DESIGNING THE INTERFACE BETWEEN DEMENTIA PATIENTS, CAREGIVERS AND COMPUTER-BASED INTERVENTION

GARY GOWANS, RICHARD DYE, NORMAN ALM & PHILLIP VAUGHAN University of Dundee, Scotland

> ARLENE ASTELL & MAGGIE ELLIS University of St Andrews, Scotland

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People with Alzheimer's Disease (AD) experience progressive degeneration of cognitive skills and the cumulative loss of short-term memory function. This severely impairs their ability to communicate with relatives and caregivers. The 'dehumanizing' effect that is engendered by the loss of communication skills, and the subsequent psychological and emotional distress experienced by people with AD and their caregivers are perhaps the most significant and detrimental psycho-social characteristics of AD. This paper demonstrates how our multidisciplinary, user-centred approach to design for computer-based assistive tools for people with AD can support progressive, nonpharmacological intervention and promote improved quality of life in dementia care environments.

INTRODUCTION

The twentieth century was witness to revolutionary advances in healthcare provision. The unrelenting progress of pharmacological and surgical intervention allied to a more acute awareness of nutritional and dietary requirements have factored prominently in extending the average life expectancy of human beings to unprecedented levels. As a direct result of this there has been a significant shift in the proportion of older people to younger people in world populations, and it is evident that this proportional shift continues to grow. If we consider that the incidence of cognitive impairment caused by dementia-related illnesses (ie Alzheimer's disease) increases from the age of 65 to reach 1 in 4 people over the age of 85 (Jorm *et al*, 1987), this then represents a human problem of global proportions. PAPERS DESIGNING THE INTERFACE BETWEEN DEMENTIA PATIENTS, CAREGIVERS AND COMPUTER-BASED INTERVENTION

'What is the use of a book,' thought Alice, 'without pictures or conversations?' (Carroll, 1865)

Think of the 'book' in guestion as someone with dementia. This would go some way to describe the prevailing attitude towards people who experience cognitive impairment and communication difficulties caused by Alzheimer's Disease. As human beings, we depend upon our cognitive skills and powers of communication to establish and sustain our place in the world, to let the rest of the world understand us, to form and sustain supportive, caring human relationships - to be human. We are judged by our cognitive abilities and powers of communication on a daily basis. So much so, that the loss of these abilities somehow makes us less than human. The 'dehumanizing' effect that is engendered by the loss of these skills, and the subsequent psychological and emotional distress experienced by family caregivers, are perhaps the most significant and detrimental psycho-social characteristics of AD.

> 'Patients face a progressive loss of self and family members must adapt to an individual who often seems like a stranger. Family caregivers, in-turn, experience isolation, anxiety, depression, and increased physical illnesses'. (Beck, 1998)

Although AD severely impairs short-term memory function, many people with dementia (inclusive of severely impaired cases) often retain a strong facility for long-term memory. People with Alzheimer's may not remember something that was said only minutes before, but, given appropriate sensory stimulation, many AD patients retain the capacity to, for example, iterate complicated stories from their formative years, or recite numerous verses of a song learned in childhood.

INTERVENTION: THE GOOD, THE BAD AND THE INDIFFERENT

The most widely used non-pharmacologic intervention to support improved communication and interaction between caregivers and people with dementia can be broadly referred to as 'reminiscence therapy'. Photograph albums, artifacts, memorabilia, music, tactile activities like biographical painting or knitting, even reminiscence theatre and retro-environments and so on are used to stimulate long-term memory to promote positive interaction, activity and communication. Reminiscence therapy, when witnessed in its most positive incarnations, promotes a shared, positive human experience and supports people with dementia and caregivers in developing a mutually supportive, caring relationship.

