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WAYFINDING AID FOR THE ELDERLY WITH MEMORY DISTURBANCES

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Abstract

A global increase in aging population, combined with a growing number of people with dementia, creates new challenges to develop guiding technology for people with memory disturbances in their daily activities.

In this study we have tested the prototype of a wayfinding aid using predefined routes. The orientation advice was given through three modalities, visual, audio and tactile signals, two of which were used at a time.

Nine subjects, aged 59–90 years (with a median age of 84 years) participated in the user study at a rehabilitation unit in Pyhäjärvi, Finland. Their severity of dementia ranged between mild and severe, and walking abilities ranged from “frail to hobby skier”. In addition, two elderly persons were recruited as control subjects.

In most cases, the orientation with the wayfinding aid on predefined routes succeeded, with a few misinterpretations. The most common difficulties included: straying from the defined route, finding the right door, and the attractions of real-life context like other people. The severity of dementia didn't seem to predict success in orientation with the wayfinding aid. Using the landmarks wasn't as successful as using “left”, “right” and “go straight on” commands as the wayfinding advice.

Keywords: Wayfinding, Assistive technology, Elderly, Memory disturbances

1 Introduction

Population is aging globally, with the percentage of those aged 60 and over expected to double between 2009 and 2050. Also, the older population itself is aging. Currently, the eldest group (persons aged 80 years or over) constitute 14% of the population aged 60 or over, and constitute one of the fastest growing segments of the population. It is expected that by 2050, 20% of the eldest population will be aged 80 or over. (OECD 2007; United Nations 2009) Over twenty-four million people have dementia today, and that number is expected to double every 20 years to 81.1 million by the year 2040 (Ferri et al. 2005).

Memory loss with disorientation is often the first symptom of dementia, and can be a frustrating and frightening experience (Brawley 1997). Getting lost is also a safety risk. In a five year longitudinal study by McShane et al. (1998), 40% of the subjects who were suffering dementia and lived at home with a caregiver got lost outside their home. The number could have been higher if their poor physical or cognitive ability didn't immobilize them or if they haven't been prevented from exiting by locking the doors.

The aging of the population, along with increasing numbers of people with memory disturbances, creates challenges to develop and design guiding technology that assist persons in their daily activities. New technologies should be suitable for domestic use since, according to our previous study, the elderly are willing to carry on their existing lifestyle (Sorri and Leinonen 2008). Another reason for developing assistive technology for domestic use is the weakened opportunity to get help from family members, because the proportion of the elderly living alone is increasing. In addition, the children of the elderly are also ageing. (United Nations 2009) Also, moves to unfamiliar environments such as nursing homes are associated with negative performance in orientation (Sheehan et al. 2006), along with the considerable costs of institutional care for both society and the patients and their families.

Successful independent living involves more than just the ability to carry out daily activities in the home. The ability to stay mobile, to get out and use local facilities and outdoor environment, to maintain social connectivity and enhance quality of life also contribute to successful independent living (Goodman et al. 2005; Sorri and Leinonen 2008). Wayfinding aids could also serve the purpose supporting the safety of the elderly, their long-term and temporary memory, and control of own life, which have been identified as other respected values of novel technologies (Sorri and Leinonen 2008).

The aim of this study was to raise these challenges by developing technology which would help the elderly with memory disturbances in wayfinding. The paper first presents the theoretical background, as well as the related research and motivation for this study. We continue by describing the research methods and practical implementation of the research. Finally, we introduce and analyze our findings and conclude with discussion and proposals for future research.

2 Related Research

2.1 Human-computer interaction and the elderly

The literature available on ageing and technology use is extensive and includes many studies conducted on computer use and training for the elderly (Bradley and Dunlop 2005; Czaja 1996). However, very little research has focused on what makes an interface usable for the elderly (Hawthorn 2000; Bradley and Dunlop 2005). Zajicek (2001; 2004) has investigated the burden and influence of traditional user interfaces among the elderly. Literature reviews done by Hawthorn (2000) and

Zaphiris et al. (2005) have suggested that the physical and cognitive burden on the elderly should be taken into account when designing a user interface for the elderly. However, there is still lack of the research that includes subjects from the most elderly age group and those with memory disturbances.

