Modality preference and performance when seniors consult online information

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P. Wright, A.J. Soroka, S. Belt, D.T. Pham, S. Dimov, D.C. DeRoure, H. Petrie. Modality preference and performance when seniors consult online information. Gerontechnology 2008; 7(3):293-304. Four studies explore the behaviour of older people when using two sets of online reference materials, one involving maps and the other giving details of universities. In the first two studies 32 people aged 59-78, chose their preferred information modality (text, voice or both) when using both sets of materials. Although 13 people (41%) chose to listen for at least one task, only 7 people listened on both tasks. These seven people had lower scores on a pre-test of spatial working memory but higher scores on a test of verbal short term memory. This suggests that people's cognitive resources influence their media choices. In studies 3 and 4 another 32 people, aged 60-80, did both tasks but with no choice of modality. 16 people heard the voice for the map task but not for the universities, and 16 people had the modalities reversed across tasks. Overall, the voice did not change accuracy or speed, but these studies provided further evidence that the benefit of audio in reducing errors was a function both of a person's cognitive resources (verbal short term memory and spatial working memory) and the demands of the current task. It is concluded that many older people would choose to listen if interfaces made this option easily available.

Keywords: modality, information search, interface, preference, voice, audio

The potential value of information and communication technology for older people and those who support them is increasingly being recognised - particularly the usefulness of informational websites[1]. Although the content of such sites may sometimes have begun as printed leaflets, digital media afford much richer communication options. Three of the features of digital documents that distinguish them from printed information are: (i) navigation options can take readers directly to the relevant small sections of text that are of interest to them; (ii) the documents can provide audio, so text on screen can be spoken; and (iii) graphics can be animated. Research by educational psychologists has shown that the combination of listening while watching a graphic animation is particularly effective in assisting understanding and remembering[2]. The present study examines whether listening is also an advantage in tasks where the text does not have to be remembered, and when the readers are much older than those usually taking part in educational research. There is evidence that interfaces which appeal to young adults are not necessarily those preferred by older people[3,4].

The studies reported here examined two complementary aspects of behaviour, people's preference for information in certain modality combinations and their accuracy and speed when there was no choice. This would enable an assessment of the appropriateness of their choices. Relying on the accuracy or speed data alone might not detect that people had to work harder to maintain the same level of performance, and so would have a preference for the information modalities they found easiest to work with. Studies 1 and 3 differed in whether people chose to have voice/silence or whether this was pre-selected and could not be changed. Studies 2 and 4 explored whether voice has a role to play when the content is verbal rather than graphic. Again the studies differed in whether the voice was optional or imposed.

Because older people often have memory problems[5,6], 'open book' reference tasks were chosen and people only had to consult the information on screen in order to be able to answer the questions. This kind of reading activity has received relatively little attention from researchers concerned with reading processes, although there is some educational research with students[7]. In contrast, researchers interested in human-computer interaction have explored how people navigate through digital documents in a range of contexts[8]. Reference tasks, in which people seek answers to queries that they have, may be typical of the way computer resources such as the www are used by older people. So they are the focus of the studies reported here even though it is known that people are more likely to listen when following online procedural instructions than when consulting online reference materials[9].

Reference tasks can vary in how precisely the target information is specified, and so differ in how much decision-making is involved[10]. On the one hand there are simple searches with almost no decision-making (for instance wanting the phone number of a particular shop) and people know when they have found the answer. Other searches may have under-specified criteria, such as wanting something to wear for a special occasion. Here it can be harder to know when the answer has been found and when to stop searching. The present research focus will be on simple reference tasks where the target is fully specified. Even here there remains diversity because either the answer may be found at a single location (for instance if checking item availability at a store), or it may be necessary to compare information across locations (for instance comparing a price in two or more stores). Although such comparisons involve memory processes, the information can be re-checked if forgotten. So information-consulting tasks remain very different from educational learn-and-remember tasks. In order to assess the effect of increasing memory demands, the present studies included questions where the answer was on a single page as well as questions where a comparison had to be made across pages. All main tasks shared a similar interface, but in the choice tasks

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(studies 1 and 2) people were able to select whether to listen while they read, or listen instead of reading, or consult the on-screen information in silence.

