Auditory Navigation for Persons with Mild Dementia

Supportive outdoor navigation for persons with mild dementia in the European COGKNOW project

Johannes de Boer

Student MSc Communication Studies, University of Twente

Committee

1st supervisor	Thea van der Geest	*Faculty of behavioral sciences, University of Twente*
2nd supervisor	Lisette van Gemert	*Faculty of behavioral sciences, University of Twente*
External supervisor	Marike Hettinga	*Telematica Instituut*

University of Twente
Enschede - The Netherlands

Telematica Instituut

Colophon

Date : 10 November 2008
Version : 1.0
Change :
Project reference: COGKNOW
TI reference : TI/RS/2008/036
Company reference :
URL :
Access permissions : Public
Status :
Editor : Johannes de Boer
Company : Telematica Instituut & University of Twente
Author(s) : Johannes de Boer

Synopsis:
This exploratory study compares the effect of two kinds of auditory navigation for persons with mild dementia. We compare the differences in using familiar and unfamiliar voices, and in using earcons (a specific type of warning sounds). A literature study and experiment were conducted to create guidelines for outdoor navigation for persons with dementia.

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Used abbreviations

Abbreviation	Explanation
CCA	COGKNOW Cognitive Assistant (Application on mobile device)
Assistant	COGKNOW Cognitive Assistant (Application on mobile device)
CDN	COGKNOW Day Navigator (All COGKNOW applications combined)
CHH	COGKNOW Home Hub (Application on stationary device)
F Condition	Familiar voice only condition
FE Condition	Familiar voice with warning sound condition
GUI	Graphical User Interface
Device	The mobile device
PDA	Personal Digital Assistant (The mobile device)
PwD	Person with Dementia
PwDs	Persons with Dementia
PWS	Preferred Walking Speed
UI	User Interface
U Condition	Unfamiliar voice only condition
UE Condition	Unfamiliar voice with warning sound condition

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1 Introduction

The last few decades the demographics of developed countries have changed and are showing a growing number of elderly people. The growth of this part of the population results in a growing need for support of elderly people in their daily life. About 2% of the elderly population suffers from mild dementia. In Europe, around 1.9 million people suffer from dementia. In the Netherlands alone there are almost 300.000 persons suffering from dementia. (Alzheimer Nederland, 2007)

For these people it is hard to be in charge of their own life. The COGKNOW project focuses on a solution that assists these people in keeping performing their daily life activities.

1.1 The COGKNOW project

The goal of the COGKNOW project is to achieve a breakthrough in the development of a successful user-validated cognitive prosthetic device with associated services for people with mild dementia (Castellot, 2006), meaning that the project tries to find digital solutions to assist persons with mild dementia (PwDs) to navigate through and stay in charge of their days.

The COGKNOW Consortium consists of 11 participating companies, universities and research institutes from across Europe. The Information Society Technologies (IST) program of the European Union funds the project. This program is one of seven major thematic priorities of the European Union's Sixth Framework Programme (FP6) for Research and Development.

The idea behind COGKNOW is that the growing number of people with (light) dementia in the European Union need a way to fulfil their needs in four areas: remembering and reminding, communicating and interacting, daytime activities, and safety (Castellot, 2006). These four areas of needs are the foundation for the functionalities of the COGKNOW system.

In remembering and reminding, the system focuses on helping the PwD to remember, for example, the location of items and performed activities. The function also reminds PwDs to undertake certain actions, for example preparing food or going to appointments. With communicating and interacting, the system assists the PwD to keep in touch with others via telephone or in real life. Supporting daytime activities gives PwDs the opportunity to undertake activities that they normally will not do on their own. Finally, the safety function of the systems enhances the feelings of safety of the PwD in and outside of their homes. Examples of this service is supporting to make dinner or finding their way home.

The project takes into account human, technology and business factors. This ensures that scientific knowledge about human characteristics, technology potential and market relevance will be applied.

Three field trials are included in the COGKNOW project in which a prototype of the system will be tested. Field trial 1 was conducted in June and July 2007. Field trial 2 took place in the summer of 2008, and field trial 3 will take February-May 2009. In order to achieve the goals of the COGKNOW-project a list of functional requirements has been developed.

As discussed earlier in this section two of the main areas for the COGKNOW project are to enhance feelings of safety and to perform daily life activities. An option for supporting PwDs in these areas is the use of a supportive navigation system.

1.2 Motivation for research

In late June and the beginning of July 2007, field trial 1 was conducted in Amsterdam, Belfast, and Lulea (Sweden). Preliminary conclusions (Holthe & Andersson, 2007, Bengtsson & Sävenstedt, 2007) showed a lack of engagement with the developed mobile device of the project, the COGKNOW Cognitive Assistant (CCA) by the participants. The evaluation report of field trial 1 describes that interviews and observations indicated that user friendliness, usefulness and accessibility of the devices was questioned by many of the participants. Percentages or numbers are not given in the report. However, most participants say that the size and screen size of the device is appropriate, but they find it difficult to use, and there are too many options on the screens.

When evaluating the outcome of the first field trial, participants in the project mentioned the lack of outdoor support. An overview with state-of-the-art devices for PwDs was created (Davies, 2007), but no system for outdoor support the home was mentioned. A navigation system on the CCA had to be developed. Due to the mental and physical limitations of PwDs, much thought had to be given to the interaction design of the system.

When looking at the documentation of the COGKNOW project it appeared that limited thought had been given to how PwDs handle the CCA. In addition, no research questions had been determined in how people will use and evaluate a navigation system on the CCA. Until now, most research on navigation systems has been into how the visual component had to be developed. However, because of the mental and physical limitations of PwDs we decided to focus this exploratory study on developing guidelines for the audio component of the navigation system for people with mild dementia using the COGKNOW Cognitive Assistant (CCA).

1.3 Outline

This report will first address the literature study, followed by the focus of the study and an overview of the research questions in chapter 2. In chapter 3 the design of the study is explained, followed by the context setting in chapter 4 and the results in chapter 5. In chapters 6 and 7, we address the conclusion and discussion of this exploratory study.

2 Literature & focus

This chapter includes the most important subjects from the literature. In section 2.1, we discuss the influence of mild dementia on daily life. Section 2.2 addresses the modalities of a mobile device. Section 2.3 addresses user studies with people with mild dementia. Last, section 2.4 draws a preliminary conclusion on basis of the findings in the literature and addresses the research questions of this exploratory study.

2.1 Influence of mild dementia on daily life

Persons with (mild) dementia often show a decline of skills in various areas. Basis of most of these problems is loss of recent memories. There are more signs that will show a (advanced) stadium of dementia. For example: difficulties in performing daily tasks, problems with language, time and place disorientation, problems with abstract thinking, misplacing things, and loss of initiative. (Alzheimer's Disease International, 2007)

The most common early symptom of dementia is loss of short-term and recent long-term memory. This kind of memory loss differs from ordinary forgetfulness in that persons with dementia (PwDs) cannot remember other facts associated with the thing they have forgotten. The Alzheimer’s Disease International website gives an example of this kind of problem: “a person with ordinary forgetfulness may briefly forget their next-door neighbour’s name but they still know the person they are talking to is their next-door neighbour. A PwD will not only forget their neighbour’s name but also the context.”

Besides memory problems, PwDs often find it hard to do everyday tasks. These tasks can be very basic like making a cup of tea and turning on the radio. In addition, PwDs have difficulties in finding simple words because they forget them. Writing and speaking can get very hard for them.

PwDs often have problems with place and time. They can forget which day of the week it is, whether it is day or night, where they are, and how to get home. Regularly a PwD will even get lost in familiar places like a nearby shopping mall, park or street.

Not all these signs will occur with every PwD. Every person is unique and dementia affects people differently, One’s health, social situation, and personality will make that no two people have symptoms that develop in exactly the same way.