Developing a wayfinding system raises many human-computer interaction (HCI) research issues with multi-modal interfaces, for example small displays and adaptive user interfaces. The characteristics of the small display devices and the cognitive, sensory, and motor skill characteristics of the elderly imply that traditional user interfaces relying on icons and textual labels are inappropriate for the elderly to use for effective communication. Oviatt and Cohen (2000), and Beeharee and Steed (2006), argue that there is also a need to develop novel interaction interfaces based on audio and speech modalities. Oviatt (2000) recommends that an adaptive user interface be designed; in other words, an interface that changes over time to better support repeated tasks and particular behavioral characteristics of the individual user. Jorge (2001) considers that another important HCI research challenge is how to provide context sensitive assistance to help mobile but cognitively impaired users. There are few studies focused on user performance of multimodal feedback with the oldest old and the elderly with memory disturbances. For example, Burke et al. (2006) performed a meta-analysis of 43 different studies, and none of the studies included research subjects from these pathological populations. In addition, Goodman (2005) notes that current navigation device designs do not usually consider the needs of the elderly. Mobile devices often have small displays and complicated menu structures. Goodman also notes, it is important that navigation systems for the elderly place minimal cognitive demands on the user to avoid causing distraction and confusion.

2.2 Wayfinding with dementia

People with dementia tend to fail in planned wayfinding. According to Passini et al. (1998) one reason for this is that Alzheimer patients have problems creating an overall plan for wayfinding. They have far better performance in simple wayfinding sub-plans like reaching an entrance. Monacelli et al. (2003) and Brawley (1997) note that spatial disorientation is frequently observed with individuals aged 70 and over who show no other sign of mental deterioration. McShane et al. (1998) argue that wandering away from home is a common symptom of memory disturbances, and may be a reason for institutionalization. For elderly people with dementia it is common that they cannot position themselves accurately (Brawley 1997), and they have difficulties in finding and retracing their steps to return back home (McShane 1998; Passini et al. 1998). Unfamiliar environments have been found to be especially challenging to the elderly with memory disturbances (Kulyukin et al. 2008; Brawley 1997).

A study by Liu et al. (1991) argues that memory and visuospatial deficits influence the wayfinding problems for elderly people with memory disturbances, which may pose frustration among the elderly (Brawley 1997). According to Sheehan et al. (2006), designs of outdoor environments that encourage safe navigation for elderly people with memory disturbances may have direct benefits on quality of life, and indirect benefits in terms of reduced institutionalization.

Brawley (1997) and Passini et al. (1998; 2000) both state that elderly individuals with memory disturbances are able to understand signs. The signs should be kept simple, because numbers are easily forgotten and colour codes or abbreviations or pictograms don't work. (Passini et al. 1998; Passini et al. 2000). Passini et al. (1998; 2000) also say that Alzheimer patients' difficulties with understanding signage originates from problems in distinguishing relevant information from irrelevant, and making nonsense links between closely situated messages. Landmarks are particularly useful in wayfinding for the elderly (Goodman et al. 2004; 2005). Findings from the study by Sheehan et al. (2006) reveals that subjects with dementia and the control subjects were able to identify close and distant landmarks equally,

and the demented used them consciously in wayfinding. Distinctive landmarks are useful in wayfinding even in subjects with moderate dementia (Brawley 1997).

