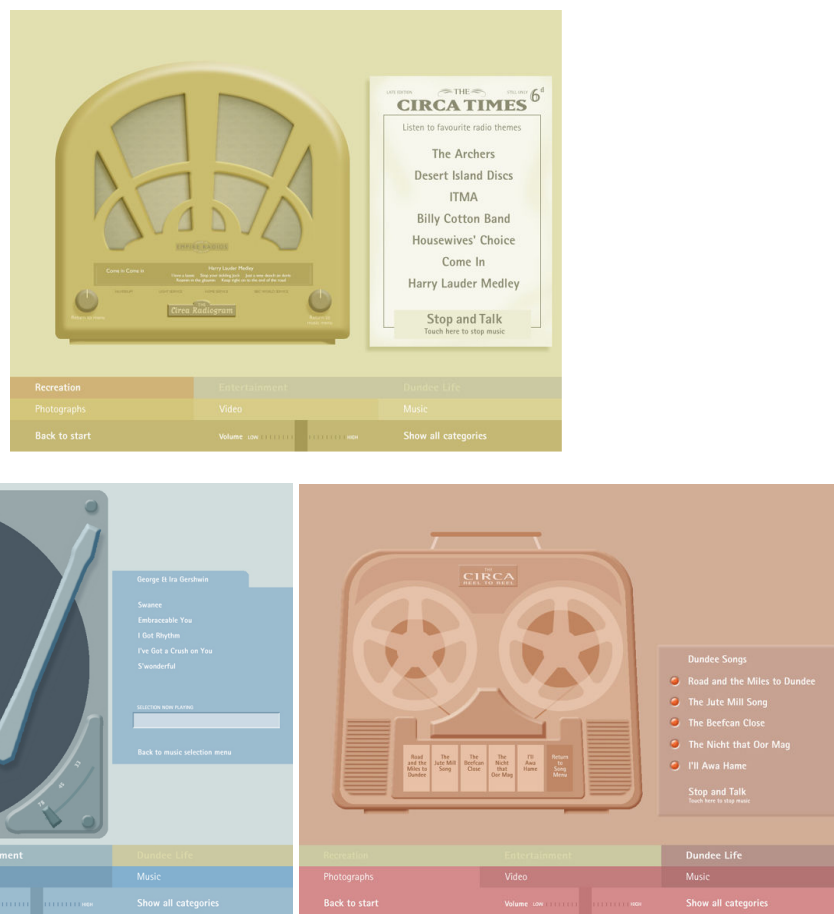


FIGURE 2: Music is accessed through representations of the type of player that might have produced it in times past. The record player and the reel-to-reel tape recorder are animated to give the impression of working while the song is played.

4. EVALUATING THE PROTOTYPE

An evaluation was performed to determine if people with dementia were able to make sense of the system, and understand its use well enough to direct a carer in operating it, or to operate it themselves. In the evaluation sessions, the system was compared with traditional reminiscence sessions. In a traditional session, the carer takes the responsibility for guiding the session, and at all points compensating for the short-term memory problems of the person with dementia. We designed the CIRCA system so that it hopefully would be able to take over this role of supporting the cognitive abilities of the person with dementia, freeing the carer to take part in the session more naturally. Eighteen people with dementia and their carers took part. Each person with dementia and their carer undertook a 20 minute reminiscence session: nine using the prototype, and nine using traditional reminiscence methods. As expected, the carers did most of the direct operation of the touch screen, but they were often prompted and directed by the person with dementia. With encouragement a number of people with dementia also made direct use of the touch screen to make selections.

The carers were asked to complete a questionnaire at the end of each session. All the sessions were video recorded, and all the items accessed using the prototype were logged. A protocol was developed for observing and recording behaviour during the sessions, to identify the degree of participation, engagement and enjoyment of the experience.

Eighteen people with dementia took part, 13 women and 5 men. Nine participated in CIRCA sessions and nine participated in traditional reminiscence sessions). The age range was 65-95 yrs. The Mini Mental State Examination (MMSE) is a rough measure of degree of severity of dementia ranging down from 30 (no measured cognitive impairment) to 0. The MMSE range was from 2 to 23

Profile of participants :

<i>CIRCA sessions</i>		<i>Traditional sessions</i>	
<i>Age</i>		<i>Age</i>	
Mean	82.00	Mean	81.88
Standard Deviation	7.93	Standard Deviation	6.17
Range	65-95	Range	71-89
<i>MMSE</i>		<i>MMSE</i>	
Mean	14.88	Mean	16.00
Standard Deviation	6.71	Standard Deviation	6.14
Range	2-22	Range	5-23

Carers
(N = 12)

A between subjects protocol was used (Mann Whitney test).

