Engaging multimedia leisure for people with dementia

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N. Alm, A. Astell, G. Gowans, R. Dye, M. Ellis, P. Vaughan, P. Riley. Engaging multimedia leisure for people with dementia. Gerontechnology 2009; 8(4):236-246; doi: 10.4017/gt.2009.08.04.006.00 Dementia is the loss of cognitive abilities, particularly the use of working (short-term) memory, usually as a result of Alzheimer's disease or stroke. Dementia occurs primarily in older people, and while it does not affect all of them, its rate of occurrence rises steeply from about 1 in 5 of people in their 80s to 1 in 3 of those in their 90s. As our population balance shifts towards the older end of the spectrum, the incidence of dementia will continue to increase. The ability to take part in enjoyable activities is a faculty which can decrease markedly with the onset of dementia. And yet having fun is an essential part of life. We have been working on using technology to support activities for people with dementia that make life enjoyable. These include having entertainment, being creative, and enjoying a conversation. We have been developing computer-based multi-media systems to support a person with dementia to continue to enjoy taking part in these activities. The entertainment system supplies engaging content and built-in prompting to keep the user supported and involved. The creative tool allows a person with dementia to compose their own musical sounds, regardless of any musical background. The communication support system restores to the person with dementia the ability to carry out a conversation with a relative or carer, by making use of relatively well-preserved long-term memories. All three systems have been evaluated with people who have dementia, using a range of qualitative and quantitative methods. The results show that all three approaches can give positive outcomes, and further work in this field is recommended.

Keywords: multimedia, leisure, dementia

Dementia is the loss of cognitive abilities, particularly the use of working (short-term) memory, usually as a result of Alzheimer's disease or stroke. Dementia occurs primarily in older people, and while it does not affect all of them, its rate of occurrence rises steeply from about 1 in 5 of people in their 80s to 1 in 3 of those in their 90s[1,2]. As our population balance shifts towards the older end of the spectrum, the incidence of dementia will continue to increase[3].

The effects of dementia can be quite devastating for the person and their family, and pose significant challenges to professional carers. There is currently no way to stop or reverse the physical causes of dementia. Until such help is found, there will be a need to develop social and technological supports for people with dementia and their carers.

Possible roles for technology

A number of efforts are underway to use technology to help ensure the safety and physical wellbeing of people with dementia. Prototype systems have been developed for automatically monitoring activity in the home, in order to alert carers if there is a possibility that a fall or other worrying event has occurred[4]. Memory prompting systems are being developed to increase the time an older person with increasing memory loss can retain their independence[5,6].

But equally important are activities that make life enjoyable, which can decrease markedly with the onset of dementia. These include entertainment, being creative, and enjoying a conversation. We have been working on computer-based multi-media systems to support a person with dementia to continue to enjoy taking part in these activities, which are essential for a fully rounded life.

Interactive entertainment

The ability to entertain oneself is an important facet of a full life. As well as a quality of life issue, a practical problem is that people with dementia currently need uninterrupted attention from carers all day, which can lead to burn-out in relatives, and can make paid carers retreat from an overwhelming sense of demand into just providing the basics of survival.

We are investigating ways in which an interactive entertainment system for people with dementia could engage them and then support and prompt them in such a way so that they would be able to use the system unaided. The first issues we addressed were what sort of content for an interactive system would be appropriate and engaging for older people and what kinds of prompts would be necessary to keep the person engaged and enjoying using the system[7,8].

From our discussions with professionals working with people with dementia one approach which seemed useful was to find ways of restoring to the person the ability to carry out activities which were no longer possible for them which involved exploration, fun, and a sense of accomplishment. The interactive systems we then developed involved virtual environments, games, and virtual activities. We began by developing virtual environments for users to navigate. We wanted to assess the general usability of these for people with dementia. We also wanted to investigate ways to prompt people with dementia to make use of the touchscreen to carry out activities unaided. In our evaluations we first obtained the views of professionals in the field as to appropriate content for such a system. We then had people with dementia try out a variety of prototype interfaces to determine which content worked best, and to begin to gain an understanding of what sort of prompting mechanisms might begin to enable them to use such a system on their own, without a carer present. We created two virtual environments by means of photographs digitally combined to make a realistic 3D setting which could be explored and enjoyed on a large touchscreen. The environments which were photographed and reproduced in explorable 3D were a botanic garden with a large hothouse and a museum. This environment included an open space with grass,