2.3 Previous studies of wayfinding aids

There have already been some efforts in developing technological solutions to help the elderly and people with various functional impairments in wayfinding. For example, Strothotte et al. (1995) developed the MoBIC travel aid to increase the independent mobility of blind and elderly travellers by providing useful information for the user. The MoBIC consists of two interrelated components: the MoBIC Pre-Journey System to assist users in planning journeys, and the MoBIC Outdoor System to execute these plans by providing users with orientation and navigation assistance during journeys. Helal et al. (2001) designed a wireless pedestrian navigation system for blind individuals. This system integrates several technologies including wearable computers, voice recognition and synthesis, wireless networks, Geographic Information System and Global Positioning System. The system augments contextual information to the visually impaired and computes optimized routes based on user preferences, temporal constraints (e.g. traffic congestion), and dynamic obstacles (e.g. ongoing construction work). Environmental conditions and landmark information queried from a spatial database along the user's route are provided instantaneously through detailed explanatory voice cues. The system also provides capability for the user to add intelligence, as perceived by the blind user, to the central server hosting the spatial database.

Goodman et al. (2004) describe the design of a pedestrian navigation aid for a handheld computer, which guides the user along a route using photographs of landmarks, together with audio and text instructions that reference these landmarks. This aid was designed with older users in mind who often find their mobility hampered by declines in sensory, cognitive and motor abilities. Also, Veldkamp et al. (2008) have created a pedestrian navigation system for the elderly with beginning dementia. The system consists of a palmtop computer (PDA) that sends audio information via Bluetooth. Chang et al. (2007) have presented a wayfinding prototype system with deviation recovery for individuals with cognitive impairments. This system is based on geo-coded tags, PDAs and a tracking system. The PDA displays the photographic just-in-time directions and instructions to the user on a web browser.

Heuten et al. (2008) have developed a non-visual support called the Tactile Wayfinder that utilizes the sense of touch by guiding a mobile user en route with the help of a tactile display. It was proven that their normal subjects were able to perceive stimulation changes quickly and accurately, and could feel where they occurred. A spatial tactile display worn as a belt conveys the necessary information non-visually, non-intrusively, and hands-free.

iWalker is a multi-sensor, walker-mounted wayfinding system for the elderly with cognitive and visual impairments designed by Kulyukin et al. (2008). It is designed to operate in a physical space equipped with embedded sensors. The sensor suite of the iWalker device consists of an encoder, a digital compass, two radio-frequency (RFID) readers, and two RFID antennas attached to the rear wheels. All the sensors communicate with a laptop mounted on the walkers's seat.

3 Research Methods and Implementation

3.1 Methods and study setting

The aim of this research was to develop a prototype of a technological solution to help the elderly with memory disturbances with wayfinding. The focus of this study is on wayfinding, and preventing wandering away from home is out of scope for this study. The target user group of the appliance is the

elderly still living at home. To develop the system to suit the individuals with possibly declined cognitive abilities, a decision was made to test the system with subjects who already have memory disturbances.

This user study serves as a basis and proof-of-concept for the next phases of our research. In this first phase of the research the objective was to test and evaluate a prototype for wayfinding, and gain valuable experiences and input for future research. User-centred methods were used to understand the needs, expectations and usability requirements of the target group (Abrams et al. 2004; Beharee 2006). The user-centred design teams benefited from an extensive literature review, previous study (Sorri and Leinonen 2008), and brainstorming sessions with the multidisciplinary research team, which included experts from the areas of information systems, architecture, geriatrics and medical technology. For evaluating the developed technological wayfinding aid “Wizard of Oz” method was used, in which technology being refined is simulated to appear as a coherent entity for the user (Veldkamp et al. 2008). In the early phase of the design process subjects were carrying out selected tasks of wayfinding in real-life contexts. Abowd et al. (2002) pointed out that controlled studies in usability laboratories cannot lead to deep, empirical evaluation results. What is needed is real use in an authentic setting. Problems were expected with information acquisition from the subjects, as there are only some previous experiences of data gathering with the oldest old (Schwartz et al. 1998; Suzman et al. 1992). Also, memory disturbances may present their own challenges. The subjects tend to forget recent events and questions presented in the interview, and they may also have abstract thinking and verbal ability impairments (Edwards 1993).