All the people with dementia were able to make sense of the material the system was presenting, and showed an understanding of how it worked. Some spontaneously commented several times that they were enjoying using CIRCA. One person said, "It takes you back and refreshes your memory". Other spontaneous comments were : "This covers everything", "Good thing, this", "It's good to remember things", and "That's entertainment!" One person said she certainly would like to use CIRCA again. She said she thoroughly enjoyed it and found it very interesting and "something new". Another person commented that she enjoyed using the system herself.

In comparing CIRCA with using traditional reminiscence aids, we found that the person with dementia was offered a choice of reminiscence subject/materials more often when using CIRCA ($U = 1.50, p < 0.001$). We also found that the person with dementia chose reminiscence subjects/materials more often when prompted when using CIRCA ($U = 3.60, p < 0.001$). The traditional sessions were characteristically a series of one question from the carer followed by one response from the person with dementia. The CIRCA sessions were more of a conversation, with each person contributing an equal amount, and control of the direction of the conversation being shared. The carers asked more direct questions when using traditional reminiscence methods ($U = 5.00, p = 0.01$).

5. CONCLUSIONS

CIRCA proved to be usable by people with dementia. Their problems with short-term memory did not stop them from understanding the material presented to them, and working out how to navigate to other material, either by directing the carer or using the touchscreen themselves. CIRCA facilitated a more equal participation in

communication for the person with dementia, as compared with traditional reminiscence. In offering a richness of choice, the carer could hand over more of the control of the session to the person with dementia. By choosing reminiscence items, the person with dementia guided the session. In this way, people with dementia could set the agenda and pace of the session. This was enhanced by the fact that people at earlier stages of dementia could use the touchscreen themselves.

By providing an engaging focus of joint attention, CIRCA allowed the carer and the person with dementia to explore a wide range of topics provided in various media. This created subjects of conversation for both parties which could be changed easily and quickly. Moreover, periods of silence which might create awkwardness in traditional reminiscence sessions were filled continuously by CIRCA. What was supplied was a third element in the interaction that at the same time relieved the carer of the sole responsibility for directing the session and provided stimulating possibilities for conversation.

The person with dementia could use CIRCA in different ways. They could tell a story or simply enjoy the experience of exploring the presentations with another person. By 'filling in the gaps' in a typical conversation, CIRCA encouraged a failure-free social interaction.

CIRCA encouraged the person with dementia to take a more active part in creating the reminiscence session, and carers as a result asked fewer direct questions in CIRCA sessions, compared with traditional reminiscence work. Several carers mentioned that they felt less pressure to maintain the conversation when using CIRCA. Moreover, in contrast with traditional reminiscence sessions, time spent using CIRCA did not need to be planned by the carer. Thus, the experience of reminiscence could be more relaxed for both parties.

This project has been a multidisciplinary effort, with participants from software engineering, psychology and design. We feel this is an essential aspect of this work. One way this is evidenced is in the attractive and interesting look that the system has, which has been produced by an experienced team of designers. The look and feel of the system is polished, professional and inviting. We are convinced that the look of the system invites engagement in a way that a worthy but less aesthetically pleasing interface might not. This relates to what some designers have called the 'aesthetic-usability effect'. Aesthetic designs are perceived as easier to use than less-aesthetic designs [14,15,16]. And since the aim of this system is to engaged the continued attention and involvement of people for whom this has proved difficult, this is not just a matter of a desirable extra feature.

6. FURTHER WORK

Following the lessons learned from the evaluation of the system, improvements and additions are being made to the system as follows :

(1) The system will be made modular with a separation of form and content, to allow the creation of new material easily. This will allow for localisation of the material, and also for the potential to include personal material, where this is suitable.

(2) The system will be extended to allow for a larger number of themes and individual items to be available, with a random choice of three of these being made by the system for each session, in order to keep the continued interest of relatives and carers. Similarly, the number of potential media items will be increased, with a random selection being made among these each time the system is used. This was felt to be particularly important given the fact that the equal control over the interaction was dependent on both conversation partners sharing a unique experience, so that the carer did not need to feel 'in charge' of the conversation.

Plans are also underway to extend what we have learned about interfaces that are usable by people with dementia to develop an interactive entertainment system which they can use on their own, without a carer to assist them. Whereas the CIRCA system was developed as a conversation support, and not as a provider of entertainment, we would like to develop a range of systems that can engage and hold the involvement of people with short-term memory deficits in a way which is stimulating and entertaining. CIRCA has shown that technology can help restore a degree of lost social functioning. What we would now like to do is to develop ways of helping people with dementia to enjoy themselves without the need for the constant presence of a carer or relative. This could be significant help, since one of the principle pressures on families and care faculties is the inability of people with dementia to occupy themselves in satisfying activities without the continual involvement and guidance of another person.

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