trees, shrubs, flowers and a bench. The user could choose to enter a hothouse and explore that, where, as well as 'moving around' and enjoying it visually, they could activate short videos clips of fish swimming and bees buzzing round a flower. The museum environment was one large room of paintings, sculpture, and ceramics. It was possible to zoom in on individual pieces and get more information presented about them.

As well as trying out photographically realistic scenes, we were interested to see if an entirely artificially created 3D environment (*Figure 1*) could be engaging for users with dementia, so we created a virtual old-fashioned pub interior, with bar, customers, and bar furniture and signage from the past. In the bar it was possible to activate video clips of a pint of beer being pulled with old-fashioned hand pump, and two customers having a game of dominoes. The garden, the museum and the pub environments all had appropriate background music playing softly as the user explored them.

Having created these three prototypes, we introduced them first to professionals working in the field of dementia for them to try out and give us feedback. Then we introduced them to people with dementia.

Thirteen professionals working in the field of dementia care tried out the virtual environments of the botanical garden, the museum and the pub. Participants were invited to use the computer by themselves for as long as they liked. When they had finished each user was asked to complete a questionnaire about the virtual environments. The questionnaire asked the participants which of the environments they thought was the best for our purposes and what that particular one added to the experience which was valuable. We also asked if they had any suggestions for improving the environments, and suggestions for further environments.

One respondent commented, "I like to see things that are related to the person with dementia's life". Another commented on the nature of the contents, stating that it was "Good to see moving pictures". Of the 13 respondents, 8 expressed a preference for one of the 3 virtual environments. Of these eight, 5 preferred the botanical gardens. The reasons for this included reference to the contents such as "beautiful to look at"; "excellent music"; and "lovely scenery". One respondent commented, "the range of possibilities is greater than the other environments".

Eleven respondents commented on the value of making virtual environments available to people with dementia. Respondents said that it was "very realistic" and "the garden – more real looking and multidimensional. Provides a choice of where to go and what

Figure 1. Two virtual 3D environments to explore on the touch screen - a large hothouse as part of the botanical gardens setting, and the interior of an old-fashioned pub; the hothouse was realised with still photographs digitally joined; the pub interior was modelled entirely in the computer, with surfaces and photos of people overlaid on the 3D model

to look at more closely". Other comments referred to the engaging properties of the environments, such as "an escapism into a relaxing, enjoyable and engaging environment". Further comments were "holds the attention" and "stimulates memories, gives enjoyment through several senses – colour, movement and sound". Further comments referred to the possibility for giving back some control to people with dementia. These included "greater variety and therefore more possibilities for everyone"; "it brings fun and a sense of achievement - you can make things happen; and "you can control what you are looking at".

One respondent additionally commented that the activity provided "Confidence building opportunities". Other additional comments referred to the ease of navigation, the size of the control buttons and the on-screen instruction. Some respondents made suggestions for additional environments, which included: shopping, dancing, roller skating, fairground rides, animals in a zoo, and seasonal presentations.

The virtual environments were then evaluated with people with dementia. The touch screen system was taken to a day centre for people with dementia. Five people with dementia (three women and two men) tried out the virtual environments. Each participant was invited to see the virtual environments with a member of the research team. Each participant was encouraged to use the touch screen individually and explore the environments. When they had finished each participant was interviewed.

All of the people with a diagnosis of dementia appeared to enjoy looking at the virtual environments and three out of the five tried using it independently. All participants spontaneously commented about the experience both when using it and afterwards. It was apparent that the botanic garden was the most popular environment with this group, just as it had been with the dementia care professionals. The participants with dementia commented on the contents, for example "lovely garden", "beautiful flowers", and "looks like a good pint" (in the virtual pub). One person went further in relating to the experience with the comment "I'll sit here (bench in garden) for a while". Another person commented on the totality of the experience, saying "the music is in time with it all" (in the botanic garden). A final group of comments reflected the user's reaction to the experience including "amazing", "wonderful", "clever".