The wayfinding advising technology was tested on predefined routes. The routes were built in common areas of the Karpalokoti dementia rehabilitation unit and its’ near surroundings in Pyhäjärvi, Finland. In order to create the study setting to resemble the wayfinding obstacles the subjects are likely to face in their daily lives, wayfinding tests were performed both indoors and outdoors and in the same environment in which regular activities were happening in the rehabilitation unit and surrounding areas. To test if the subjects were following the navigational aids provided by the system, some parts of the routes were designed to purposely increase the chance of leaving the correct track. For example, the architecture did not always support the guided track, and there attractions were incorporated such as other people or pleasant views. The test consisted of three different indoor routes with stopping points between each one instead of having one long route; the purpose of this was to provide the subjects an optional resting spot between individual routes in consideration of the age and other functional impairments of the subjects. Activities were organized in intermediate stopping points that were planned to provide us more information on subjects’ eye-hand coordination, discernment ability and readiness to participate in this study.

3.2 Wayfinding aid and tested components of orientation

Wayfinding advice was given through three modalities, namely visual, audio and tactile signals, of which two were used at time. The wayfinding aids described in section 2.3 incorporated only one modality except the aid designed by Goodman et al. (2004), which utilized two different modalities. Nevertheless, there was no comparison of modalities. According to Burke et al. (2006) an additional modality to visual feedback improves overall performance, since an additional modality captures user’s attention more quickly than visual alone and thereby improves performance scores and reduces reaction times with little to no impact on error rates. According to Lemmelä et al. (2008) the aural, visual, physical and cognitive loads of walking in a public place are equal, therefore without testing a different set of modalities, prediction of which modality would be the most successful and optimal one is impossible. The combinations of modalities in this study were chosen according to the Reeves et al. (2004) and Obrenovic et al. (2007) recommendation of taking into account subject’s preferences and

their capacity of senses. In order to ensure better understanding among the research subjects, the wayfinding advice was kept as intelligible as possible.

Presbyopia is the normal worsening of vision with age, especially near-sighted vision, and it affects everyone (Mordi and Ciuffreda 1998). In addition, extreme sensitivity to glare, reduced contrast sensitivity and restricted color recognition are age-related. Ability to comprehend written text starts to decline with moderate dementia, but single words can still be effective in orientation (Brawley 1997). In addition to different degrees of vision impairment, approximately two thirds of people 75 years and over have at least mild hearing impairment. Typical features of presbycusis are declined capacity to separate high frequencies, recruitment (silent sounds are inaudible, intense sounds soar), and word recognition is low compared to hearing decline (Sorri and Huttunen 2003). In addition, reduced sensitivity to touch is found to be age-associated (Brawley, 1997).

Previous studies also lack sufficient testing and evaluation on what type of wayfinding cue in a given modality (e.g. text vs. photograph vs. arrow on visual signal) are the most appropriate and effective for the elderly with memory disturbances. Thus, in addition to investigating the most optimal combination of modalities, this study also focused on exploring the usability of different types of wayfinding cues.

The visual signal used in this wayfinding system included text with a picture. This study used both the text and the picture since they support the meaning of each other. The pictures used were direction arrows on top of a blank background or on top of a photograph taken from the subject's current position (see Fig. 1). Photographs of landmarks were also utilized. The color of a direction arrow was yellow, since that color is most easily identified by the elderly and Alzheimer patients (Wijk et al. 2002). To assure good contrast, the text consisted of black block letters on a white background. Maps are the traditionally used to display geographical data, but were not used in this study due to the increasing complexity and because some people with memory disturbances have severe difficulties in understanding maps. Additionally, in a study by Goodman et al. (2004), the subjects preferred pictures of landmarks to map view.


<p>Visual signal:</p> 	<p>Audio signal:</p> <p>Käännä vasemmalle (in English: Turn left)</p>
	<p>Tactile signal:</p> <p>Left wristband vibrates</p>

Figure 1. Wayfinding advice in three modalities.