It is known that diversity among peer groups increases with age[11] and that people vary in their multimedia preferences[12]. In all four of the present studies the behaviour of older people was related to sensory and/or cognitive factors associated with the ageing process. Before engaging in the reference task, brief assessments of three sensory/cognitive abilities were made, all of which if impaired might be expected to increase the choice of spoken text: (i) Visual scanning: the ability to search for and read information from the screen was assessed using a short 'phone-book' task. (ii) The ease of hearing and understanding the computer voice, plus the ability to remember what it said, would also be likely to influence multimedia choice. So a short auditory digit span test was devised. (iii) Visual-spatial skills were assessed because in a simulated real-world task it has been found that visual-spatial skills had significant impact on performance when people completed online fuel tax forms for trips taken by truck drivers[13]. Visual-spatial skills have also been shown to predict differences among students on information search tasks[14], and technology use by older adults in Japan[15]. It has already been reported that the selection of audio on the maps reference task was related to people's visual-spatial ability[16,17]. In order to explore the generality of this relation the other reference task (Universities) was chosen to have highly verbal content, sometimes as prose and sometimes as itemised lists.

Methodology

Participants

Studies 1 and 2.
32 adults (age range 62-78, mean age 67.5 years) were recruited by advertising in local papers for people up to 80 years to receive payment in return for providing feedback on the project's talking computer.

Studies 3 and 4.
Another 32 adults (age range 60-80, mean age 67.3 years) were recruited in the same way as for studies 1 and 2.

Materials and tasks

All materials were presented online via a 15 inch (38 cm) touch-screen display (Protouch), with a resolution of 1024 x 768, driven from a Dell Inspiron 4000 laptop running Windows 2000. The volume of an audio speaker adjacent to the screen was adjusted to suit each person at the start of the session.

Pre-tests
Pre-tests were devised to be readily understood by people who might be unfamiliar with computers. These pre-tests provided a useful snapshot of people's sensory and cognitive abilities, and they also gave participants the opportunity to become familiar with reading and responding to the touch-screen display before the main task. Only the Verbal Short Term Memory task involved audio.

Visual Search
This task involved using information that was visible in different parts of the screen, and primarily indicated how easily people could read information from the screen. A name and address were shown at the top of the screen on the right and people were asked to locate this target in a 20 item

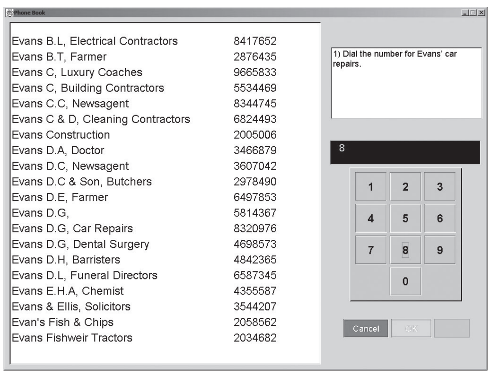

Figure 1. The visual search task with addresses and phone numbers listed on left and the keypad on right

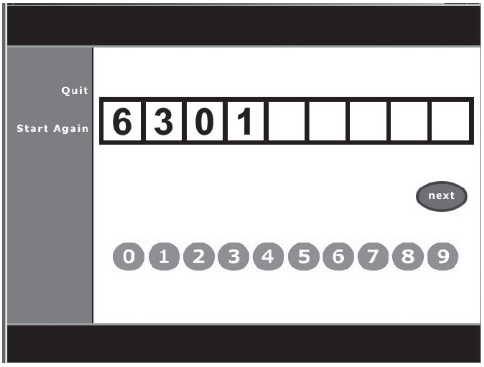

Figure 2. Screen display in the Verbal Short Term Memory task

phone list, then tap the seven digit phone number into an onscreen keypad (*Figure 1*) and check it was correct before continuing by tapping the OK button. There were eight trials, each having a different target and phone list.

Verbal Short Term Memory (STM)
This task was presented to participants as an opportunity to comment on the acceptability of the computer voice, and it provided a measure of how easily people could hear and remember the spoken information. People listened to a sequence of audio digits from the computer and then tapped this digit sequence into a row of buttons at the foot of the screen (*Figure 2*). As the buttons were clicked the digits appeared in the horizontal row of boxes in the middle of the screen. In total there were 12 digit sequences which varied in length from four to nine digits. Some came from a human female voice, others from a male synthetic voice (Microsoft SAM).