After evaluating virtual environments we began constructing a series of virtual activities and games, in order to explore the possibilities of the users being actively and continuously involved with an interactive experience. The activities and games were developed by the software team, which consisted of an experienced software engineer and computer games designer.

The activities we developed were (*Figure 2*):
(i) Video clip viewer to convey to the user the experience of: walking dogs on a beach, seeing dolphins at play from the vantage point of a small boat, looking around a restored Spitfire airplane on the ground and seeing it flying;
(ii) Virtual animal: a bird sitting on a bird house (sings, flaps, flies on command);
(iii) Creative activities: painting a pot, making a sculpture, playing chimes, playing the bongos, blowing bubbles.

The games developed included:
(iv) Amusement arcade games: pinball, slot machine, bingo, a demolition yard game;
(v) Fairground games: shooting gallery, coconut shy, tapping the monkey, balls into clown mouths;
(vi) Sports: crazy golf, beat the goalie, ten-pin bowling.

Five people with dementia (3 women and 2 men) tried out the first of the virtual activities and games as they were developed, with and without a helper present. The purpose of these initial tests was to be sure the

Figure 2. An interactive game - Beat the Goalie, and a creative activity - Paint the Pot; the ball behaves correctly in terms of real world physics: touch the right side to send it off to the left and so on; touching a paint pot picks up that colour and touching the (rotating) pot lays the colour on it

activities and games we were developing were along the right general lines, and to detect and sort out any problems with them at an early stage.

The next stage involved an iterative approach to the design process, with people with dementia from the day centre trying out technical 'sketches' of all the prototypes listed above as we developed them. Over the period twelve people with dementia (7 women and 5 men) were invited to try out the virtual activities hosted on the touch screen in a day care setting.

Most of the users engaged well with the activities. We learned a great deal about how to structure the interaction to avoid confusion or boredom. Activities with a clear and always present goal worked best. Activities which were familiar, not surprisingly, also worked well. Activities which were less successful involved occasional pauses when it was not clear what to do next, or just what was happening. Comments from users included "That's brilliant! I'd be there all day!", "Isn't that lovely? Can I take this home?", "Not bad considering I didn't know what I was doing".

Devising ways to replacing a helper by having the system itself prompt the user was an important part of this project. We planned to experiment with increasingly intrusive levels of prompting, so that we could determine the minimum level necessary to still ensure success. To assist us we developed a software tool to measure users' response time to prompts. Prompts could be provided, in increasing order of obtrusiveness, by :
(i) An interface which was simple and easy to figure out;
(ii) Visual reminders (such as an onscreen button flashing);
(iii) Text boxes which could pop up with instructions or suggestions;
(iv) Spoken messages to the user;
(v) An onscreen avatar to deliver instructions and suggestions to the user.

Our method of testing the prompting was to leave the users alone with the system, once we had got them started with it. We could see what they were doing from the next room via the video camera. Having tried the first four prompting methods, we found that a well-designed interface, along with occasional text-box prompts was sufficient. It proved not necessary to create avatars. This was a welcome finding, since we were concerned that the split attention which would be required in order to deal with an avatar and the activity itself might prove too much for users. The spoken prompts with synthetic speech we found did not work well. The synthetic speech was quite understandable to people without dementia, but our participants with dementia simply ignored the

speech, as if nothing had been said. This interesting outcome relates to work being done on difficulties older people in general and people with dementia is particular may have with understanding synthetic speech[9-11]. Visual prompts were better than verbal prompts in that they were better at keeping the initiative with the user. Users have enjoyed even the unfinished prototypes and engaged with them for extended periods without continual support from another person.

Our conclusion, having experimented with these environments, activities and games with people with dementia, is that a successful interactive experience must have the following characteristics:
(i) An engaging, attractive and colourful interface, which promises enjoyment;
(ii) Always obvious what to do next, either because of the way the interface behaves, or because of a specific prompt;
(iii) An element of challenge and skill mastery to the experience (i.e. there is a 'point' to it, even for people with little working memory);
(iv) Continual feedback provided on the user's performance - encouragement when they are not succeeding at a task, and praise when they do succeed.