As discussed in chapter 1, the COGKNOW-project aims to assist PwDs at four areas (remembering, maintaining social contact, performing daily life activities, and enhancing feelings of safety.) This study focuses on navigation for PwDs, which we categorize in the last area.

2.1.1 Influence of dementia on ability to navigate

As mentioned in the previous section, the orientation in place and time is often disrupted when people suffer from dementia (Alzheimer's Disease International, 2007). This means that people are less able to find their way to an appointment or to their home. In this case, we can speak about navigation skills: the skills a person needs to find his way to a specific location. These skills are fundamental to community access, personal independence, and community integration (Fickas, Yao, Sohlberg & Hung, 2007).

Because of the limitations in their navigation skills, PwDs will feel less secure in going out on their own, and are more dependent of their caregiver. Using a mobile system can reduce this dependency. Carmien (2005) studied the effects of using a handheld prompting system for persons with cognitive disabilities and caregivers. In this study, Carmien let young adults with cognitive disabilities use a handheld prompter. These young adults were diagnosed as “trainable Mentally Handicapped” (IQ 55-72). On this handheld, the young adults were provided with a photograph-based task divided in a number of steps. Examples of tasks are doing groceries, washing dishes, or folding laundry. During every step of these tasks, a photograph was shown, and an audio message could be heard. The caregivers scripted the steps of the task; they also made the photographs and audio messages. Carmien let the young adults carry out the tasks, and found that they were very well able to handle the device, do groceries and find their way home.

Although Carmien used trainable Mentally Handicapped in his study, the results are still usable for our study. The system used by Carmien did not really require participants learn skills, only the ability to recognize photographs and operate a simple mobile device.

An interesting conclusion from this study is that after the caregivers scripted the tasks, they do not have to be present during the execution of the task. Nolan, Mathews & Harrison (2001) found similar findings in a study on external memory aids to increase room finding by PwDs. They used photographs of participants to enhance room finding in a nursing home. All participants suffered from Alzheimer’s disease, and often had problems finding their rooms. In the study, participants were shown a photograph of themselves as young adults combined with a sign stating their name on the door to their room. Normally, a nurse had to walk residents to their room very often (across the participants the general room-finding rate was 34%). During the intervention, the average room-finding rate increased to 85%. Thus, there was over a 50 percent mean increase in participants’ ability to find their room following the intervention. This meant a substantial decrease of effort required from the nurses to bring residents to their rooms.

2.1.2 Influence of dementia on using mobile devices

As we look to navigation solutions aimed at the commercial market, we often see mobile navigation devices. These navigation systems (like TOMTOM, Navigon or Garmin) will not suffice for our target group. These navigation systems contain too many functions, and use an aerial map interface. Because PwDs often have difficulties using maps, these kinds of systems are not suitable. Studies from Carmien (2005), Fickas et al. (2007), and Van der Berg, Burgman, Hilbers, Kamerman & te Lintum (2008) however used a mobile solution to navigate and carry out tasks. These systems are adapted to people with cognitive impairments, as they do not use maps or text but arrows, spoken messages and landmarks.

Various studies have been conducted to develop a mobile navigation system for people with mild dementia. However, some problems often come up when using such a system.

First, PwDs often suffer from a decrease in eyesight. This is common among elderly people and should be taken into account when designing a system. Secondly, PwDs often lack fine motor skills and therefore have higher risk in dropping items. Thirdly, PwDs have problems with their memory and are less able to learn new devices. Therefore, some limitations should be taken into account when developing a mobile device system; this will be discussed in the next section.

While contributing to the development of a navigation system for PwDs we not only want to know which type of system is beneficial for them, but also what it means for the capability to use such a system.

As described in section 2.1.1 PwDs often have disrupted (navigational) skills. However, these skills are essential for community access, personal independence, and community integration (Fickas, Yao, Sohlberg & Hung, 2007). Since traditional navigation systems on PDA's and mobile devices contain dozens of functions, they are often too complex in use for PwDs. Therefore, a traditional navigation device (like TomTom, Navigon or Garmin) will not be a sufficient supportive tool for these people.

Hence, important for this study is to determine what type of navigation system is easy and understandable for PwDs. In order to determine this, a measuring tool is needed. Often used and validated over the years, in experimental research is the measured load on working memory of participants in a study. Measuring the load on working memory of participants in a study give an insight in how difficult or how hard participants experienced the experimental tasks. Therefore, we think it is important to measure this during our study.

2.2 Modalities of mobile devices

As we look to mobile devices available, there are two modalities that are widely available on these devices: a screen and a speaker. Although there are vibration (a third modality) units built into PDAs with mobile phone functionality, they are often not building into other mobile devices. Therefore, we only focused on the first two modalities in literature. The following two sections describe what is known about these modalities.

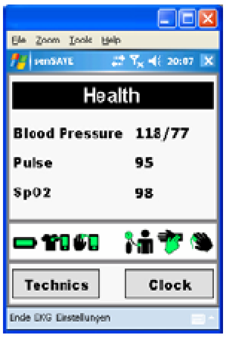
2.2.1 Visual interfaces

In the field of visible interface research, a lot of progress has been booked in recent years. However, interfaces special for PwDs are not that common. The problem is that with complex interfaces used in most commercially available systems, PwDs will strand in the system.

PwDs often forget what they are doing, while they are still doing it. For example, they pick up the remote control from the coffee table, but already forgot what they wanted to see. This problem brings limitations towards a visual interface. PwDs will not remember what they saw five minutes or three screens ago. Lorenz, Mielke, Oppermann & Zahl (2007) describe six different user interfaces with specific navigation structures in their study to develop a mobile health-monitoring device for elderly. Their goal was to find out if a certain kind of interface was better usable for PwDs. Examples from all six user interfaces can be found in Figure 1.

For elderly persons and persons with low visual abilities only three interfaces were tested. Most interface elements on the other interfaces were too small or the complexity was too high.

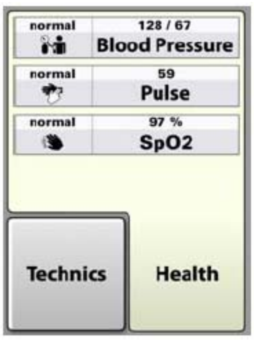
The first interface (named basic interface) used a simple navigation with two tabs. The functions were divided across two windows. The second interface (advanced interface) used graphical symbols and animations, had almost no text, and ran inside a normal MS Windows mobile application window. This interface is more complex than the basic interface. The third interface (basic plus) was based on the basic interface, but included additional display features for health and technical indicators. In this way, users did not see all indicators (blood pressure, pulse, blood oxygen saturation level/Sp02) in one screen, but divided over several screens.



The advanced user interface

The basic interface

The sequential interface



The basic interface plus

The professional menu interface

The professional icon interface

Figure 1: Lorenz' GUIs for a mobile health-monitoring device for elderly

All interfaces used a consistent screen layout on all screens. This means that every screen looked and worked the same way. This consistent use of interfaces is advised in many studies and handbooks like Vanderheiden (1994) and Carmichael (1999). A consistent structure in every screen makes the software easier to understand and operate for the user. The so-called advanced interface and basic interfaces appeared to be the favourites among test-subjects with acceptable usability.

The three interfaces that were not tested by elderly persons and persons with low visual abilities (the sequential interface, the professional menu interface, and the professional icon interface) contained more text and smaller icons and items. The professional interfaces were integrated in the MS Windows mobile menu structure; the sequential interface let users navigate through all menu options by pushing the left or right buttons on screen.