Spatial Working Memory (WM)
To reduce anxiety about a task which some people found difficult, this was presented to participants as an opportunity for them to comment on the possible uses of animation. People viewed a graphic sequence in which a square of paper was folded three times and pierced by a pin. They then selected which of five graphics depicted the unfolded paper (*Figure 3*). There were six such problems, three of which were animated and three were static, derived from a web version of this task available from[18]. That version was based on measures of visualization ability included in cognitive tests previously developed[19,20].

Main tasks
Study 1
People answered 16 multiple-choice questions about road routes between two locations in the UK. The route was shown on a map above the question (*Figure 4*). For all participants half the questions involved only one map, and half required comparing information from three routes. By tapping buttons in a panel on the left of the screen, people could choose to work with

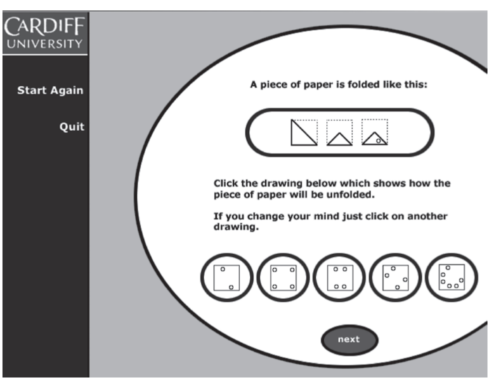

Figure 3. Screen display in the Spatial Working Memory task showing the sequence of folds at the top, and the pin hole options when unfolded

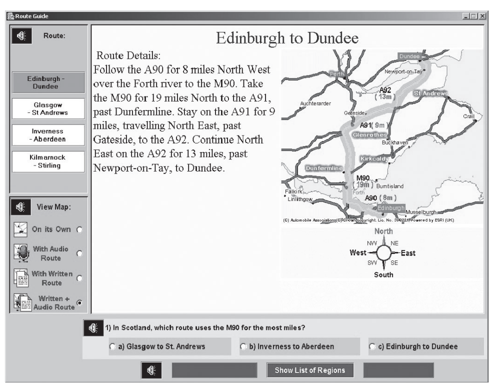

Figure 4. Screen display in the main Maps task

the map alone, or a map plus an auditory description of the route from a female synthetic voice (Microsoft SAM), or a map plus a written description of the route that was identical to the auditory information and shown to the left of the map, or all three information sources: map + written text + spoken text. To cope with the non-standard pronunciation of some place names, the text-to-speech synthesizer did not read the text shown on screen but read a parallel text in which place names were spelt in the way that resulted in appropriate pronunciation.

People worked at their own pace with ample time to change their mind about the way information was presented. If selected, the text appeared all at once on the screen. For half the participants the highlighted route on the map was animated and for the other participants the highlighted route between start and destination was shown already completed on a static map.

All trials began with a question, to which participants responded by navigating to the appropriate map using the top panel on the left of the screen where regions within the UK were listed (for instance Scotland, Wales, Midlands, etc). When one of these regions was tapped, the panel changed to show four pairs of starting points and destinations. This two-level hierarchic design was an attempt to comply with the suggestion that menu structures for older users should be shallow[21], while recognizing that an alphabetic listing of all 32 pairs of starting points and destinations would probably seem confusing, and would be contrary to the evidence that limiting the number of choices required at any one time can be helpful when adults have cognitive problems[22]. Other research has established that having navigation options remain visible alongside digital documents can help readers[23].

No route information was displayed in the centre of the screen until presentation options had been selected from the lower green panel on the left of the screen. The panel remained visible throughout the trial, so presentation options could be changed at any point. Selections did not carry over from one trial to the next but had to be made at the outset of every trial.

Study 2

The materials were chosen to be mainly verbal rather then visual-spatial and provided information about British universities. The overall layout of the screen was similar to Figure 4 with a three-option multiple-choice question at the bottom of the screen. 16 questions such as, 'How many students does Sheffield University have?' were answered by selecting the appropriate university from the top left-hand panel which then listed the following four options: (i) Introduction, which when clicked displayed in the centre of the screen a paragraph of on average 108 words; (ii) QAA (Quality Assurance Agency) Report, which when clicked listed departments within that university which had passed a recent quality assurance inspection; (iii) Facts and Figures, which gave details of staff and student numbers, university income, etc; (iv) Location, which showed a picture of where in the UK the university was located and gave a short paragraph (25-31 words) about that location. The lower left-hand panel offered three modality options: Audio alone, Text alone, Audio and text which, as in Study 1, had to be selected on each trial before any information appeared in the central panel.