The audio signal used was a natural voice to prevent anxiety in the subjects, since synthesized speech is highly intelligible but rarely natural (Howard et al. 2009). Smither (1992; 1993) discovered poorer performance in older adults with remembering and understanding computer generated speech, and attributed this to short-term memory demands. A low female voice was used in the implementation because the subjects were presumed to have declined capacity to separate high frequencies (Sorri and Huttunen 2003). The advice given by audio signal was simple and very similar to the correspondent visual signal (see Fig. 1).

The tactile signal used was vibrating wristbands, the purpose of which was to support turning left and right (see Fig. 1).

The tested components of orientating included: starting out on the routes, keeping on the correct track, recognizing landmarks, being guided back to the correct track, and recognizing the destination.

3.3 Study equipment and data collection

The transmitting visual signal a walker-mounted 10.1 inch screen with internet connection was used. Audio signal was transmitted via mobile phone and Bluetooth wireless headset which covered one ear only to allow the subject to hear the sounds of surroundings and to be able to communicate with other people. Tactile signal was transmitted via vibrating wristbands that communicated through shortwave radio. There was a recall button mounted to the walker for use if the subject wanted the advice repeated. For locating the subjects, walker-mounted cameras, surveillance cameras at the rehabilitation unit, and shortwave radio were used.

The test events data was collected by videotaping, audio recording, recording the walker-mounted cameras, participatory observation and taking notes, and interviewing the subjects. For data analysis the videotapes, audio recordings, and researchers' notes were transcribed, and time stamps were added for every single event occurring during the wayfinding routes. The data analysis was done in collaboration with a multidisciplinary research team.

4 Research Subjects

The study was conducted during 2009-2010 at the Karpalokoti dementia rehabilitation unit in Pyhäjärvi, Finland. Three, two-day test events were conducted; the first one in December 2009, the second in January 2010 and the third in June 2010. Nine subjects, consisting of five females and four males between the ages of 59 and 90 (median age of 84 years) participated in this study (see Table 1). Some subjects participated in more than one test event, and the total number of test rounds was seventeen, comprising of twelve indoor test rounds and five outdoor test rounds. The severity of dementia of the subjects was between mild and severe, Mini-Mental State Examination (MMSE) scores (Folstein et al. 1975) were between 3 and 23 (average 12) and walking condition ranged "from frail to hobby skier". The frail subjects participated only in indoor wayfinding test rounds. There was no remarkable difference in MMSE scores of the subjects participating in indoor or outdoor routes. The subjects were customers or permanent residents of the dementia rehabilitation unit. The subjects in this study were significantly older and their MMSE scores lower than in studies mentioned in section 2.3. The controls were two males, aged 72 and 82 years, who lived in a senior house nearby. The subjects and/or their relatives had given their informed consent for the study participation.

5 User Study Findings

In analyzing the data researchers' on-site observations and notes were heavily relied on. Interviewing did not prove to be a successful method for acquisition of information from the subjects as the subjects had more severe memory disturbances than in previously discussed studies. During the wayfinding test events the subjects occasionally times got help from the nurses without asking, even though nurses were requested to abstain from helping the subject along wayfinding routes in any way. Aforementioned aid appeared as very discreet, i.e. at some decision points a nurse might have secretly steered the subject in the correct direction. Therefore, performance of some subjects was possibly enhanced due to this outside help.

The majority of the subjects succeeded in wayfinding with a few misinterpretations. The subjects performed surprisingly well in turning left and right at points where there were no strong outside attractions. Indoors, two out of twelve subjects continued straight on instead of turning, but no subjects turned in wrong direction. The subjects made 0-4 errors per an indoor route and 0-6 errors on the outdoor route, and the controls performed the route without any mistakes (see Table 1). Subject's severity of dementia or gender didn't seem to be a predicting factor for success in orientation with the wayfinding aid. The subject's physical condition and spryness during the test event seemed to be a bigger predicting factor for performing better. As was expected based on previous studies, the most common difficulties were straying from the predefined route (Sheehan et al. 2006), finding the right door among the similar ones on a double-faced corridor (Brawley 1997), and real-life attractions like other people or pleasant view. Straying from the defined route occurred at intersections of separate spaces. The strayed subjects were guided back to the defined route with wayfinding prompts. Another discovery was that guiding subjects back to the correct route could be further reinforced by addressing the subject using his or her name together with the corrective orientation advice. Finding the correct door on the route turned out to be the most complicated task, even though they were marked with 20*20 cm red and green rectangles and used them as additional cues, i.e. as artificial landmarks. Another reason for signage being unsuccessful was some subjects paid attention only one side of the corridor.