Remarkable in the conclusions of this study are the bad results for the sequential interface. Recently the use of sequential interfaces (interfaces that offer the user the possibility the slide easily between the different functionalities) on stationary and mobile devices and in software has gained much popularity. This can be seen in the iPod and iPhone from Apple inc., TouchFLO 3D from HTC, Windows Vista from Microsoft, and many other products. The sequential interface from Lorenz et al. however was not well understood by most elderly respondents. In addition, also the professional interfaces did not score well.

Many mobile devices nowadays make use of touch-screen interfaces. Medical specialists are often of the opinion that this is not a workable solution for PwDs who often lack the skills to operate mobile devices. Alm, Dye, Gowans, Campbell, Astell & Ellis (2003) however discovered that touch-screen interfaces can be used in a good way for PwDs. The direct sense of manipulating the screen seems to offer enough affordance. With a little encouragement and assistance, they often work very well. An important consideration however, is the use of large button and texts, because elderly often have trembling hands.

2.2.2 Auditory interfaces

Besides the visual interfaces, we saw that an auditory interface can also be beneficial for users. Brewster (2002) stated that by adding sounds to buttons on a touch-screen, the usability of these buttons increases, and smaller buttons could be used in an interface. Decreasing the size of buttons however increases the workload required to operate it, and therefore should be used with caution for PwDs. However, Brewster also stated that the use of audio can decrease the workload for elderly people while operating a mobile device. Although not studied, we expect that the same should be true for PwDs. Most PwDs have reached a considerable age and lack extended experience with digital interfaces.

Earlier research has shown that the use of sounds can help persons communicate more effective with interfaces (Brewster, Wright & Edwards, 1993). Sounds can be used to present information otherwise unavailable on a visual display. It is a useful complement to visual output because it can increase the amount of information communicated to the user or reduce the amount of information the user has to receive via the visual interface.

When looking at the possibilities for the use of sounds (other then voice) in a navigation system, we hade to conclude that not many studies were performed on this. Therefore, we looked further into the use of sounds as a certain type of guidance in daily life. Systems that use a sound followed by a voice message are the public information systems of national railway companies and airports. In this context, a specific melody is used as a warning for the message to come. These warning sounds however are not found in currently existing navigation systems.

In order to use audio warnings in a navigation system we have to determine which type of sound is suitable in such a system. Looking again to the railway stations and airports we see that mostly short and easily recognizable audio warnings are used. A comparable type of sound (short, structured, recognizable) was studied by Brewster, Wright & Edwards (1993). They studied the use of earcons. An earcon is a brief, structured sound pattern used to represent a specific item or event. Brewster et al. discovered that compared to unstructured bursts of sound, earcons are a far more effective means of communication.

In their study, they conducted an experiment to find out if earcons were an effective means of communicating information in sound. They used three groups of twelve subjects; half of the subjects in each group were musically trained (they could read and recognize notes, rhythms, and timbres). Subjects were shown a screen with 10 icons; each icon was attached to a sound.

In the next phase subjects were shown a menu, where every button was also attached to a sound. In the third phase, they had to match the original icon with the original sound. The subject gained points by matching the right sound to the right icon. In the last phase, the subjects heard two sounds, and were asked to give information about the sound they heard.

Results from the study show that musical timbres in earcons are more effective than simple tones. Also high levels of recognition can be achieved by using the pitch, rhythm and timbre in a careful way. Between earcons used in a system there should be large differences between lengths, register (octaves), rhythm, and intensity. Only with large differences, users will notice an earcon. Blattner, Sumikawa and Greenberg who already in 1989 found that sounds are more recognizable when using distinctive rhythm, pitch, length and timbre also mention these results.

In another, more recent study Fickas, Yao, Sohlberg & Hung (2007) tried to determine which kind of navigational prompting-system would be of best benefit to persons with cognitive impairments. Participants walked a pre-defined route with a wrist-mounted mobile device. The Latin Square method was used to counter-balance the different prompts modes with the four different routes. Participants were 20 individuals with various types of acquired brain injury, with age ranging from 24 to 67 years. An observer was present to record the responses of participants during the experiment. Each route contained the same number of navigation choices (crossings, roundabouts, etc.) Fickas et al. compared four modes of prompting in their studies: First, an aerial map with navigation arrow; secondly a point of view map with navigational arrow; third step-by-step visual instruction; and fourth a step-by-step auditory only instructions.

The results showed that the highest navigation score was obtained when using the audio prompts. Participants reported that using audio prompts was more helpful (60%), easier than the aerial map and point of view map. Using a point-of-view image however was still considered usable by many participants: 20% of the participants found it the most helpful prompt mode. This means that a successful navigation system for people with cognitive impairments should probably include auditory navigation, but should not exclude visual instructions.

Ficas et al. found that the use of speech-based prompts in navigation guidance in addition to a visual-only interface is clearly superior to image-based prompts, and more effective than text-based prompts.

In addition Bornträger, Cheverst, Davies, Dix, Friday & Seitz (2003) discovered some interesting results while letting people walk in a city with a context-aware city guide. The study compared four different visual interfaces: An audio only interface, map interface, an interface using text, and an interface using pictures. Participants could change the interface to their preference during their walk in the city. The system measured how long, and during what circumstances, which screen was shown. One of the findings was that people often choose for the picture-interfaces while the audio message was being played, the maps view was preferred when no audio message was played. In addition, people often stopped walking when the system played an audio message.

Another study by Nakamura, Kawashima, Sugiura, Kato, Nakamura, Hatano, et al. (2001) showed that people are far more capable of recognizing familiar voices than unfamiliar voices. Nine male volunteers between 20 and 34 years old participated. Random Japanese people and people familiar to the participants spoke Japanese sentences. The duration of each sentence was about 2.0 seconds and each sentence was repeated one time directly after its first presentation. During the experiment participants had to push a specific button (left or right) while hearing a familiar voice saying a sentence for the second time. About one-fourth of the spoken sentences were from familiar voices. Eighty-four percent of the responses were correct, and the mean percentage of the true-positive responses was 66% (50-100%).

After the test, users were asked to identify the familiar voices. In the interview, each subject correctly answered all of the names of the speakers.

More recently, Winkler & Cowan (2005) made an overview of studies that target audio and voice recognition by humans. Studies from the last 20 years in psychology were discussed on the subject of what types of acoustic information can be retained in long-term memory. The results suggest that the brain stores features of sounds and those are registered, saved and later on recognized by people. When a matching sound is heard, people tend to react automatically to these sounds.

When we combine the result of the last two studies, we expect that the use of familiar voice in a navigation system should contribute to the effectiveness of such a system. However we have to keep in mind that that, because no similar studies have been conducted, there is no direct theoretical evidence for such an effect.

2.3 User studies with people with mild dementia

As shown by the cited work of Fickas et al. (2007), audio prompts work very well for persons with cognitive impairments, and are far more effective than maps. Other research by Goodman, Brewster & Gray (2005) showed that using landmarks within navigation devices can be particularly useful for older people, and that speech, photographs and texts are very effective ways of presenting landmark information. Although landmarks are available in the real world, they are rarely available in electronic navigation devices. The main reason for the absence of these aids is the difficulty in producing them. Maps and geographical information are widely available. However, pictures and photos of landmarks combined with geographical information are not.

Various studies however encourage the use of landmarks. Research from Goodman, Brewster & Gray (2005), May, Ross, Bayer & Tarkiainen (2003), and Fickas, Yao, Sohlberg & Hung (2007) are in favour of using landmarks. In addition, a recently completed explorative study within the COGKNOW project by Van der Berg, Burgman, Hilbers, Kamerman & te Lintum (2008) asked PwDs and caregivers about their preferences on using arrows, maps or landmarks in a navigation system for PwDs. Especially PwDs themselves remarked how easy it was to follow instructions that consisted of photographs with landmarks. They found navigating with landmarks easy because no words or sentences had to be remembered.