Study 3

The Maps task used in Study 1 was presented without the modality selection panel. For half the participants 'Map+Text' was preselected, for the other participants 'Map+Audio+Text' was preselected.

Study 4

The Universities task used in Study 2 was presented without the modality selection panel, but with either the 'Text alone' or

Table 1. Multimedia choices in Studies 1 and 2

Trial	Mean (SD or %)	
	Study 1 Maps	Study 2 Universities
Mean trials audio chosen (maximum=16)	4.6 (6.7)	5.9 (7.0)
Number of Listeners (maximum=32)	9.0 (28.1%)	11.0 (34.4%)
Trials Listeners chose audio (maximum=16)	14.9 (1.8)	15.2 (4.42)

'Text + Audio' preselected. Those participants who had audio in Study 3 had text alone in Study 4, and vice versa.

Results

Modality choices

Table 1 summarises how often people chose the voice in the first two studies. For completeness the first row of data shows the mean number of trials on which people chose to hear the voice (maximum=16). However, these choices were not normally distributed and it would be a mistake to think that most people chose to listen on four or five trials. Sometimes people just listened for a trial or two and then preferred to work in silence, whereas other people listened throughout the task. So a more useful indication of people's preference is given by defining a Listener as someone who chose the audio on more than 50% trials within that study. There were 13 people (40.6%) who were Listeners in at least one of the studies but only 7 people (21.9%) were Listeners in both studies. The sample size is small for percentages to be reliable, but Table 1 suggests that on each task between one quarter and one third of these older volunteers were Listeners. Although a minority, this is not a negligible group of people.

Table 2. Relation of modality choice to speed and accuracy of performance in Studies 1 and 2

Multimedia chosen	n	Errors (SD)	Time in s / trial (SD)
Map Listeners	9	3.3 (2.1)	127.6 (37.1)
Map + Silence	23	3.5 (2.0)	100.7 (28.7)
Universities Listeners	11	1.9 (1.6)	70.5 (19.0)
Universities + Silence	21	2.2 (3.4)	71.6 (13.5)

If people chose the modalities they found most helpful when doing each task then there might be no overall difference in level of performance on the main tasks. This expectation was borne out by the data in Table 2 which summarises the errors made and time taken (seconds) on each task for those who chose to listen and those who preferred silence on that task. The universities task was done faster and more accurately than the maps task but there were no statistically significant differences within either the Maps or the Universities task as a function of whether people chose to work with the voice on or off.

Relation to cognitive profile

In order to give a clear distinction between the cognitive abilities of those who did and those who did not choose audio, people listening on only one task were excluded from this analysis. Table 3 summarises performance on the three cognitive measures

Table 3. Relation of cognitive measures to whether people chose to listen or not

Cognitive measures & age	Rarely listened (n=20)	Listened on both tasks (n=7)
Visual Search	7.1 (1.9)	6.7 (1.9)
Verbal STM	4.4 (1.6)	6.4 (2.2)
Spatial WM	3.1 (1.8)	2.1 (1.2)
Age	67.8 (4.2)	66.7 (5.7)

for those who were Listeners on both tasks, and those who were not Listeners on either task. As expected, Table 3 shows that Listeners tended to have lower Spatial WM than non-listeners but this difference was not statistically significant on Spatial WM errors ($t(24)=1.26$). However, their greater difficulty with Spatial WM tasks was reflected in times (Spatial WM times of Listeners was 215.6 sec and of those who did not choose audio was 178.2 sec ($t(24)=1.60$, $p=0.06$, one-tailed)). This is consistent with a previous suggestion that those who find the spatial WM task more difficult are more likely to choose audio[16,17].

Table 3 also suggests that verbal STM became a relevant factor when the maps and universities tasks were considered together. People who chose audio on both tasks had higher accuracy scores on Verbal STM than non-listeners ($t(24=2.58$, $p<0.02$, two-tailed). This was not apparent when the Maps task was considered previously[16,17], and suggests that different cognitive resources were recruited by the main tasks in Studies 1 and 2.