We have now tried out these activities in groups as well as singly. Here one person at a time uses the system, and the rest act as an audience. The fairground games in particular, which are colourful, noisy and obvious, seem to have the ability to hold the attention of the whole group and draw it into the fun, with lots of comments and cheering at the individual performer's successes.

The next stage for this project is to determine which of the many activities we have tried out work best, and why. It will then be possible to construct a compendium of games and activities which have proven effectiveness for possible commercial distribution.

Being musically creative

Looking beyond entertainment, as important as that is, a further challenge would be to devise technology which could help a person with dementia to carry out a satisfying creative activity. For our purposes we defined computer-supported creativity as an activity which is directed by the user, within limits provided by the system, which produces a result which is innovative, individual and, ideally, aesthetically pleasing.

A number of studies have shown the potential of people with dementia to be creative. Activities such as music and painting can positively influence the sense of well-being of people with dementia, with those participating showing improvements in self-esteem and mood and decreased agitation[12,13]. All of these approaches have involved a great deal of imaginative planning and hard work on the part of carers to support the person with dementia in being creative. We have been working on ways to use technology to take over some of the support needed by the person with dementia in order to carry out creative activities. We have developed a system, called ExPress Play (*Figure 3*), to support failure-free musical composition, which always has a successful outcome, that is intended to enable people with dementia to participate in active music making regardless of prior musical experience. The system was accessed via a touch screen, and used chords, which could be selected to represent varying musical moods, to enable par-

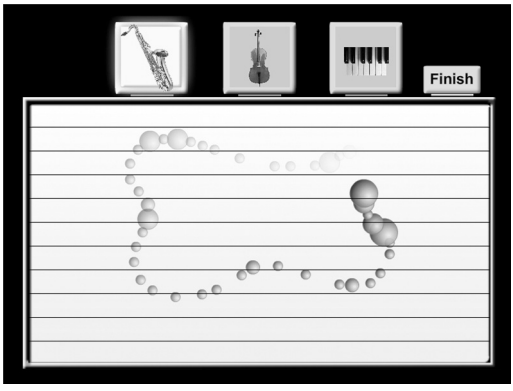

Figure 3. The ExPress Play interface showing mood selection (via one of the instrument icons) and the visual results of the user dragging a finger around the screen, making music

ticipants to make coherent and pleasant sounding music[14].

The user was able to select one of three moods: happy, sad or angry, represented in the version shown in Figure 3 by, respectively, a saxophone, a violin, and a piano keyboard. The user could then create music by dragging their finger round the touchscreen. When the screen was touched, two types of feedback were given – audio and visual. Users heard a chord playing whilst also seeing circular shapes appear on the screen under their moving finger. These circular shapes provided instant and continual feedback, and added a pleasing visual component to the experience. As the user's finger moved, so they began to draw on the screen, leaving a trail of circles behind. This visual trail provided a continuous prompt that something happens when the screen is touched.

The size of the circles was dependent upon the speed that the user moved their finger across the screen. The faster they moved, the smaller the circles that appeared. The circle colour was chosen to match the mood selected, with the happy screen having yellow circles, the sad screen having blue circles and the angry screen having red circles. The circle colour was made darker than the background and the circle shape made 3-dimensional, in order that the circles stand out prominently in the foreground. The trail of circles was set to fade gradually from the end as the user moved around the screen. This ensured both the background and the trail being created were easily visible to the user at all times.

Moving up the screen caused the pitch of the chord to become higher. Moving down the screen caused the pitch to become lower. A further visual clue to the change in pitch was provided by evenly spaced horizontal lines on the screen. As the user moved over a line, the chord sound changed to the next pitch. As the user moved to the right the sound became louder, and as they moved to the left the sound became quieter. It was hoped that being able to change volume would enable users to add more feeling to their music. Dynamics can be used in musical compositions to change the emotional effect of melody and harmony. As the intended users may have hearing impairments, the volume was arranged so that it did not fall below a set minimum value.

