

Title: User-centred Development of a New Interactive Memory Aid

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Chapter 1

User-centred Development of a New Interactive Memory Aid

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1.1 Introduction

At the beginning of this research, a participant who lives with memory loss every day of his life attempted to explain what he wanted in a memory aid. “Imagine a memory which is outside you and responsive to you but doesn’t control you”. This, then was the challenge: to design an effective aid which would be a natural extension to the memory which you and I do not realise just how much we depend upon.

Memory problems are often associated with the ageing process and they are one of the commonest effects of brain injury. Such problems can severely disrupt daily life and put huge strain on family members and carers (Wilson, 1995). Electronic memory aids have been used as a compensatory approach to provide reminders to individuals, and in particular a small pager device has been evaluated with great success. The ‘NeuroPage’ system was developed in the USA by Hersh and Treadgold (1994). The user carries a telephone pager which alerts them by sound or vibration when a scheduled message is displayed on the alphanumeric screen. The overall operation is performed via collaboration between a local memory clinic and a commercial paging service. In consultation with the user and carers, staff in the clinic decide what messages are appropriate and necessary together with the appropriate time and date for transmitting them, and this information is sent to the commercial service which enters the data into their central paging system.

The aid has been evaluated by Wilson, Emslie, Quirk and Evans (2001) in a study involving 143 clients of ages ranging from 8 to 83 years. It has been found to be very successful, particularly with people exhibiting severe memory, attention and organisational problems.

Based on this success, the current study is to develop an electronic memory aid which will maintain the basic functionality of the pager system, whilst enhancing the service in terms of interactivity and functionality. Enabling two-way communication between a memory aid 'device' and a base station can provide the reassurance to relatives and carers which is required to reduce their workload and worry and increase the independence of the user of the system.

Increasing the functionality of the memory aid presents challenges regarding the usability of the system. These will be addressed by the user-centred design methodology which this paper describes. This approach to the development also enables investigation of the best way to involve older people in the prototype development. Initial qualitative findings of this process are detailed in this report.

1.2 Background

1.2.1 Memory Loss

Memory loss can take many forms and affect many people, though it is a decline in prospective memory, the ability to 'remember to remember', which is particularly relevant to the design of a memory aid. Prospective memory is known to deteriorate in relation to age (McDaniel and Einstein, 1993) and is one of the most common forms of impairment following a brain-injury. Brain-injured users characteristically have difficulty remembering most kinds of new information, including future events, although have normal to near/normal immediate memory (Wilson, 1995). One way to gauge the extent to which these problems can affect the every day life of these people is to look at the messages which users programmed into the NeuroPage memory aid system. Wilson *et al.* (1997) report that the most common messages used on this system were "good morning, it is 'day and date'", "take your medication now", "fill in your diary", and "make your packed lunch". These messages reveal an underlying deficiency in basic memory functioning which has serious implications for day-to-day living.

Older people suffer similar problems. In normal ageing, different degrees of impairment affect different forms of memory. In a population based study of almost 12,000 older participants (65 years+), Huppert *et al* (2000) found that only 54% of the subjects successfully completed an event-based prospective memory task. Participants were recruited from five centres across the country through their local GP's, with care being taken that the 'very old' (75 years+) were equally represented in the sample. The memory task involved participants being given an envelope and being told that later on they would be asked to write a name and address on the envelope, at which time they should also remember to seal it and write their initials on the back. Ten minutes elapsed between these instructions being given and the task enactment being carried out. Success in this task was strongly and linearly related to age, which is illustrated by highlighting the results

in the youngest age group (65-69 years), where 68% succeeded, against the oldest age group (90 years+) where only 19% performed the task successfully. The underlying significance of this research is that just under half the population of adults over the age of 65 in the UK suffer from some form of prospective memory impairment, and that as a consequence the safety and well-being of many older people may be at risk. A device to aid memory therefore has huge potential. In view of the reluctance of new-technology uptake which exists amongst many older people, it suggests that a memory aid device may prove even more effective if taken up by the 'young-old' to aid them in later life.

1.2.2 Current Electronic Memory Aids and Usability

Despite the prevalence of prospective memory problems amongst older people, the vast majority of research in this area has focussed on the rehabilitation of individuals from brain injury. A number of ways of improving lost memory functions have been investigated and applied (Harris, 1992). These include strategies such as artificial mnemonics and repetitive practice (a restorative approach to improving memory) and the use of external aids such as calendars and diaries (a compensatory approach). Whilst some restorative methods have been successful (Raskin and Sohlberg, 1996), it is the compensatory approach which shows greater potential, with prospective memory deficits being 'replaced' by prompting the user to carry out tasks and appointments with an external aid.