'Drawing on long-term memory, patients receive support and encouragement from peers and the group leader as they share events from their past. This sharing may promote integration of self through resolution of past conflicts and the re-creation of a unique individual.' (Greene, 1998)

This type of intervention, however can be very time-consuming, requiring organization, collection and storage of materials, and may often rely upon comparatively 'cumbersome' technologies such as tape recorders, CDs or video tapes/DVDs. Our observations indicate that current practice often places the pressure of stimulating and sustaining conversation upon the caregiver, while the person with AD commonly assumes a more passive role. This can, in turn, prove stressful for the parties involved and contribute to lessnaturalistic interaction in conversational scenarios.

Non-pharmacologic interventions are very much left to the vagaries of any given care-institution or personal caregiver. Quality of care, in this respect, varies from extremely high standards in some facilities, to negligible or non-existent in others. Moreover, quality and quantity of therapy is influenced by availability of resources, location, staffing and even the inclination or goodwill of individuals. It is an easy option for under-resourced care-home staff to leave a lounge-full of dementia patients in front of a video for three hours, if, for example, organizing a reminiscence session is perceived to compromise the time required for cleaning, toileting, feeding and administering proscribed medication.

'The use of non-pharmacologic interventions in practice is limited. The biggest barrier is the lack of financial resources . . . the perception that medication is easier to administer, and a system that does not address the quality of living with dementia from a holistic point-of-view.' (Cohen-Mansfield, 2001)

OUR GOAL

Our work endeavours to exploit the combined skills of design (expertise in graphical multimedia interface and computer-gaming design), computer science (expertise in designing systems for the physically and cognitively impaired), and psychology (expertise in language function in dementia-related impairment) to develop computer-based tools that support nonpharmacological intervention in dementia care environments. CIRCA (Computer Interactive Reminiscence and Conversation Aid) is an EPSRC (Engineering and Physical Sciences Research Council) funded research project – a collaboration between the Department of Graphic Design and the Department of Applied Computing, University of Dundee, Scotland, and the Department of Psychology, University of St Andrews, Scotland. By combining multidisciplinary practice and a user-centred approach to the design process, we have produced a computer-based tool that can stimulate and support communication in conversational settings in dementia care environments.

THE CHALLENGE

The challenge lay in designing an interactive multimedia on-screen experience that can satisfactorily meet the particular needs of our target demographic, that is people with dementia, their families and caregivers. The solution had to address a number of criteria:

- support easy start-up
- support intuitive navigation for a novice-user demographic
- elicit memories to prompt and support reminiscence, communication and social contact
- promote 'non-immersive' engagement (ie the system should work as a communication prompt, not a purely sedentary pastime)
- support an enjoyable shared experience
- support the cognitively impaired person in having a more proactive and equitable role in shared conversations
- relieve caregivers of the pressure of constantly needing to 'prop up' conversations
- promote 'failure-free' activity (in this context 'failure' refers to both technical and emotional

'failures' such as frustration due to poor technical performance and emotional distress caused by, for example, inappropriate/distressing data content)

- support customization of content, for example to accommodate individual personalization and/or different geographical requirements
- promote and support good practice in reminiscence intervention.

THE DESIGN APPROACH

From the beginning we adopted an iterative approach to the design process. To this end an advisory group was formed comprising representatives from Dundee City Council Social Work Department, and Alzheimer's Scotland: Action on Dementia. 40 people with AD and 30 caregivers were recruited to participate in, and evaluate, prototype testing. The evaluations were conducted in over a dozen care facilities located throughout Dundee and the North Fife Region of Scotland.

PRELIMINARY STUDY INTO VISUALLY PROMPTING RESIDUAL CONVERSATION SKILLS

Initial studies were conducted examining the impact of Alzheimer's Disease on conversation and communication abilities, specifically looking at tapping into residual conversation skills using prompts. In the study, 21 people with probable Alzheimer's Disease (pAD) were shown photographs of 6 different annual events. Each event was depicted by images of food, scenes or people and presented in both black-and-white and colour formats. The participants' level of cognitive impairment was divided into 'mild', 'moderate' and 'severe', based on their Mini Mental State Examination score. Participants were invited to discuss their memories of each event with the alternate use of 'specific' and 'general' prompts.