Twenty-five people with dementia participated in evaluations of ExPress Play, each taking part in three sessions spaced out over a number of days. All the sessions were videotaped. In addition a tool was developed to automatically track and record all the selections, movements, and timings during a session. In this way it was possible to replay the sound and display generated during each session for analysis. Ten minutes was decided to be a good duration for each session. However, we decided not to stop participants abruptly if they were deeply engaged in play, but rather stop them at an appropriate time. In fact more participants played for longer than 10 minutes than expected, and where time constraints were not an issue (for instance, only one participant to be evaluated), there was less urgency to stop a participant who was engaged than where time constraints existed. It did seem that participants would generally have played for longer than the 10 minutes had no time constraints been implemented.

When asked after sessions, the majority of participants said they enjoyed using ExPress Play (21/25 in the first session, 23/25 in the second and 24/25 in the third session). After all the sessions 22/25 participants said they would like to use ExPress Play again.

There was a significant increase in the duration participants played between session one and three ($t(M=25, df=24)=-2.89$, $p=0.008$). Similarly, changes in the number of finger movements recorded on the touch screen over the three sessions were evident, with increases seen in the number of simple movements made (right, left, up and down) and compound movements (right-up,

right-down, left-up, left-down). The number of moods selected to play also increased as the sessions progressed. These were unexpected results, suggesting some sort of learning taking place, which will merit further investigation[15].

In terms of being creative, users of the system all produced unique musical output. The tracking data showed that each person had a completely individual pattern of use of the system. The different trails of finger movement clearly showed some individuals favouring staccato dabs at points in a row, some making points all over the screen, others opting for continuous lines horizontally, vertically diagonally, or in swoops. None of the participants played in the same way as the others.

One criterion we set ourselves for creativity was that the results be (ideally) aesthetically pleasing. It is of course difficult to judge aesthetic value. This perception varies between individuals, between cultures, and in any culture over time. However, it is fair to say that results of the current version of Express Play would be better described as 'interesting' or 'amusing' than 'beautiful'. We speculate that a more careful choice selection and design of the sound units used to produce the music could make a big difference to the perceived beauty of the output, and we plan to explore this possibility. We are also looking into the possibilities of a commercial version of ExPress Play.

Having an enjoyable conversation

Conversation is the bedrock of human communication. Through conversation we learn to talk, are socialised, we establish our place among our peers and the wider society, and we express daily and continually the sort of person we are[16]. Conversation is a mutually constructed social activity, where each participant is equally responsible for keeping it going, and trying to make it interesting and entertaining[17]. One of the most devastating effects of dementia is the deprivation of the ability to converse. Without working memory, conversation becomes impossible. For many people the basic structure can remain to an extent, so greetings, farewells and other forms of ritualised speech are still possible, but the rest can be utterly repetitive or apparently meaningless to a listener. 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 the person's sense of wellbeing, and put severe strains on family and carers.

Although short-term memories are not available in dementia, longer term memories can be relatively well preserved. This is because long-term memories are stored in the brain in a different way from working memory. With dementia, the difficulty is to find a way to prompt these long term memories. This can be done by a family member who knows the person's history well, but it can be hard work, and does not make for a relaxed and natural interchange, with both participants contributing equally.

There may be a role here for technology to take over the task of prompting and supporting, freeing both parties to enjoy the resulting conversation. We have developed and evaluated a system called CIRCA, which performed this role. CIRCA consisted of a hypermedia structure with reminiscence material as content, accessible via a touchscreen. The system relieved the carer or relative of the task of continually supporting the person with dementia in a conversation. Instead they could join with them in exploring and enjoying the multimedia material, which then had the effect of regularly triggering long-term memories. The person with dementia could then relate their story or recollection (*Figure 4*)[18,19].