Without choice of modality

Table 4 summarises the accuracy and speed with which the tasks in Studies 3 and 4 were carried out when the voice was either on or off. It can be seen that there was no consistent effect across tasks. Performance on the maps task tended to be faster and more accurate when there was audio, whereas the universities task seemed to be done better when silent. Because the audio in the main task was counterbalanced across Studies 3 and 4 it is possible that any performance reversal between the maps and universities tasks could reflect a generally better performance by one of the groups rather than being due to the change in tasks. However, there were no statistically significant differences between the audio and silent conditions within either task on errors or times (statistical analysis of times for Maps $t(30)=1.27$); for Universities $t(30)=1.74$). Given the individual differences in modality preference that were noted in Studies 1 and 2, this overall lack of effect of audio is not surprising.

Performance and cognitive profile

In the light of the results of Studies 1 and 2 it was expected that the voice being on would improve the accuracy and/or speed of people with higher Verbal STM scores and those with lower Spatial WM scores. On the basis of their Verbal STM scores (max=12) participants were divided into those with 5 or more correct (Hi Verbal STM) and those with less than 5 correct (Lo Verbal STM). The Visual-Spatial WM scores (max=6) were divided into those above 3 (Hi Spatial WM) and those be-

Table 4. Effect of audio during Studies 3 and 4 on errors and mean times per trial in Maps and Universities tasks

Multimedia + Group	Errors (SD)	Time in s / trial (SD)
Map + Audio	2.6 (2.3)	83.1 (24.6)
Map + Silence	3.2 (2.3)	93.2 (21.5)
Universities + Audio	2.4 (2.0)	65.9 (15.6)
Universities + Silence	1.1 (1.5)	56.9 (13.2)

Table 5. Number of people with high or low scores on the Verbal STM and the Spatial WM measures

Cognitive group	Study 3 Audio Maps + Silent Universities	Study 4 Silent Maps + Audio Universities
High verbal STM	9	7
Low verbal STM	7	9
High spatial WM	6	6
Low spatial WM	6	6

low 3 (Lo Spatial WM). It should be noted that although the sample sizes became relatively small for this analysis (*Table 5*) evidence that the measures were tapping different cognitive skills, rather than some general ability, came from the small overlap among these cognitive groups. Of the 16 people in the Hi Verbal STM group only 6 were in the Hi Spatial WM group; of the 16 people in the Lo Verbal STM group only 5 were in the Lo Spatial WM group.

Table 6 shows how errors on the maps and universities tasks in Studies 3 and 4 varied with cognitive group. For the maps task the Hi Spatial WM group benefited from the audio by having significantly fewer errors (Mann-Whitney (7,6)=6, Z=1.73, $p<0.05$ one-tailed), but for this cognitive group the direction of the audio effect was reversed for the universities task where significantly more errors were made when the audio was on (Mann-Whitney (7,6)=5, Z=2.33, $p<0.04$ two-tailed). This reversal is consistent with the maps and universities tasks recruiting different cognitive resources. Supporting this conclusion is the finding that on the universities task those in the Hi Verbal STM group made fewer errors when the presentation was silent (Mann-Whitney (9,7)=50.5, Z=2.01, $p<0.04$ two-tailed), whereas audio had no significant effects on errors for this group on the maps task.

People with low scores on either the Verbal STM or the Spatial WM measures tended to make more errors on both the maps and the universities tasks than did those with higher scores on these cognitive measures, but there were no reliable differences as a function of whether the voice was on or off when doing either the maps or universities tasks.

Table 6. Relation of cognitive profile to the effects of audio on mean errors (SD) in Studies 3 and 4

Cognitive group	Maps Audio	Maps Silent
High verbal STM	1.6 (1.2)	2.3 (2.0)
Low verbal STM	3.9 (2.6)	3.9 (2.4)
High spatial WM	1.3 (1.6)	3.6 (2.5)
Low spatial WM	3.2 (2.6)	2.8 (2.3)
	Universities Audio	**Universities Silent**
High verbal STM	2.0 (1.2)	0.8 (1.1)
Low verbal STM	2.8 (2.5)	2.0 (2.9)
High spatial WM	2.7 (1.7)	0.7 (0.8)
Low spatial WM	2.3 (2.7)	1.7 (2.1)

Table 7. Relation of cognitive profile to the effects of audio on mean times per trial (SD) in Studies 3 and 4