PRELIMINARY RESULTS

All six events in both black and white and colour and all image types were equally successful in eliciting recollections and exchanges. In terms of response types, more general memories and positive comments were produced when specific prompts were used as opposed to when general prompts were supplied. The moderate group produced significantly more general memories, specific memories and total output than the severe group and significantly less total output than the mild group - moreover, the moderate group employed 'conversational tactics' in an attempt to mask their conversational difficulties.

These findings suggest that even in the later stages of Alzheimer's Disease people can interact meaningfully when prompted specifically. Furthermore, output in the moderate stage is often characterized by 'cover-up' strategies, indicating both an awareness of conversational limitations and a desire to conceal them.

The sessions for these initial studies used video filming to record the reminiscence sessions and all of the footage was transcribed to inform our findings. This was a very useful but time-consuming process and it was agreed that we should work with a combination of assessment techniques for measuring interaction, for example, coding sheets which would allow us to record specific characteristics of responses such as laughter, smiles, singing, talking and eye contact allied to selective video analysis. A questionnaire was also developed to record and gauge the impressions of both family and professional caregivers with regard to the design and usability of the system. DATA CONTENT AND INTERFACE DESIGN

Multimedia design, as the name suggests, presents an array of media (text, photographs, animation, video, music, computer-generated objects and environments), all of which can be successfully combined in the development of computer-based information systems such as software applications and games. Our preliminary study demonstrates that generic illustrative or photographic material is successful in eliciting conversation in therapy sessions. Historically, music has also been successfully employed to support reminiscence intervention and many studies exist which support the therapeutic value of music:

> '... benefits (from the use of music) may include psychological mood improvement, intellectual stimulation of speech and mental processes, physical sensory stimulation, and motor integration'.

(Aldridge *et al*, in Beck, 1998) Videos are sometimes used by care staff as a palliative tool, often as a means of pacifying clients with dementia when, for example, other essential tasks need to be dealt with. Since it is impossible for people with Alzheimer's to follow a lengthy or complex narrative the value of watching videos as an activity is limited. 'Respite' videos designed for people with Alzheimer's are available and include ambient content: film of natural environments with soothing music and little or no narrative. Again these are designed to occupy the patient whilst giving the caregiver respite. Customer testimonials point to some success with regard to this as a respite aid for caregivers.

Video, perhaps a recording of a family member, is also used to simulate social contact although one study that investigated this in the context of reducing inappropriate behaviour in AD patients revealed:
'A comparison of sensory stimulation
(individualized music tape) to simulated social
contact (video of family member) to actual
social contact (one-to-one interaction) revealed
that actual social contact had the highest
impact in reducing verbal/vocal inappropriate
behaviors.' (Cohen-Mansfield, 1997)
It is evident that positive social interaction is hugely
beneficial in respect of improving the quality of life in
dementia care situations, and to this end promotion of
a positive, equitable, shared experience is integral to
the CIRCA design philosophy.

SYSTEM CONTENT

Although we would later test 3D animations and QTVR environments it was decided to initially limit the media content to audio, video and photographic imagery. It is evident that the use of archive material in traditional reminiscence intervention practice can be successful in stimulate long-term memory. It was therefore decided from the outset that this would form a large part of the CIRCA database. Ideas regarding the thematic content were discussed amongst the team, and solicited from our wider partnerships. Highlighted amongst other themes were: public events, media/ film, news, local life, travel/holidays, occupations, fashions, hobbies and recreation, entertainment, sport, house and home. Through an iterative process this list was reduced to three categories: 'recreation', 'entertainment' and 'local life'.

With 'time-based media' (music and video) content, consideration was given to the duration of events – it was important to remember that we did not want to create a wholly 'immersive' experience and

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that our prime goal was to elicit memories to prompt and support conversation. It was agreed that video should be selectively edited down to short, succinct scenes whereas with music it was decided that it might be beneficial to retain whole songs, since, in a group situation, people might wish to join in a 'sing-a-long'.