In the study of Van der Berg, et al. (2008), that was comparable in its design to the study of Fickas et al. (2007), participants walked a pre-determined route while receiving spoken instructions via their earphones and watching a mock-up navigation system consisting of PowerPoint slides on the PDA. Great concern in this study however was the distraction the participants showed while using the device. The environment became less important to the participants while they used the system, and they were especially distracted when multiple instructions followed each other in a rapid order.

Concluding we can state that although using landmarks is the most desirable of navigating for people with mild dementia, using sound is the most feasible one. While developing a navigation system for PwDs, their cognitive impairments need to be kept in mind during the whole process.

2.4 Focus

As seen in the previous sections, various research areas can contribute to the design of a successful auditory navigation system for PwDs. Although several studies advertise the possibility of using an audio-only solution, this is not advisable for a navigation system for PwDs because they often experience hearing loss. Therefore, in this exploratory study a combination with visual guidance was used. However, we were unsure on how such a system could be of most benefit to persons with mild dementia. The research question of this study was therefore:

> *“Which type of auditory guidance is most beneficial to persons with mild dementia using a navigation system?”*

According to Nakamura, Kawashima, Sugiura, et al. (2001) it is advisable to use familiar voices in systems, however he did not test this with PwDs or in combination with a navigation system. Because PwDs often have a caregiver at home, it could be expected that they know and recognize this persons’ voice easily. In order to determine if the use of familiar voices work beneficiary for PwDs, we answered the following sub question:

> *RQI: What is the effect of the use of familiar voice on the quality of way finding in a navigation system for PwDs?*

In addition, there also is a gap in the knowledge about warning sounds. Warning sounds (in our case earcons) are used as a navigation solution, and are also used during experiments with persons with cognitive impairments. However, no combined research has been done into the use of voices and earcons. We expect that these forms of auditory guidance contribute to each other. Therefore, we tried to answer the following sub question:

> *RQII: What is the effect of the use of structured audio warnings (earcons) on the quality of way finding in a navigation system for PwDs?*

Besides answering the questions on the effect of using different types of audio in navigation systems, the cognitive part is very important by PwDs. Because of the cognitive disabilities of PwDs mentioned earlier in this chapter, we need to make sure that a system is used that is as easy and as low on cognition as possible. In order to get a clear understanding of this we will try to answer the following sub question:

> *RQIII: Which type of auditory guidance in navigations systems contribute to a lower cognitive workload for PwDs?*

In order to develop a system that is not only usable for users but also appreciated by users, we need to know if they prefer a certain type of auditory guidance. Unfortunately, elderly people often lack experience in the use of computers, mobile phones and similar systems. Mostly because they did not have to work with them during their working live, but also because they often do not like them. Important to get a clear view of their preferences and to see if they actually like the system we want to develop, we need to look at their satisfaction level. The satisfaction of someone who used the system for a while gives a good impression in how likely it is that they will use a system in the future. A preference for a certain type of auditory navigation will most likely lead to better acceptation of that type of systems. Therefore the last sub question was:

> *RQIV: Which type of auditory guidance in navigation systems do PwDs prefer?*

3 Research design

The main focus of this chapter is the design of the study. In our exploratory study, four PwDs walked a predefined route with four different types of auditory navigation. During and after the walk they were asked questions on experienced cognitive load and user satisfaction. The study was carried out in the southern district of Enschede (The Netherlands).

First of all, we describe the results of pre-study interviews with two experts in section 3.1. In the following sections we describe the research design. First the criteria for selecting participants is discussed in section 3.2, the use of the MMSE questionnaire is explained in section 3.3, the procedure in section 3.4, an explanation of the prototype can be found in section 3.5, the used voices in section 3.6 and the measures in section 3.7. Finally, in section 3.8 an overview of the analysis is given. The measures section is divided in three sections, corresponding with the research questions.

3.1 Preliminary expert interviews

To form our research design for the study, pre-study expert interviews were conducted with two experts in this type of research. Experts were selected on experience in relevant research areas (dementia, mobile devices). One of the experts had experience in developing a PDA-based system for young people with cognitive impairments. The other had experience in conducting research for people with mild dementia. The design of this study and the results of the expert interviews can be found in Appendix A. The results were translated into guidelines that contributed to the design of our study. The guidelines are divided into two different categories. First of all the experts gave information on how to design an experiment with PwDs (Table 1), secondly they gave information on how to develop a navigation system for PwDs (Table 2)

#	Experiment guideline description
1	Provide participants with a information-sheet conducting all necessary information of the experiment (where, when, contact person)
2	Take into account the way how to approach participants, helping them to understand what their task is and what the study is about
3	Ask permission to make photographs and to participate in the study
4	Time the experiment, do not make it too long for the participants
5	Do not assist the participant too fast in completing a task, letting them fail will give much richer information
6	Verify that participant understands a task by asking specific questions about it
7	Ask the caregiver for specific personal problems he expects for the participant
8	Make the caregiver feel secure about the situation of the participant
9	Make audio recordings of participant and experiment leader during the experiments, to speed up analysis of data

Table 1: Results from expert interviews; Design of the experiment

#	System guideline description
1	Make the system as easy as possible. Understandable, recognizable, and small amount of information are the keywords for success
2	PwDs can not process too much information simultaneously, especially not when given through multiple modalities at once
3	Limit the number of options and menus as much as possible
4	Make the system foolproof, do not let other applications on the device disturb the experiment
5	Make sure audio messages are clear, comprehensible and short
6	Language used in audio messages should be clear, not in commando-style, but also not too informal
7	Do not use too many verbs in audio messages
8	Timing of audio messages should be pre-tested

Table 2: Results from expert interviews; Design of assistive navigation systems

Although some of these guidelines seem very clear and logical, it unfortunately happens too often that researchers do not benefit from the experiences of others. For this study the guidelines laid out in these results have been used to select participants, develop the model and execute the experiment.

3.2 Participants

Participants were selected according to the inclusion criteria mentioned in Table 3. These criteria have been defined because the expected target group for the auditory navigation system has the same characteristics. In the COGKNOW project the same inclusion criteria are used, (except criteria 3 and 6, which address the special focus for this study). In order to determine if the participant did not suffer too severely from dementia, we asked the participants to complete the Mini Mental State Examination (MMSE) from Folstein, Folstein & McHugh (1975) and Molloy, Alemayehu & Roberts (1991). More information on the MMSE can be found in the next section.

#	Criteria description
1	Participants had to live independently in their own homes or residence
2	Participants had to suffer from mild dementia, and have a score between 17 and 25 points on the MMSE Questionnaire
3	Participants had to be able to walk at least 1 kilometer without help
4	Participants and their caregivers had to sign the informed consent
5	Participants had to understand what was expected of them during the experiment
6	Caregivers had to be available to record their voice
7	Participants had to have reached the age of at least fifty-five years

Table 3: Inclusion criteria for participation

When participants indeed matched the inclusion criteria and scored successfully on the MMSE Questionnaire, they were asked to participate and an appointment was made. Also an informed consent (Appendix G) form was filled in by the participant in which they agreed with the use of photo and video equipment during the study.

The participants participated in the study between April 1st 2008 until April 17th 2008. Four elderly women with mild dementia participated in the experiment. Three of these participants used a walker to move, one of the participants walked independently. The age varied from 75 until 85, and they all had an MMSE score between 20 and 24 points, that is within our predefined range.

Finding the right participants for the experiments took approximately three weeks; during this period, the researcher approached 12 persons to participate. Seeking out these persons was done in cooperation with the healthcare unit manager of a home for the elderly in Enschede, The Netherlands. All possible participants were visited in their homes by the researcher. Due to the physical limitations described earlier in this section, six persons were not found suitable to participate; their abilities to walk or to walk outdoors independently were too limited. The other two persons that did not participate had no interest in participating due to their antipathy to the use of modern technology or because of forecasted weather conditions.