Subject	Gender	MMSE	Modalities	Indoor 1	Indoor 2	Indoor 3	Outdoor route
1a	F	15	Audio + tactile	1	4	2	-
2a	F	23	Audio + tactile	1	3	0	-
3a	M	13	Audio + tactile	0	2	1	-
4a	M	16	Audio + tactile	0	0	0	-
5a	F	16	Audio + tactile	0	0	1	-
4b	M	13	Visual + tactile	0	2	0	-
2b	F	23	Visual + tactile	1	1	1	-
6a	M	3	Visual + audio	0	1	1	-
1b	F	15	Visual + tactile	0	0	1	-
7	F	11	Visual + audio	0	0	1	-
5b	F	16	Visual + tactile	0	-	-	-
1c	F	15	Visual + audio	-	-	-	2
2c	F	23	Visual + audio	-	-	-	5
3b	M	13	Visual + audio	-	-	-	6
6b	M	3	Audio + tactile	-	-	-	0
8	M	7	Audio + tactile	-	-	-	1 (short)
9	M	Control	Visual + audio	-	-	-	0
10	M	Control	Visual + tactile	-	-	-	0
11	F	10	Visual + audio	2	2	1	-

Table 1. The number of wayfinding errors. Letters a, b and c indicate separate test events. Dashes indicate no participation. The subjects are listed in chronological order of the test events.

The actual poor performance data of two subjects (5b and 11) is inaccurate in reporting the number of errors. Subject 5b was in weak physical and cognitive condition during the test event. She completed only the first indoor leg with extreme hesitation and lots of outside help preventing her from making wayfinding errors. Further, subject 5a's performance was far better in previous month's test event, which can be explained by the fact that performance of the pathological subjects can vary from day to day (Edwards 1993). The poor performance of the subject 11 can be explained by severe perceptual impairment. She needed substantial outside help in order to prevent her from injury. She was walking against the walls and she didn't recognize the edges of the paper when she was painting. When using

technology the impairment appeared as denial of touching the screen (she didn't recognize the edges of the screen) and experienced difficulties understanding visual wayfinding advice.

In general, using the landmarks didn't turn out to be as successful as "turn left/right" and "go straight on" as wayfinding advice. The landmarks were mostly tested outdoors since there were no distinct landmarks to utilize indoors. In indoor setup the previously mentioned bright colored rectangles on the doors were used as artificial landmarks. However, some subjects used pre-existing written signs on the doors instead of the rectangles, even though some rooms were named quite abstractly and the text size of the signs was quite small. Most likely, the subjects were used to using the existing signage rather than the new ones. Outdoors the landmarks were more natural and distinctive, like the first intermediate stopping point which was a table with violets and flowerpots. The table was well recognized. The other two landmarks, which were on first two test rounds (1c, 2c), were not so successful. They were a blooming apple tree and a green shed. The subjects didn't recognize an apple tree and they called the tree "rowan". The shed most likely didn't have strong enough contrast to the early summer green background. We changed the apple tree to an orange chair located under the tree and installed a red post-box on the wall of the shed. These two new landmarks proved to be more successful, and more easily recognized.