It is in this area that technology has been used as an aid to memory. Current personal digital assistants (PDA's) and palmtop computers provide time management software which has the potential to be used as a diary/alarm system for people with memory impairment. Kim *et al.* (1999) introduced a Psion Series 3a palmtop computer to a 22 year old man whose memory skills were poor and who was currently undergoing rehabilitation for a closed head injury. Staff at the rehabilitation centre programmed alarms to remind him to attend therapy sessions and ask for medication and the patient was able to carry out all tasks without further cues. In an additional study, Kim *et al.* (2000) reports on a trial involving 12 brain injured patients using a Psion Series 3a computer to assist with memory dependent activities in their day to day lives. In a follow-up interview 9 of the 12 participants judged the device to be useful to them on a daily basis, whilst all patients recommended that the palmtop should be continued to be used in outpatient therapy for brain injured patients.

Further studies by Van de Broek (2000) and Willkomm *et al.* (1997) have evaluated the use of a Voice Organiser device as a memory aid. The Voice Organiser is a handheld dictaphone which can be programmed to replay messages at time periods specified orally by the user. The user is alerted to a message by an alarm, and on pressing a button the message is replayed. Van de Broek asked five subjects with significant acquired prospective memory impairment to perform prospective memory tasks, both with and without the Voice Organiser, over a period of three weeks for each phase. All subjects improved during the

introduction of the Voice Organiser, with three subjects establishing a routine which persisted to a certain extent following the removal of the device. Similar results have been obtained by Wilson *et al.* (1999), who reports that a severely memory impaired user of NeuroPage improved on time-based tasks, such as preparing a meal, from 50% success rate pre-pager to 100% during use of the NeuroPage device. For some tasks, the higher success rate was maintained once the pager had been removed due to the establishment of a routine. Other key points to be taken from this study were that the subjects remained in control by choosing the wording of their own messages and that the pager was seen as prestigious rather than an embarrassment.

A common thread within the evidence available is a consideration of who might benefit from such technology. Wilson and Moffat (1984) found that learning to use electronic organisers produces great problems for memory impaired people, and reports from Kim *et al.* (2000) detailing subjects requiring supervised training twice a week suggests that the level of training required is not diminishing as the technology advances. When this is considered in conjunction with recent research (Clare *et al.*, 2000, Wilson and Evans, 1996) which shows that memory impaired people benefit from errorless learning techniques, it is clear that the training required to learn how to use electronic memory aids should be minimal and produce as few errors as possible. In contrast, current time-management software running on PDA's require at least some training for an average user. Although the ease of use of such software applications varies across the range of devices available and the platform on which they run (PalmOS/PocketPC/EPOC), they are not designed for memory impaired people. Wright *et al.* (2001) conducted a study in which an interface specifically designed for brain injured users was employed on two styles of PDA's. It was found that users who had suffered traumatic brain injury could use the PDA's successfully as memory aids, pointing to the need for a custom designed interface for such users.

Usability is therefore a key factor in whether an electronic organiser can be successfully employed as a day-to-day memory aid. A parallel report on WAP usability (the technology used to access the internet from mobile phones) by Ramsey and Nielsen (2000) gives detailed evidence of the problems of creating usable systems for small screen space such as mobile phones and PDA's. Scrolling pages, screen layout and the use of images and text all contribute to a difficult usability problem which can only hamper the use of these technologies as an external memory aid.

Older users provide an additional dimension to the problem. One of the critical points for usable interface design from this perspective is the decline with age in the ability to process items in working memory (Salthouse, 1994). Zajicek (2001) highlights this point by suggesting that memory impairment reduces the ability of users to build conceptual models of the working interface. Further contributory factors to the problems for older people when utilising a small, electronic memory aid are changes to vision, including declining visual acuity, contrast sensitivity and reduced sensitivity to colour, particularly blue-green tones (Hawthorn, 2000), all of

which make a small PDA interface difficult or impossible to see. When combined with difficulties in control of fine movement (Vercruyssen, 1996) and the impact this would have on the ability to manage a small touchscreen device, older people present a user group with very specific needs in this design area.

Together these factors point towards an interface with reduced and clearly displayed functionality which minimises the load on working memory. This implies intuitive usability which requires minimal training and visibly maintains the structure of the system at all times.

1.3 Current Study

The approach taken in the current research was to pin-point the deficiencies highlighted in the currently available electronic memory aids and use this as a basis to investigate and formulate the requirements for a new external memory aid. The areas where improvements could be made are perceived to be:

- the lack of two-way communication between user and carer through the aid;
- commercially available software applications being unsuitable/difficult for memory impaired users to learn and interact with;
- devices with small screens displaying small text and making interaction difficult for older users due to poor vision and/or dexterity.