The participants that did participate were all very enthusiastic to work with young researchers and to see if this new technology was a possible solution for problems they could anticipate in the future.

Although the number of participants was not very large, we expected it to be sufficient for the study. The study was carried out as an explorative and qualitative study, not a quantitative one.

3.3 Assessing mental status of participants

As announced in the previous section we used the MMSE Questionnaire (Folstein, Folstein & McHugh, 1975, Molloy, Alemayehu & Roberts, 1991) in order to select participants. The MMSE is a tool that can be used to systematically assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. In the exam a maximum of 30 points can be scored. A score of 23 or lower is indicative of cognitive impairment.

A great advantage is that the exam only takes 5-10 minutes to administer and is therefore practical to use. Since the development in 1975, the MMSE has been used in clinical practice and research. In the COGKNOW-project participants are selected based on their MMSE score. The MMSE Questionnaire is included in Appendix H.

The MMSE Questionnaire was used to select participants. PwDs that were interested to participate in the study were visited for an orientation interview.

Participants that scored between 17 and 25 points were considered as having mild dementia, and could participate in the study. The use of this range was based on the inclusion criteria in other COGKNOW workshops and field trials.

The MMSE was conducted in the home of possible participants after they received some general information about the study. When participants fell into the light dementia range, they were asked to participate voluntarily in the study.

3.4 Procedure

Before the actual experiment started, the researcher went to the caregivers home in order to record the sound files with the caregivers’ voice. With these sound files the adapted TomTom voice for the caregiver could be developed. For more details see section 3.6.

Shortly before the start of the experiments the researcher went to the participants' home in order to prepare them for the walk. There was a last chance to ask questions, and an audio-recorder was placed on the upper arm over the sleeve of the participant's coat.

The walk was divided into four routes that were connected to each other. Every route maintained the same number of decision points (points on the route where a direction has to be chosen), and the same difficulties in decision points. In the experiment participants were asked to walk 4 routes, divided over two days. In order to eliminate order effects every type of auditory cue was randomly assigned to a route for every participant and participants walked the routes on two separate days.

Participants walked two routes with a familiar voice, and two with an unfamiliar voice. Divided over these routes the participants received warning sounds both in the familiar and unfamiliar voice condition. Table 4 gives an overview of the experimental design

	Voice only	Voice + Warning sounds
Unfamiliar voice	U (CONTROL)	UE
Familiar voice	F	FE

Table 4: experimental conditions

During the experiments the researcher reported the performance of each participant with an observation form. Each deviation, question or error was registered, and the location was registered on a map of the neighborhood. The observation form can be found in Appendix E, an example of the used map in Figure 2. The written out observation forms and maps are included in Appendix F. Explanations of all used variables are given in Table 6 and sections 3.7.1, 3.7.2 and 3.7.3.

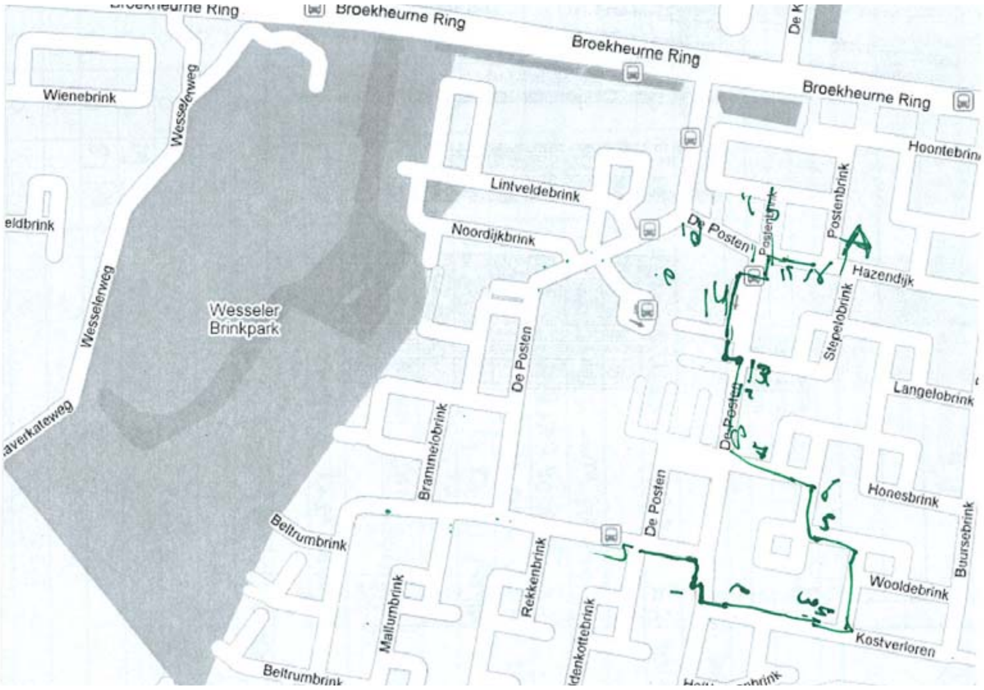


Figure 2: Used map-noting sheet

The participants were randomly assigned to a certain order of routes and conditions. The experiment always started with route A or C, and concluded with routes B or D. An overview of the used routes can be found in Figure 3. Table 5 gives an overview of the distances in each route.

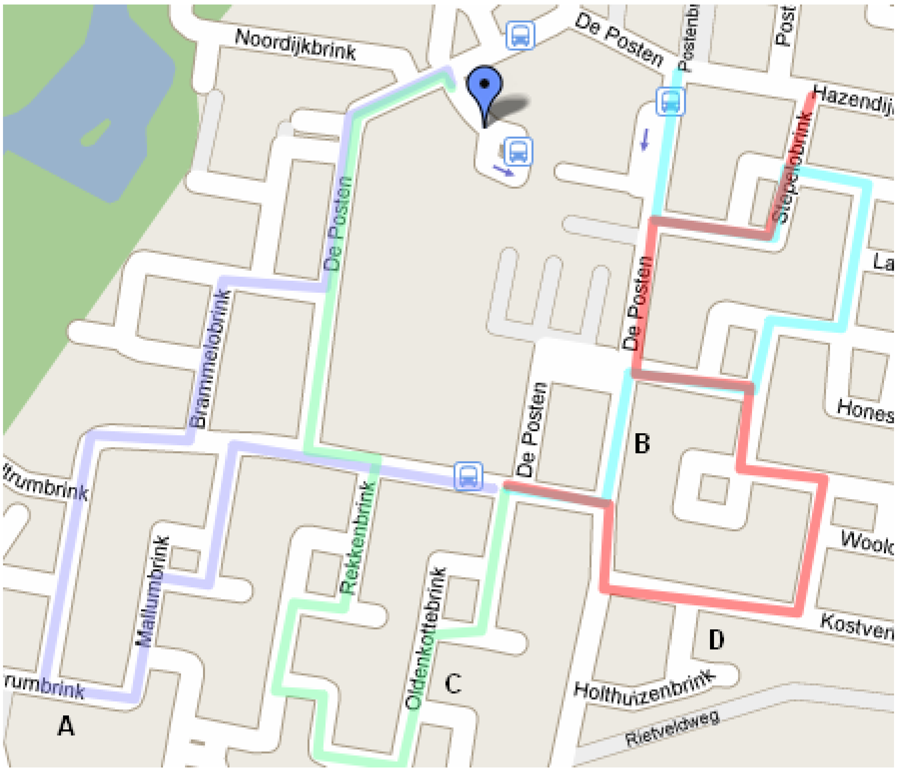


Figure 3: Walking routes of the experiment

	Distance	
A	1,16	km
B	0,79	km
C	0,97	km
D	0,89	km
Total	3,81	km

Table 5: Distances of the four walking routes

During each route the participant had to answer the questions of the TLX Questionnaire (see section 3.7.2). The time taken to complete this questionnaire was noted and subtracted from the total walking time. After each route the participant had to answer the questions of the satisfaction questionnaire (see section 3.7.3).