A wide variety of archive material ranging from the 1930s to the 1970s was collected and categorized, and initial concepts for the interface design were progressed. The database content was analyzed to start organizing a navigable layout and a grid system was developed to structure particular information in regular and recognizable positions in order to promote continuity. We initially used a palette of muted pastel tones for the foundation of the interface to give contrast and strength to the photographic and video content. The database grew to include a selection of local traditional folk songs and famous recordings from the early 1930s through to the 1970s, while film featuring short scenes from classic cinema and local archive film of industry and recreation (for example, raspberry-picking) were included. Photographic content included famous film stars of Hollywood's Golden Era with links to some film clips. Archive shots of street scenes, dance halls, football teams and jute mills (80 per cent of Dundee's working population at one time were employed in this industry) added to the local content. Individual screens within these sections also included some brief text information describing the photographic content. This is not only helpful in placing images in a historical context for younger caregivers; it is also useful for people with dementia, many of whom still retain the capacity to read small pieces of information.

Music player

In the music section of CIRCA animated montages were



Figure 1. Music is accompanied by animated representations of old style players – turntable, reel-to-reel and bakelite radio.

initially designed to accompany individual songs. *We'll Meet Again* – a popular song from the Second World War sung by Vera Lynn – was accompanied by selected images from the period, edited together in a series of dissolves. While these animated vignettes were aesthetically pleasing and absorbing, it was felt that this was contrary to our philosophy of 'non-immersive' engagement. This approach would also require individual treatments for every piece of music to be included in the database. To resolve this problem we created animated on-screen representations of period music-players: a rotating record turntable (Figure 1), a reel-to-reel tape and a Bakelite radio.

Preliminary feedback and findings We started using the prototype with our test subjects in late spring/early summer 2002 using video to record sessions and recording caregivers' feedback through our 'use-ability questionnaire'. The results from the questionnaire showed that all participants enjoyed interacting with the system and when asked could not identify anything they did not like. When care staff were asked what they particularly liked, diversity and choice of material proved significant. It was also stated that the system got clients talking more than usual and that the interface was easy to use.

When asked if there should be more text-based information some of our test-users suggested this could be good for caregivers, for example, biographical information of the film stars. Issues relating to readability were raised (contrast and point sizes) and this would feed back into the design process. We also observed that our dementia-impaired users were physically interacting with the system and that from their seated positions this required a degree of physical effort. To alleviate this problem we moved all of our main controls for the interface to the bottom of the screen. Due to the vagaries relating to the furnishings of individual care environments it became evident that we needed to look at continuity concerning the ergonomics of interacting with the system. To this end we purchased a monitor stand which would allow us to position the screen easily in front of the users, no matter what their seated position. This also allows the participants to manoeuvre the screen very easily between themselves at any time during a CIRCA session.

COMPARING CIRCA TO TRADITIONAL REMINISCENCE

Comparisons were also drawn with traditional reminiscence sessions. It was clear from our observations of a typical traditional one-to-one reminiscence session that the onus to initiate conversation and to 'chain-link' topics in a spontaneous way was placed upon the caregiver. This can often lead to a repetitive strain of conversation relying on familiar/safe territory and a general feeling of artificiality. (It should also be noted that the fact that the subjects were being recorded on video would no doubt contribute to this atmosphere.) Conversely, and perhaps paradoxically, CIRCA appears to promote a much more relaxed atmosphere. In a number of similarly recorded sessions many of the people with dementia – inclusive of mild, moderate and severe subjects – happily sang along with the audio tracks that also proved successful in prompting conversation. It was also noted that the CIRCA sessions prompted a good degree of 'humorous banter' which added to the fluidity of the experience and promoted a more natural atmosphere. Perhaps three of the most significant outcomes were:

- CIRCA prompted memories from a number of individuals which none of the caregivers had heard before;
- Some people who normally reacted poorly to traditional reminiscence intervention were more involved and alert;
- 3. People with dementia enjoyed physically interacting with the system.