From this platform, the research was undertaken from a user perspective, involving discussions with both older people and brain injured people, together with investigation into suitable technology that is currently available.

1.3.1 User Centred Design Process

1.3.1.1 Methodology: Interviews and Focus Groups

In order to begin designing the prototype under development, 10 older and 7 memory impaired people were interviewed about their current strategies for remembering in their day to day lives. Participants were recruited from sheltered housing and a disability rehabilitation clinic in the local area. Interested volunteers were suggested to the researchers by management or carers, with the interviews being conducted within the homes of the participants or within a day centre which the individuals attended.

Following a structured interview procedure, participants were asked about the memory aids which they currently use, such as a calendar or notebook, together with any other strategies used to help them remember things. They were also questioned on their experience of using technologies such as mobile phones and

personal computers, what they considered to be an acceptable size and weight of a memory aid, and what they would ideally like a memory aid to do for them.

In addition to interviewing, 4 focus groups were conducted with older residents of sheltered housing schemes. These proved to be very valuable. The discussion focused on the problems people had with their memory, together with opinions on the PDA's which were passed round to the participants. Interesting findings from these meetings were the responsiveness the participants showed to the technology, despite many of them never having seen devices of this nature before. Interaction with the touchscreens, which are the main input mechanism for the majority of PDA's, proved to be an intuitive concept to which this particular group of older people quickly adapted.

It was also interesting to note that a group of more than 3 individuals within a focus group became hard to manage, as difficulties with hearing, attention and the ability to follow the thread of a conversation proved to be hamper many participants contribution. Future methodology for user-centred design may need to consider this when involving older people in design and prototype development.

1.3.1.2 Qualitative Findings

The findings from these sessions produced several points. Perhaps unsurprisingly, the most commonly used aid/strategy amongst people questioned was a calendar or notebook. The diverse and specific responses to questions regarding the ideal functions of a memory aid made the results hard to categorise. A clear theme, however, was that participants wanted to be reminded not only of what they had to do, but *why* they had to do it.

A further concern voiced by the users was the usability of the system. The need for "big buttons", "clear prompts", "nice and friendly", and "user control" were all statements which revealed the users' awareness of their need for a usable as well as a useful aid. In addition, many of the younger, memory impaired users were aware of the hardware requirements of a memory aid and asked for "flashing light", "alarm", "voice recognition" and "portability". This technical awareness was not evident in the older group of subjects as one might expect from a generation of people less exposed to developments in technology.

This information produced the general hardware requirements for the prototype memory aid, which gave guidance to investigations of the potential technologies which are currently available to be utilised in the aid. Mobile phone technology is currently being integrated into PDA devices, and new technologies and devices are frequently coming on to the market in this rapidly expanding area. The potential for the use of this technology as a memory aid is enormous as it allows for a truly interactive system which can keep the memory impaired user in contact with a remote, possibly unmanned base, potentially removing the necessity of a call centre for a functional system. Remote access to the device could be provided through a base station which could also be accessed remotely from any PC which was live on the internet. This would allow reminder messages to be entered into the

system from a large number of suitable locations at any time of day, and thus be completely independent of a third-party call centre.

1.3.2 Development Phase: Initial and Future Prototypes

Following the evaluation of these findings, the first prototype was developed as a web-based system which would run independently on a PDA. This provided a measure of what the interface of the memory aid could look like and a basic functionality which allowed users to explore interaction with the system. The prototype aims to reduce the load on working memory by ensuring that all elements of the system are visible at all times. This is in itself a challenge which exaggerates the usability problems presented by the small screen size of the PDA.

The continuation of the development phase will be informed by a series of pilot evaluations with users of this initial prototype. This will involve tracking the users' movements through the system in order to identify potential usability problems or functionality which is redundant or missing, together with videoed observation for interpreting the user feedback. Such interactive evaluation and gathering of feedback will enable design iteration, ensuring that the ideas developed are sound before further prototypes are developed.

The second stage prototype will be implemented for use within an extended informal trial period carried out by the Oliver Zangwill Centre in Ely, who form part of the multi-disciplinary team involved in the current study. Results from this study will be fed back to the design team for a major system revision. The final prototype will be formally reviewed with memory impaired and older users.

1.4 Conclusions

Memory has been shown to decline with age. Although technology has been used and proved to have a positive effect on helping with these kinds of problems, usability and technological difficulties have limited the potential in terms of the number of users who can benefit from these aids. These difficulties have also reduced the extent to which the aids can contribute to longer lasting independence and safety of users. The current study is work in progress to develop an interactive memory aid which focuses on the usability problems encountered with previous aids whilst providing an aid which can be used easily and practicably in everyday situations.

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