Cognitive profile	Maps Audio	Maps Silent
High verbal STM	81.7 (22.1)	86.2 (21.5)
Low verbal STM	84.9 (28.8)	98.6 (19.7)
High spatial WM	81.9 (25.7)	97.3 (20.0)
Low spatial WM	92.3 (26.0)	72.9 (21.6)
	Universities Audio	**Universities Silent**
High verbal STM	60.5 (19.1)	56.1 (14.6)
Low verbal STM	70.2 (13.4)	67.2 (19.9)
High spatial WM	70.3 (17.3)	52.5 (7.8)
Low spatial WM	60.2 (14.0)	57.3 (14.9)

Where audio has had no effect on errors the times taken to complete the task offer an alternative index of task difficulty. Table 7 shows that on the maps task the performance pattern evident in the errors was reflected in the mean times (i.e. audio helped high Spatial WM but not low Spatial WM) but these time differences were not statistically significant (Hi Spatial WM $t(11)=1.22$, ns; Lo Spatial WM $t(10)=1.41$, ns).

For universities the time data mirrored the error data, with performance for each of the cognitive ability groups tending to be slower with audio than when silent, but the difference was statistically significant only for the Hi Spatial WM group ($t(11)=2.32$, $p<0.05$ two-tailed). The reasons for the lack of statistically significant effects may lie in the small sample sizes and the large variations within each group.

Discussion

It was noted that for most people the multimedia choices made on a task remained consistent across trials. This was unexpected. It had been thought that questions involving the comparison of information across several locations might change people's multimedia choices. Perhaps in the present tasks the increment in cognitive demands when more than one location needed to be consulted may have been too small to influence people's multimedia choices. Not only could people check back if they forgot information but, for questions such as 'Which of routes A, B, C was the longest?' or 'Does university A,B,C have the most medical students?' participants needed only to remember the current answer after each comparison. So memory demands were small, and further research is needed to determine if modality choice and the effects of modalities on performance will change when memory demands increase.

There are three main findings of interest from these studies:

First, a sizable minority of older people selected a voice output from a computer when given the opportunity and while engaged in a straightforward information reference task (Studies 1 and 2). Across these two tasks the total number of people wanting audio in one or other task increased. So it may be reasonable to assume that if there had been more than two very different tasks then the total number of people wanting audio in one or other task would have been higher still. When people could choose whether or not to listen, no accuracy or speed differences were found between those who listened and those who worked in silence. This suggests that people were making choices which were appropriate for supporting their cognitive strategies.

Secondly, people's choice of audio varied with the task. When the audio was imposed it reduced errors in the more pictorial maps task but increased errors in the more verbal universities task. However, the choices people made did not reflect this simple, task-dominated view. It was found that many people changed their modality choices between the maps and universities tasks, which suggests that people were responding to the cognitive processing resources required by specific tasks rather than classifying themselves as either listeners or readers. The question-answering tasks used in these studies were amenable to a range of strategies, especially those questions involving more than one location, and this may have increased the diversity among participants.

And lastly, the support that audio provided for accuracy and speed was a function of an individual's cognitive resources (Studies 3 and 4), with Spatial WM being relevant in the maps task and verbal STM being relevant in the universities task. It is possible that this may relate to differences in cognitive styles that some researchers have referred to as the distinction between imagers and verbalisers[24]. If people with low Spatial Working Memory tend to be verbalisers, then listening while looking at a map could help them integrate the two information sources; whereas reading the text either before or after viewing the map leaves them with a difficult integration task if they cannot easily remember the map. In the universities task people with a good verbal STM do not need the assistance of an auditory record, and can read much faster than they listen. So the voice being on impedes performance. Although plausible, this explanation does not account for the observation that in Studies 1 and 2 it was people with higher Verbal STM who were more likely to choose to listen on both tasks.

The findings from these studies suggest possible boundary conditions to the multimedia principles arising from educational research[2] which has often involved students studying for a memory test. In contrast, the present studies were more akin to an open-book reading task where information only had to be consulted rather than memorized. In such tasks both cognitive task demands and available cognitive resources may be critical factors determining the effects of multimedia combinations. In a study of older people using printed leaflets, it was found that older people were impaired by graphics that had no detrimental effects on younger adults[25]. So design advice based on single studies seems unlikely to be useful in relation to multimedia combinations. Instead, what is needed is a task taxonomy in terms of the processing resources required to do specific tasks (it has already been mentioned that memory demands were relatively small in the present study).