During the experiments a research assistant was present to videotape the experiments and guard the safety of the participants. This assistant did not interfere during the experiment, and did not talk to the participants beforehand on what he was about to do during the experiment.

After the last route was finished the participants were brought back to their home and thanked for their participation. They received a gift for their participation.

3.5 Prototype & Hardware

In order to maintain technical feasibility in the COGKNOW project, a currently existing windows mobile-based navigation system was required for navigation. The project already possessed a number of PDA's from HTC, type P3300. These devices were used for the experiment. After discussing several software possibilities within the project-team, the TomTom 6 SDK engine was chosen as the most desirable system for use during the field trials and pre studies. The reason for this choice was that the TomTom 6 SDK had sufficient functionalities to conduct the study. In addition, developing a system with comparable functions would take severely more time to develop. In addition, in the COGKNOW project the same SDK was used to develop a comparable system that would be used during the field trials.

The adapted version of TomTom that we used had no menus, and all functions and status bars were removed from the screen, except the remaining distance to the next decision point. Users could only navigate the pre-programmed route in the system.

The TomTom interface uses three different types of visual navigation: 2D aerial-map navigation, 3D map navigation, and arrow navigation. According to the findings in the literature, the use of maps is very difficult for people with cognitive impairments. Therefore, we only used the arrow navigation. Examples of the screens participants saw can be found in Figure 4.

Figure 4: Examples of the adapted TomTom application and device

Participants could choose between hanging the device around their neck with a cord, or just hold it in their hands. To hide all the hardware buttons a metallic case was put around the PDA.

3.6 Voices

As mentioned earlier, the participants walked two routes with the help of the familiar voice of their caregiver. Participants were not informed about this beforehand, although they knew that their caregiver was contacted for an interview.

With every caregiver 43 words were recorded for use during the experiment. A list of these words can be found in Appendix D. This preparation-session was conducted approximately one week before the participant participated in the experiment.

During the session the volume of the recorded voice was checked to make sure it was usable for the experiment. After the session the recorded voices were implemented in the TomTom software.

3.7 Measures

During and after the experiments several types of data have been gathered. The data gathered can be divided in the three themes introduced in chapter 2: effectiveness, load on working memory, and user preference. An overview of these measures can be found in Table 6 and will be explained in the following three sub-sections. A more visual impression is displayed in Figure 5.

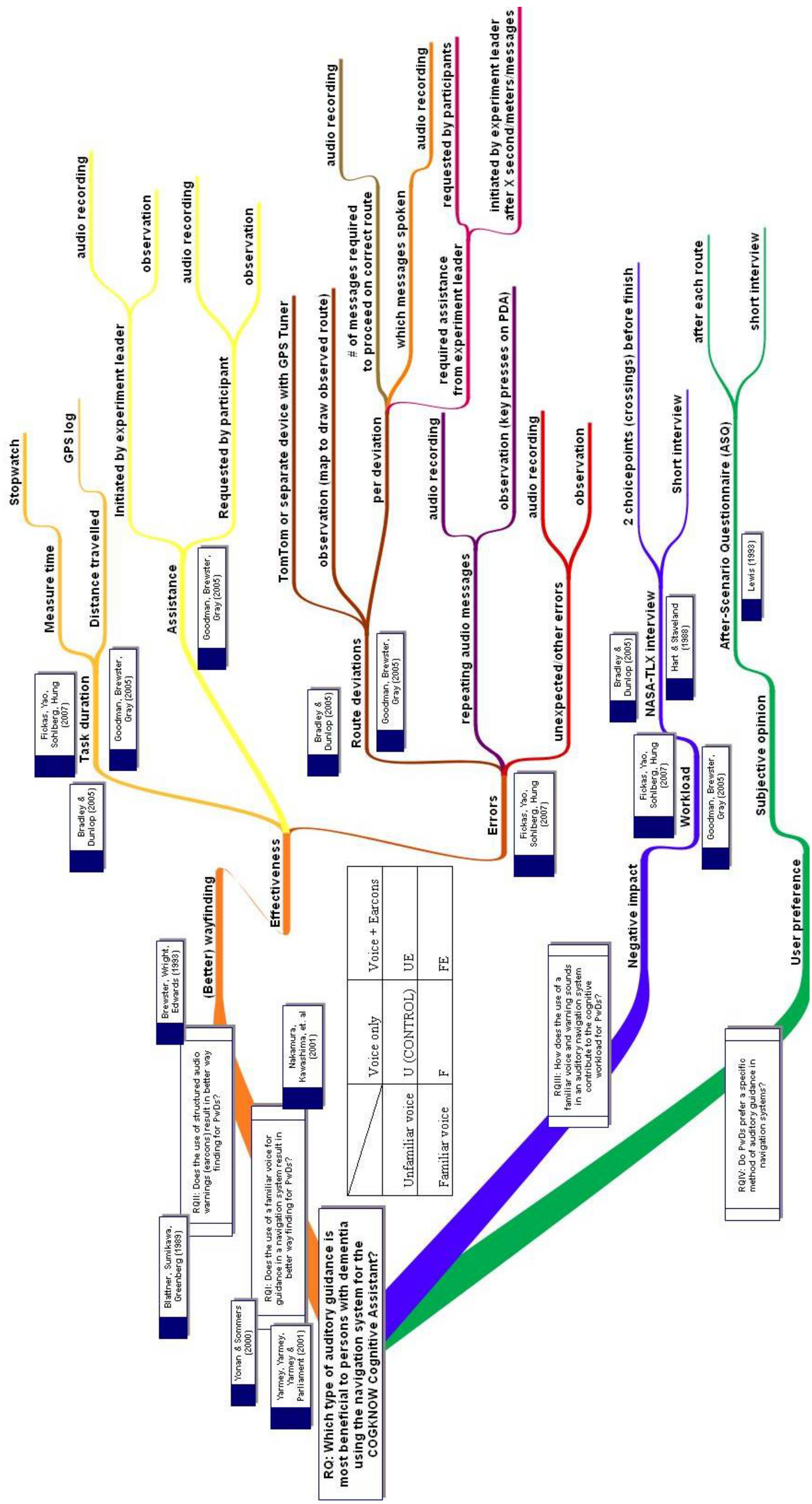


Figure 5: Visual overview of the study

Variable	RQ	Measure		Method	Units	Explanation	Reference
Effectiveness	RQI RQII	Task duration	Time taken	Stopwatch	Minutes, seconds	Time to complete route can be used to compare different conditions on certain route, and average speed of route, condition and participant	Fickas, Yao, Sohlberg, Hung (2007) / Bradley & Dunlop (2005) / Goodman, Brewster, Gray (2005)
			Task completion	Observation	yes / no	Stating if the participant did complete the task.	
			PWS	Stopwatch, distance measuring	minutes	Preferred walking speed of participant when not operating the device.	
			Distance traveled	GPS-log	meters	Distance walked during a route to compare between conditions and participants	
		Errors	Route deviations	Observation, Map, GPS-log, Audio recording	number of deviations	Deviation from pre-defined route gives information on hearable audio message and attention of participant	Goodman, Brewster, Gray (2005) / Fickas, Yao, Sohlberg, Hung (2007)
			Repeating audio messages	Observation, Audio recording	numbers of times a message is repeated	Registering audio messages can be used to determine if a audio message is being repeated at certain points or after certain messages	
			Other errors	Observation, Audio recording			
		Assistance	Initiation by experiment leader	Observation, Audio recording	number of times a researcher intervenes	Assistance during the experiment initiated by the experiment leader can be necessary when something goes wrong technically of with the participant	Goodman, Brewster, Gray (2005)
			Request by participant	Observation, Audio recording	number of times a participant asks foor help	There is a possibility that the participant forgets what he is doing or has a question and approaches the researcher	
Load on working memory	RQIII	Cognitive load		NASA-TLX	TLX-score	Ask questions via short interview shortly before end of each route	Fickas, Yao, Sohlberg, Hung (2007) / Bradley & Dunlop (2005) / Hart & Staveland (1988) / Goodman, Brewster, Gray (2005)
User preference	RQIV	Satisfaction		Satisfaction questionnaire	Satisfaction score	Ask questions via short interview after each walked route	