NEW DIRECTIONS USING VIRTUAL ENVIRONMENTS

As part of the design development of CIRCA we created a number of prototype interactive Quicktime VR (QTVR) environments. QTVR allows us to create on-screen, 'scrollable', 360 degree environments using photographic references. QTVRs have been used very effectively on tourist websites to show locations 'in the round', for example, a city square or a view from the first tee of a golf course. When combined with authoring software (Macromedia Director) we can

design control panels and link video (Quicktime) or photographic illustrations to 'hot-spots' within the on-screen environment; we can designate an area within the location as an active 'button' and call up a video window or illustration. In this way we can, for example, scroll round a garden, click on a flower and call up a more detailed photograph of that flower or activate a Quicktime video showing bees collecting pollen from it. To this end, we developed three interactive QTVR environments - the location types being based upon the suggestions of our user group and the wider team. The three locations were an art gallery, a public bar and a botanical garden. An interesting technical distinction between the locations is that the garden and gallery environments were created using photographic references, whilst the pub was created using 3D object and environment modelling software. This technology, which is used extensively in computer gaming design and animated films, would significantly influence the future direction of our research.

The botanical garden (Figure 2) environment allows the user to scroll round the garden by touching



Figure 2. Botanical Garden. Quicktime VR 'scrollable' environment with interactive 'hot spots' to access video clips and details of flora.

the right or left of the screen. A control panel at the bottom of the screen offers an alternative means of navigating the interface. By clicking on hot-spots the user can bring up large detail photographs of the flowers or navigate to the hothouse where the same control mechanism allows access to photographic close-ups of the flowers, videos of the water feature, fish swimming in the pond, bees buzzing round flowers – all of which are accompanied by a pastoral soundtrack. The pub environment works in the same way to access rendered scenes of pub memorabilia, video clips of a pint being poured and a game of dominoes being played, whilst the art gallery allows access to close-up shots of selected paintings and artifacts in a display case.

QTVR USER TESTING

Our initial interest in testing the QTVR environments was to establish whether people with dementia would find the experience engaging, enjoyable and/ or worthwhile. We were also interested in feedback relating to the control/navigation mechanism.

- 11 out of 13 people who used the QTVR system felt that the environments added 'value' to the CIRCA experience.
- Words as opposed to icons appear to work best in reminding people with dementia how to operate the screen.
- Whilst all of the environments received positive feedback from our users, when asked for a preference the botanical garden proved to be most popular.
- The environments elicited many positive comments: 'Stimulates memories, gives enjoyment through several senses – colour, movement and sound'

'It brings fun and a sense of achievement – you can make things happen'

'An escape into a relaxing, enjoyable and engaging environment'

'The Garden – beautiful to look at and excellent music'.

LIVING IN THE MOMENT (LIM)

Our current research is very much influenced by this area of investigation. Living in the Moment (LIM) is a three year EPSRC-funded project that has the same team, partnership and user-testing construct as the CIRCA project. The multidisciplinary and user-centred approach continues to inform our research philosophy – only our specific goal has changed. CIRCA was designed to support communication in conversational settings – to deliver a positive, failure-free experience shared equally between dementia patients, their caregivers and relatives. Our current goal is to produce a positive, enjoyable and worthwhile computer-based interactive pastime that a person with dementia can engage in, and operate, unaided – thereby providing a 'respite window' for caregivers.

LIM CONTENT

Both photographic and 3D wireframe modeled virtual environments using QTVR proved successful in engaging our user-group. People with dementia found the experience enjoyable and relaxing and the use of the system elicited many positive comments. These results were significant as they point to many possibilities for developing, engaging, stimulating, worthwhile computer-based pastimes for people with dementia. A significant advantage of using 3D modelling software (Maya), as opposed to photographic QTVRs, is that this technology offers the possibility to create any kind, and number, of navigable virtual environments into which a diverse range of on-screen activities can be programmed. At the early concept stage of the LIM project, many possible interactive pastimes were mooted including virtual exercise, creative pastimes, (painting a picture, making and painting a clay pot), a travel experience, walking the dog, window-shopping or feeding fish in a tank. To this end, and in light of the responses to the botanical garden QTVR, we started to develop ideas for creating an interactive virtual garden.