It has been reported elsewhere that people who do not find reading easy, and people who are not native speakers of the language of the text on screen, are more likely to select spoken text when following instructions from the screen[26]. Of course a person's familiarity with the information content and other contextual factors will also influence the way a task is done[14]. Such diversity makes it difficult to know how best to provide multimedia information to specific audiences. Fortunately, interfaces that allow people to exercise their preferences for how information is presented offer a solution to this difficulty.

The present studies have focused on the behaviour of consulting online information because this is such a common reason for using the internet. For example, older adults may wish to consult health information online[27]. In the two contexts examined here only a minority of participants (41%) chose audio. When the information found has to be used to carry out a sequence of actions, i.e. when the content is procedural rather than declarative, then the choice of audio has been found to be much higher for a variety of procedural tasks[9]. This further highlights that the cognitive demands associated with consulting information for the task in hand will influence modality choice and performance.

Elsewhere it has been reported that these older participants found the touch-screen computer easy to use and most of them readily agreed to return for a second session if invited[17]. Because these volunteers were a self-selected sample, who therefore can be assumed to have a fairly positive attitude towards computer technology, no claims about the generality of this observation are appropriate. Nevertheless, their interactive experience while taking part in this study, with no keyboard involved, would most likely have been very different from previous experience with using computers at home. The synthetic voice, enhanced by the technical pronunciation fudge explained earlier, was fully adequate and acceptable to older people for information consultation such as this.

Implications

Designing for diversity by letting people select among multimedia options would appear to be a preferable alternative to providing a 'best guess' combination of modalities for the age group concerned. Indeed a strong implication of the present findings is that people, older people in particular, would find it helpful to have easy ways of combining or dispensing with information in specific modalities. This accords with the proposal that an increase is needed in 'polite computing' that respects user choice and offers users relevant, helpful alternatives[28]. It is true that many modern applications (for instance word processors and email) offer users ways of tailoring the interface to their personal liking, but these options may lie buried several layers deep in a menu structure that requires people to distinguish at the outset between an item called 'Preferences' and another called 'Customize'. It would be helpful for older people if some options, in particular modality options, were much more accessible. One example of a website that does this is Europe's Information Society Thematic Portal which includes near the top on every page a loudspeaker icon having the functionality of letting the user 'listen to the page or selected text'[29].

Although time data have been reported in these studies as a reflection of ease of performance, this interpretation is open to debate. Easier does not always mean faster and people may have a preference for opting for a slower but less demanding method to accomplish a task. Even in studies where younger adults collaborated with a computer on tasks such as finding a restaurant or planning a trip, using either speech or written text, it was found that the spoken interactions resulted in longer times to solve the problems but in a more collaborative interaction[30]. That is to say, the modality changed the style in which the task was done. There is evidence from focus groups that older adults tend to base their decisions about using computers more on the benefits they anticipate than on cost factors, which could include time spent on an interaction. One of the privileges of growing older is that there can be time to take the scenic route, to do things in whichever way feels most comfortable, rather than assuming there is a need to use the fastest or most efficient method. This fits well with recent developments within research on human-computer interaction, where there is a growing tendency to look beyond the usability of the interface and to consider more broadly the users' experience[31]. Creating multimedia interfaces that can easily be modified by users themselves to accommodate changing priorities across the lifespan, or across cognitive profiles within peer groups, would seem to be an important means of enhancing universal access.

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References

1. Lauriks S, Reinersmann A, Roest HG van der, Meilard FJM, Davies RJ, Moelaert F, Mulvenna MD, Nugent CD, Droes RM. Review of ICT-based services for identified unmet needs in people with dementia. Ageing Research Reviews 2007;6(3):223-246
2. Mayer RE, Moreno R. Animation as an aid to multimedia learning. Educational Psychology Review 2002;14(1):87-99
3. Wright P, Belt S, John C. Fancy graphics can deter older users: a comparison of two interfaces for exploring healthy lifestyle options. In: O'Neill E, Palanque P, Johnson P, editors, People and Computers 17: Designing for Society. London: Springer; 2003; pp 315-325
4. Dickinson A, Newell AF, Smith MJ, Hill R. Introducing the internet to the over-60s: developing an email system for older novice computer users. Interacting with Computers 2006;17(6):621-642
5. Maylor EA. Age-related changes in memory. In: Johnson ML, editor, The