Table 6: Measures field experiment

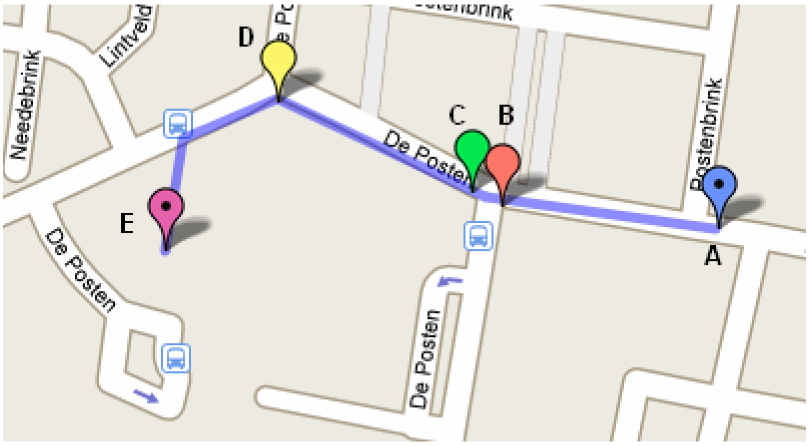
3.7.1 Effectiveness

On the device we installed GPS logging software (Franson GpsGate 2.6), in order to log the exact location where the participants walked. With this software we also had the ability to check the recorded time, as it logged the exact GPS-position every 5 seconds with a time stamp. This data was used to check the registered task duration and errors by the researcher.

- *Task duration*

Task duration (the time needed to complete a task) is one of the most common usability measures (Fickas et al., 2007, Stone, Jarrett, Woodroffe & Minocha, 2005). It is often used to indicate performance with a device or interface. During the study, the time was measured by the experiment leader with a stopwatch. The total duration of each route was registered. The time needed to complete the route was compared between routes and conditions.

Shortly after the experiment, the preferred walking speed (PWS) was measured for all participants. The total distance of this control route was 250 meters (Figure 6). Participants were not specifically informed that their walking speed would be measured during the walk back home. This because telling them could influence their walking speed.



The distance from 'A' to 'E' is 250 meters. A road crossing was required between 'B' and 'C'. For the comparison of the walking speed the distance and time between 'C' and 'E' was used.

Figure 6: PWS walking route

- *Errors*

The number of errors is often used in usability tests and interaction design to indicate performance in using a device or interface (Preece, Rogers & Sharp, 2005, Cooper, Reimann & Cronin, 2007). When causes of errors are registered, they can help to identify aspects of a design that are causing difficulties.

The term ‘error’ and the way errors are measured vary widely depending on the study it was used in. In this study, we define an error as ‘an event during the experiment that prevents the participant from successfully completing the experiment’. The following errors were registered: walking the wrong way, repeating an audio message.

With taking the wrong way, we mean that a participant deviated from the pre-defined route for more than 30 seconds or more than 50 meters. Within this margin, the participant should have been alerted by the system that he went the wrong way. This distance and timeframe was pre-tested beforehand by the researcher in the neighbourhood in which the study was conducted.

With repeating an audio message, we mean that participants pushed the repeat-button on the navigation device. Pushing this button could mean that participants did not hear or understand the whole message the first time it was presented.

All errors were registered and described on the observation form. The type of error was registered and also the amount time the error took and location of the error. After the experiment, the errors were analyzed and categorized. Audio recordings and GPS logs were used to make sure all errors were registered.

- *Assistance*

Besides errors during the experiment, participants sometimes asked a question to the experiment leader, or the experiment leader had to intervene during the experiment. When the participant approached the experiment leader with a question, or the experiment leader had to intervene with the experiment this was registered.

From all assistance occurrences the time, type, and location were registered with the observation form and neighborhood map.

3.7.2 Load on working memory

As described in section 3.4 the impact was measured by load on working memory. For the load on working memory, the NASA Task Load Index (TLX) was used. The NASA-TLX is a multi-dimensional scale designed to obtain workload estimates from one or more users when they are performing a task or immediately afterwards. NASA-TLX has been used during design and evaluation studies of visual and/or auditory interfaces, vocal and/or manual input devices, automation and decision aids, and caution, advisory and warning systems in the past 20 years (Hart & Staveland, 1988, Hart, 2006).

With TLX the experience participants had during a certain task can be measured. Factors that influence the experience of workload for the participants may come from the task itself, their feelings about their own performance, the amount of effort participants put in it or the stress and frustration a participant felt. The six factors assessed in NASA TLX can be found in Table 7.

Title	Endpoints	Descriptions
MENTAL DEMAND	Low/High	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	Low/High	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	Low/High	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
EFFORT	Low/High	How hard did you have to work (mentally and physically) to accomplish your level of performance?
PERFORMANCE	Good/Poor	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
FRUSTRATION LEVEL	Low/High	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Table 7: NASA-TLX factors

In this study we conducted the TLX as an oral questionnaire instead of a written questionnaire. This was done because PwDs often have trouble reading and filling out forms. The six factors all use a twenty point scale (five factors from Low (-10) to High (+10), one scale from good (+10) to poor (-10)) in order to determine the experience. A twenty point scale however is hard to fill in during a verbal interview, and hard to interpret for PwDs. Experience from earlier verbal questionnaires in the COGKNOW project (Dröes & Meiland, 2008) show that often a five point scale is much easier to answer for PwDs, because there are five pre-described answers possible instead of twenty numbers. Therefore the factors were rescaled to a 5 point scale as can be seen in Figure 7. Participants could answer each question from very low (1) to very high (5).

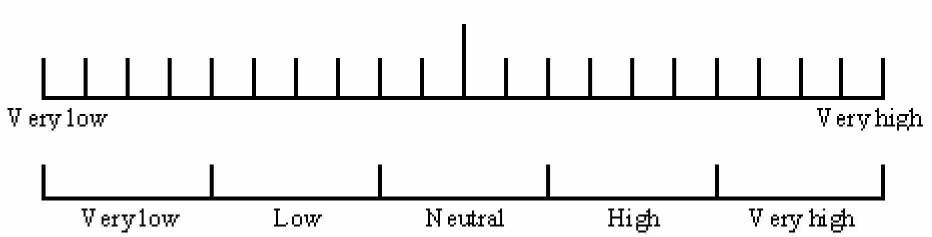


Figure 7: Old and new TLX-scales

All participants had the Dutch nationality; therefore a Dutch version of the TLX-questionnaire had to be used. However, no Dutch version was available, and therefore we translated the questionnaire. The Dutch rescaled version of the TLX questionnaire can be found in Appendix B. The translated version was reviewed by two researchers familiar with the COGKNOW research program and with this kind of active participant research. These researchers reasoned that question 6 was very difficult to answer for people with cognitive impairments, therefore we split question 6 (frustration level) into two different questions. The original question 6 was: ‘How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?’ To make it easier to answer we split this question into the following two questions:

New question 6: ‘How insecure did you feel yourself during the task?’

Question 7: ‘How boring did you find the task?’

The two researchers also reviewed these adapted questions and they agreed on using them. They were translated into Dutch and added to the questionnaire.