THE CASE FOR A VIRTUAL GARDEN

Elderly dementia patients in care homes can often experience detachment from the environment outside their domestic surroundings. This can be due to, amongst other things, lack of easy access to a garden or other exterior environment, frailty, incapacity or lack of staff resources to coordinate activities outside of the home or institution. A number of studies demonstrate that exposure to the natural environment can have beneficial effects as a non-pharmacological intervention in dementia care.

A 1997 study investigating the effects of a natural environment upon agitation and aggression in late-stage dementia reveals:

> 'A natural environment, consisting of recorded songs of birds, babbling brooks, or small animals, together with large, bright pictures matching the audiotapes . . . resulted in significant reductions in agitation in the treatment group of 15 nursing home residents, in comparison with the control group of 16 care residents who received usual care.' (Whall *et al*, 1997)

'Remaining active and alert was important to many people, and in this context, nature often acted as a catalyst and was a source of happiness to many people, who talked about getting pleasure from watching the colours of the sky and clouds and listening to the birds' (Gilliard *et al*, 2004)
'Keeping active made them happy, as did going for walks, to church, sitting out in the sun or attending to the garden.' (Gilliard *et al*, 2004)

REAL-TIME AND PRE-RENDERED ACTIVITY IN LIM

A virtual garden environment offers the possibility of a tranquil, relaxing audiovisual experience but also provides the potential to include many different areas that could support a selection of diverse activities. Currently we are developing activities that can be 'actioned' by a single touch: planting seeds and watching flowers bloom, visiting the pond and feeding the fish, viewing the birds in the trees and hearing the birds sing, going to the potting shed and 'throwing' and painting a clay pot, are some examples currently under development (Figure 3).

A selection of the activities will be experienced in a 'real-time' gaming context, for example, using one's fingers to sculpt an object and then paint that object with a selection of patterns. This interaction occurs in 'real-time', in other words it is rendered as it happens. Other interactions trigger pre-rendered animations: touching a button in the songbird section activates an animation of the birds singing. Prerendered animations support better quality in terms of rendering and visual impact, since these can include post production and in-camera effects such as motionblur, particle effects, lens flare, depth-of-field.



Figure 3. The touch screen interface allows the user to sculpt a pot from 'digital clay'. The pot can then be finger-painted as it spins.

'ON RAILS' NAVIGATION

It is important to avoid any possibility of the user becoming lost, confused or frustrated if we are to achieve our goal of positive engagement. It was decided therefore that the navigation control mechanism should be as simple as possible yet still retain an element of choice. Our current approach proffers two options to the user:

- a single button control panel at the base of the screen will supports a 'one-stop' interaction to systematically navigate the user through each of the garden areas and activities;
- a series of 'hotspot', text-led navigation 'buttons' in the garden visualization (above the control panel) will offer a choice of locations to visit, for example, 'touch here to plant some flowers'.

To facilitate movement between individual garden areas we intend to adopt an 'on-rails' approach to ensure trouble-free navigation between locations, for example, a pre-rendered animation, or 'cut-scene', will depict or simulate the motion from one place to the next. This is a technique that is commonly adopted by console game designers to facilitate movement between levels and engage the user during 'loading' periods. This technique will allow us to bring post-production values to the scenes to promote a 'heightened sense of reality'.

CONCLUSION

It is clear that computers can play a significant role in supporting older people with dementia-related cognitive impairment. Our research into computerdriven reminiscence intervention proves that the current generation of people with Alzheimer's (the vast majority of whom have never interacted with a computer before) can benefit enormously from carefully designed, user-specific support systems. (Gowans *et al*, 2004).