Cambridge Handbook of Age and Ageing. Cambridge: Cambridge University Press; 2005; pp 200-208
6. Dixon RA, Rust TB, Feltmate SE, See SK. Memory and aging: selected research directions and application issues. Canadian Psychology 2007;48(2):67-76
7. Rouet JF. What was I looking for? The influence of task specificity and prior knowledge on students' search strategies in hypertext. Interacting with Computers 2003;15(3):409-428
8. Zeifle M, Schroeder U, Strenk J, Michel T. How younger and older adults master the usage of hyperlinks in small screen devices. Proceedings ACM Sig CHI 2007; pp 307-316
9. Wright P, Pham DT, Dimov SS, DeRoure DC, Petrie H. Spoken and written language in adaptable multimedia documents. In: End of Award Report to ESRC 2005;reference L328253011
10. Wright P. Hypertext as an interface for learners: some human factors issues. In: Jonassen DH, Mandl H, editors. Designing Hypermedia for Learning. New York: Springer; 1989; pp 169-184
11. Blanchard-Fields F, Hess TM. Perspectives on Cognitive Change in Adulthood and Aging. New York: McGraw-Hill; 1996
12. Wright P. Talking computers and diversity in older audiences. Gerontechnology 2006;4(4):187-189
13. Czaja SJ, Sharit J, Nair S, Rupert M. Understanding sources of user variability in computer-based data entry performance. Behaviour and Information Technology 1998;17(5):282-293
14. Downing RE, Moore JL, Brown SW. The effects and interaction of spatial visualization and domain expertise on information seeking. Computers in Human Behavior 2005;21(2):195-209
15. Umemuro H. Computer attitudes, cognitive abilities, and technology usage among older Japanese adults. Gerontechnology 2004;3(2):64-76
16. Wright P, Belt S, Pham D, Dimov S, DeRoure D. Cognitive support for older people from multimedia options. Gerontechnology 2008;7(2):241
17. Wright P, Belt S, Soroka A, Pham D, Dimov S, DeRoure D, Petrie H. Cognitive support for older people from multimedia options. In: Proceedings of ISG'08 conference, June 2008, Pisa, Italy; Paper 161
18. Norman K. Paper folding test; http://lap.umd.edu/vz2; retrieved August 12, 2008
19. Ekstrom RB, French JW, Harman HH. Manual for Kit of Factor Referenced Cognitive Tests. Princeton: Educational Testing Service; 1976
20. Ekstrom RB, French JW, Harman HH. Cognitive factors: their identification and replication. Multivariate Behavioural Research Monographs 1979;79(2):3-84
21. Freudenthal D. Age differences in the performance of information retrieval tasks. Behaviour and Information Technology 2001;20(1):9-22
22. Freeman E, Clare L, Savitch N, Royan L, Litherland R, Lindsay M. Improving website accessibility for people with early stage dementia: a preliminary investigation. Aging and Mental Health 2005;9(5):442-448
23. Danielson DR. Web navigation and the behavioural effects of constantly visible site maps. Interacting with Computers 2002;14(5):601-618
24. Graff M. Individual differences in hypertext browsing. Behaviour and Information Technology 2005;24(2):93-99
25. Griffin J, Wright P. Older readers can be distracted by embellishing graphics in text. European Journal of Cognitive Psychology, 2008; accepted
26. Soroka AJ, Wright P, Belt S, Pham DT, Dimov SS, DeRoure D, Petrie H. User choices for modalities of instructional information. In: Proceedings 4th International IEEE Conference on Industrial Informatics, INDIN'06, Singapore, August 2006; pp 411-416
27. Czaja SZ, Sharit J, Nair SN, Lee CC. Older adults and the use of e-health information. Gerontechnology 2008;7(2):97
28. Whitworth B. Polite computing. Behaviour and Information Technology 2005;24(5): 353-363
29. http://ec.europa.eu/information_society; retrieved August 12, 2008
30. Le Bigot L, Terrier P, Amiel V, Poulain G, Jamet E, Rouet J-F. Effect of modality on collaboration with a dialogue system. International Journal of Human-Computer Studies 2007;65(12):983-991
31. Melenhorst A-S, Rogers WA, Bouwhuis DG. Older adults' motivated choice for technological innovation: evidence for benefit driven selectivity. Psychology and Aging 2006;21(1):190-195