All used advice and wayfinding equipment proved to be usable. None of the pieces of the equipment caused false sense perceptions, such as the vibrating wristbands being mistaken tics. A majority of the subjects who were given visual advice followed them. The text was especially important to them and they were reading it aloud. The text cues and direction arrows were found to be complementing each other's meaning. The photographs behind the direction arrows didn't seem to bring much additional value, since the simple arrows on a blank background worked equally well. However, the photographs were useful in presenting the distinctive landmarks, and thus contributed to the success in wayfinding tasks. Audio signal was also well comprehended. Only one subject required an audio signal change from the phonetic form to a synonym to ensure better understanding. Comprehension of tactile signal was bit unclear, since the tactile signal was only used for turning points, and interviews didn't elicit additional information about subjects' subjective perceptions of tactile signals since, as stated before, interviews proved to be quite unsuccessful for use with the target group. Still, one subject was able to communicate that tactile signals indeed helped her to better distinguish between left and right. An accident that occurred during one test route gave us valuable information on the importance of constancy of the modalities. After the headset moved away from the ear and the subject stopped receiving the audio advice, her performance declined remarkably. The recall button mounted to the walker proved to be useless for the subjects. They didn't use it independently, but the use of recall button was prompted by external help (nurse or researcher). We assume that the subjects forgot or didn't internalize its purpose.

True performance in starting out on the routes and recognition of the destination point were hard to evaluate because of the study setting. At the starting point there were several researchers preparing the subject for the route, and the subjects also knew they were participating in a test event. Similarly, at the destination point there were already researchers waiting for the subject's arrival.

The correct timing of the wayfinding advice was found to be crucial but difficult because of the varying walking speed of the subjects. If the advice appeared too early the subjects could forget them or, alternatively, they complied with the advice literally and as a result in worst cases, turned against the wall. Confirming subjects were on the correct track turned out to be beneficial for longer legs of the routes. Confirmation is also recommended by Brawley (1997), even though she refers to static

advising. The need for confirmation appeared strongly with subjects who often sought help or support for their decisions from the nurses or researchers.

In cases of misinterpretation the subjects got “stuck” in repeating actions like revolving. The “sticking” is a common symptom of dementia (Brawley 1997). With some subjects the orientation as an ongoing task weakened during the test event. In this study, external distractions such as vehicles or, nurses passing by didn’t cause any errors in wayfinding. In some cases external distractions even interrupted sticking and/or restored the orientation to the ongoing task.

6 Conclusions

The impact of the severity of dementia on performance in wayfinding is hard to evaluate because of the limited number of the subjects, and because only one subject had mild dementia and the others at least moderate. In addition, in some cases the external help from nurses affected the subjects’ performance. Nevertheless, we believe that the study findings serve as a proof of concept that the elderly with memory disturbances can benefit from wayfinding advising technology. In order to support the optimal and enjoyable multimodal interaction for wayfinding for the elderly, we have gained valuable insights into the most intuitive and effective combinations of the modalities for orientation advice, as well as an understanding of which features in indoor and outdoor environments are most effectively and reliably used in wayfinding by elderly people.

Our findings indicate that subject’s physical condition and spryness during wayfinding tasks appear to better predict succeeding in orientation with the wayfinding aid than the severity of dementia. The most common difficulties turned out to be the straying from the defined route, finding the right door, and the attractions of real-life context. Quite surprisingly, using landmarks didn’t prove to be as beneficial as “turn left/right” and “go straight on” as guiding advice. Precise and correct timing of giving advice was found to be crucial for subject’s performance, and the need for confirmation of being on the correct track appeared strongly with our subjects.

Wayfinding advising technology has the potential to provide important support for the elderly by motivating and empowering them to perform their daily activities, thus leading to more independent living. Solitary and isolation problems of the elderly can also be reduced, and quality of life as well as safety during daily activities can be improved. Furthermore, maintenance of the independence of the elderly contributes to reduced institutionalization.

In next phases of the research, exploration of different circumstances in real-world scenarios should be used to evaluate to what extent and complexity wayfinding aids can be used to aid the elderly in living independently and effectively. In addition, future research should focus on detecting undesired circumstances such as getting lost and sticking in repeating actions, while at the same time the explore options for allowing normal activities like stopping and browsing in a shop.

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