Future generations will no doubt face new challenges in developing assistive technologies for older people with dementia. Currently, traditional reminiscence intervention in dementia care relies upon low-tech solutions. This is understandable when we consider that the vast majority of the generations currently affected by Alzheimer's Disease come from a comparatively low-tech background. Today's '20, 30 and 40 somethings', however, are involved in an almost constant dialogue with computer-based technologies - technologies which cover the gamut of human-computer interaction from e-mail, mobile phones, digital cameras, 'sat-nav', to programmable consumer durables, computer-gaming and on-line communication and transactions. In short, interacting with computers will be second nature to tomorrow's generation of pensioners. It is therefore logical to assume that computers will play a far more significant roll in supporting the elderly (including those with

dementia-related illnesses) in the future. This in itself supports a strong case for continued and wider research into computer-based intervention in dementia care.

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BIOGRAPHIES

Gary Gowans has over 15 years' experience working in computeraided design and is a senior lecturer in the Design School at the University of Dundee. His research has included work for Polygram International, the Ministry of Defence and Academic Press. Exhibitions include CADE Conference, Glasgow School of Art, 2001 and 'Traces of Conflict', Imperial War Museum, London, 2002. He is a member of the International Society of Typographic Designers and a visiting lecturer at the University of St Andrews.

Dr Richard Dye is a software engineer with a special interest in using technology to overcome communication problems between people caused by physical or cognitive disability.

Dr Arlene Astell has 15 years' experience working with people with dementia. Her primary interest is in the impact of dementia on language and communication. She sees promoting continued participation in social interactions as a realistic and important goal for dementia care.

Dr Norman Alm, after an initial degree in literature and languages, had a 20-year career in social work and special education tutoring. He has for the past 18 years been involved in developing computerbased support for people with disabilities.

Maggie Ellis is a psychology graduate of the University of Dundee and is currently undertaking a PhD in reminiscence at the University of St Andrews. She has worked with people with dementia for over six years and has both practical and research experience in this area.

Phillip Vaughan's undergraduate work was based in the field of motion graphics and interactive media. He has ten years' experience as a 3D animator contributing to high-profile game titles including Braveheart, Star Trek, Teletubbies, Wallace and Gromit and Farscape. Phil currently lectures at the School of Design in Dundee and is researching ways of utilizing multimedia and virtual environments to support intervention in dementia-related cognitive impairment.

ADDRESSES FOR CORRESPONDENCE

Gary M Gowans, School of Design, Duncan of Jordanstone College of Art & Design, University of Dundee, Perth Road, Dundee DD1 4HT, Scotland, UK. Tel: +44 (0) 1382 388273

Email: g.m.gowans@dundee.ac.uk

Richard Dye, School of Computing, University of Dundee, Perth Road, Dundee DD1 4HT, Scotland, UK. Tel: + 44 (0)1382 384150 Email: r.dye@dundee.ac.uk

Arlene Astell, Psychology, St Mary's College, University of St Andrews, South Street, St Andrews, Fife KY16 9JP, Scotland, UK. Tel: + 44 (0) 1334 462056 Email: aja3@st-andrews.ac.uk

Norman Alm, School of Computing, University of Dundee, Perth Road, Dundee DD1 4HT, Scotland, UK. Tel: + 44 (0) 1382 385596 Email: nalm@computing.dundee.ac.uk

Maggie Ellis, School of Psychology, University of St Andrews, St Andrews, Fife K16 9JU, Scotland, UK. Tel: + 44 (0) 1382 384150 Email: m.ellis@dundee.ac.uk

Phillip Vaughan, School of Design, Duncan of Jordanstone College of Art & Design, University of Dundee, Perth Road, Dundee, DD1 4HT, Scotland, UK.
Tel: + 44 (0) 1382 386534
Email: p.b.vaughan@dundee.ac.uk