The system presented the users with a choice of three reminiscence themes and three media types, drawn from approximately 10 video clips, 30 music clips, and 230 photographs. The material was chosen

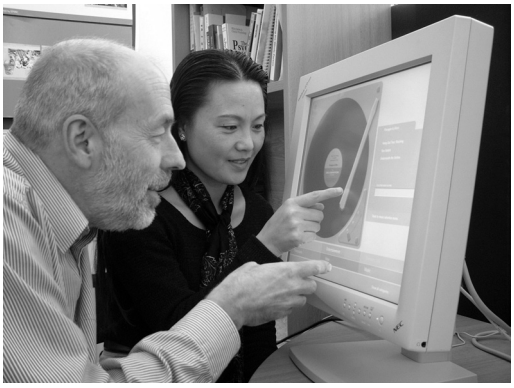

Figure 4. CIRCA provides touch screen access to a selection of material from the past - photos, videos and music, to prompt the long-term memories of the user; here a number of old tunes can be chosen to be produced on an animated record player

after consultation with about forty people with dementia and their families and carers, to determine what sort of material would be the most engaging and stimulating of conversation.

After this iterative development of the system, for a final formal evaluation, we set up communicative interactions between people with dementia and a carer, with and without the system being used. As CIRCA used reminiscence contents to stimulate conversation, the control condition used standard reminiscence material to prompt and facilitate conversation.

Given the difficulties people with dementia may have in communicating their opinions, we devised objective measures for such aspects of the interaction as engagement, enjoyment, and the degree to which a satisfying interaction is taking place. We video recorded and then coded all the sessions. We developed a set of coding techniques to describe both verbal and nonverbal behaviour that allowed us to focus on (i) the people with dementia, (ii) the carers and (iii) the relationship between the two. In particular, we tried to determine if people with dementia can be supported to take the lead more in conversations, rather than the contents and course of the interactions being determined by the carers. This would have a beneficial effect on the quality of life of people with dementia as the provision of a positive interaction, at whatever level a person with dementia understands it, can be considered a successful intervention[20]. In addition, facilitating staff to engage in successful reminiscence activities has been shown to have a positive impact on their attitudes towards the people they work with that continues beyond the activity sessions[21].

To measure the caregivers' role in the interaction, we examined instances of prompts given by the carer to the person with dementia to make a choice about what he/she wished to talk about. To examine the role of the people with dementia in the interactions we looked first at instances of choosing after prompting. Finally we examined the interaction between the two partners in the interaction. We looked particularly at the use of humour, such as making a joke or an amusing comment, by either the person with dementia or the caregiver during the interactions. We also looked at the duration of laughter and whether it occurred jointly or was it one person laughing alone.

The evaluation studies[19] allowed us to draw conclusions about the level and quality of participation of the people with dementia and of their partners in the interactions. We have identified clear differences both in the behaviour of the people with dementia and the caregivers in the two reminiscence situations. Specifically we have shown that people with dementia can be supported by the sensitive use of technology to take greater control over the interaction and engage in a more equal relationship with the caregiver[22,23]. This finding is important for furthering our aim of promoting the well-being of people with dementia and their identity as an individual with a life history before dementia. It is also an important outcome reported by caregivers in follow-up interviews.

The success of the CIRCA prototype was in part due to its use by both partners in the in-

teraction equally. The intention was to take some of the pressure off the carer and allow them to relax into a pleasant interaction without having to be concerned about guiding and controlling the conversation. The system was appreciated by carers for this reason. In the questionnaires and interviews after using the system typical comments were that an enjoyable part of the session for them as a caregiver was "the fact that the system is easy to use" and "I have never had such a good reaction from Jim before". The system was originally designed as a 'multimedia scrapbook' which a carer could make use of to stimulate long-term memories in people with dementia. In use we found that the system unexpectedly restored a great deal of equality to the interaction in that it allowed the person with dementia to exercise control easily over the direction of the conversation. In this way the system showed itself to be a third element in the interaction which facilitated a better quality of communication for both parties.

The results of the evaluations have led to a number of improvements and additions to the system, including an improved interface and expanded content, with a randomising feature to make each session unique. The CIRCA system is under consideration now for distribution as a commercial product.

Conclusion

Technology has a great deal to offer to help people with dementia not only be safe and to carry out daily tasks, but to have fun. We think a key to successful development of systems which can assist with this is a multidisciplinary team, a close partnership with potential users during development, and making sure that the balance between technology and human control is right.

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