The first step of the TLX is to let participants decide which factors are the more important ones. In order to determine the proportion between these factors an extensive questionnaire had to be filled out. Because of our special group of participants we decided not to bother them with this questionnaire, and determine the factors for them. The questionnaire was filled out while keeping in mind the major mental and physical problems of PwDs as described in Alzheimer’s Disease International (2007) and Castellot (2006). Although this method does show some traces of intersubjectivity, in agreement with researchers within the COGKNOW project this was decided as the most accurate way of determining the factors, considering the circumstances.

Each factor can be given a weight between 1 and 5 points. After filling out the questionnaire the weight was determined for each factor. More detailed information on this topic can be found in Hart & Staveland (1988). In Table 8 an overview of the determined weights is given.

	Mental demand	**Physical demand**	**temporal demand**	**effort**	**performance**	**frustration level 1**	**frustration level 2**
Weight	3	3	2	2	3	2	2

Table 8: Weight of TLX-factors

The total TLX score of a participant during one route was calculated according to the formula found in Figure 8.

- Score question = (5 * Score of answer) * Weight of factor

  *Example: A participant gives the answer 'low' on question 2. Low equals 2 points. Her score for this question is (2 * 5) * 3 =30*

- TLX Score = Sum of all questions / 17 (total weight of factors)

  Example: A participant gives the answer 'low' on questions 1 and 3, 'high' on questions 2, 5 and 7, and 'neutral' on questions 4 and 6. The scores for questions 1 till 7 are: 30, 60, 20, 30, 60, 30, 40. (= 270). The TLX score for the participant on this route is: 270 / 17 = 15.88

Figure 8: TLX Score explanation

3.7.3 User preference

The opinion of the participant is an important factor for a successful navigation system. We not only want to develop a system that is usable for PwDs, but also one that is appreciated by them. Therefore, we needed to measure how satisfied a participant was with the system after each route.

In order to measure how satisfied users were with each version of the system a questionnaire was developed. First, the researcher sought for an existing satisfaction questionnaire usable for this situation. An existing questionnaire should consist of a limited number of questions that the participant had to answer. This criterion was set up because of the limited cognitive capabilities of the participants. The only existing questionnaire that was short and seemed to conform to the subject of the experiments was the After-Scenario Questionnaire (Lewis, 1995). However, this questionnaire consisted only of three questions and mainly targeted the use of a computer system. Therefore, this questionnaire could not be used. Because of the special group of participants and perceived new type of research, we decided to develop a new questionnaire.

To develop a suitable questionnaire for the experiment we looked at what we expected the participants could actually remember of the experiments, and on which topic they would most likely have an opinion. During a brainstorm session with two other researchers from the Telematica Instituut, five questions were invented. After the questions were reviewed by the same researchers that also reviewed the new TLX Questions, we decided to use them for the experiments' satisfaction questionnaire. The participants had to answer if they agreed or disagreed with the questions on a 5-point scale (totally disagree – partly disagree – neutral – partly agree – totally agree). Table 9 gives an overview of the questions. The Dutch version of the questionnaire can be found in Appendix C.

#	Question
1.	I want to use this system more often.
2.	I felt more secure on the street while using the system.
3.	I found the system enjoyable to use.
4.	I could easily walk the given route with this system.
5.	I felt safer on the streets while using this system.

Table 9: Questions of the satisfaction questionnaire

3.7.4 Additional measures

During the experiments, we made some observations that were not expected beforehand. While analyzing the data, we gathered information for these new measures. We already expected some new error categories, as can be seen in Figure 5 and Table 6.

First of all, during the experiments the GPS module of the mobile device gave some problems (explained in detail in chapter 4), therefore we counted the number of times a GPS error occurred during each experiment.

Some of these GPS errors lead to consecutive errors by participants. These navigation errors were registered and described separately.

We already expected that participants would talk to the researcher during the experiments (assistance requested). The type of conversations could be divided in two categories. First, participants did ask questions about navigation, the second category contains pure remarks of the participants that do not influence the experiment.

3.8 Analysis

In order to analyze the data and answer the research questions of this study, we had to determine what methods we wanted to use.

First of all, we decided that a descriptive overview of all the participants and their achievements was necessary for a clear interpretation of the data. Therefore a separate chapter is included in this report. This begins with a narrative description of the participants, and some general data on the experiments in which they participated. The data from the observation form, TLX Questionnaire, MMSE Questionnaire, PWS and Satisfaction Questionnaire were used for this chapter.

Secondly we needed a good understanding of the differences between in the participants. Did they all have the same speed, the same number of errors and an equal number of questions? This data was gathered from the observation forms. In the observation forms categories were defined in which the researcher could classify his observations.

Thirdly, the differences between the routes were needed in order to determine if the routes did not give contradictory data. Only when the scores on routes were comparable then they could be used. The data from the observations form was quite helpful for this. With the time-based notes we determined how much time the participants needed to complete the route, how much time was spent in errors, and the distance differences in the routes.

After this overview was generated (see chapter 4), a start could be made with the results that answer the research questions (see chapter 5).

First, the observations forms and time notes contributed to answer the first research question, and therefore were used to clarify the differences in the experiments with the familiar voice and the unfamiliar voice. In addition, the differences between the experiments with and without the use of warning sounds were calculated with these forms. From these forms the differences in speed, time to completion, route deviations, repeating messages, and required assistance en GPS errors were used.

Second, in order to determine if the use of warning sounds and a familiar voice contributed to the experienced workload, we needed to analyze the data from the TLX Questionnaire. This was done by comparing the TLX Scores on the various conditions. Both the differences between the familiar/unfamiliar and warning sound/no warning sound were explored.

Last, to see if PwDs had a preference for a certain type of audio guidance, we compared the satisfaction scores of the various conditions. Again tables were be used to make the differences between these conditions clear.

Because of the limited distance between researcher and participants during the experiments researcher influence could not be excluded. Therefore a researcher influence check was conducted one month after the original study. In chapter 4.5 this check is described and the results discussed.

4 Context setting

This chapter encloses the results of the experiment. First of all in section 4.1 all participants and their performance are described, followed by the basic differences between the participants in section 4.2. In section 4.3 we compare the different routes, and how participants achieved on these routes. In section 4.4 we look at some general observations of the study, finally in 4.5 we discuss the researcher influence check.

4.1 Narrative & descriptive data of participants

All participants were very eager to participate in the experiment. Five minutes before the start of the experiments, the researcher visited the participants home to give some last-minute information and to prepare together for the experiment. The next four sub-sections give an overview of all the participants.

4.1.1 Participant 1

Participant 1 is an active lady who sees many things happening in her neighbourhood. While she was walking, she was frequently distracted by flowers, animals and children. This participant had the urge to repeat the spoken messages by herself by speaking them aloud or mumbling.

The walking condition of participant 1 is pretty good; during the house visit, she mentioned to be an active walker. Often she walks to the park or supermarket; she also goes to the city centre by bus. While walking without the device her average speed (PWS) is 3,4 km/u, during the experiment her average speed was 3,21 km/h, a decrease of 5,6% in speed.

The participant scored 24 points on the MMSE Questionnaire. Descriptive data on participant 1 can be found in Table 10.

Gender	Female	**Total time taken**	1:27:47
MMSE	24	**Time in errors**	0:16:52
Average speed	3,21 km/u	**Nett walking time**	1:10:55
Age	79		
Average TLX score	14,04	**Total distance**	3,82 km
Average Satisfaction score	2,2	**PWS**	3,4 km/u

Table 10: Descriptive data of participant 1

During the experiment, the participant experienced two main problems. One of the biggest problems had nothing to do with the experiment, but with her physical condition. One of her toes was infected, so she was tired fast and had to rest two times during the experiments. A visual interpretation of the experiments with participant 1 can be found in Figure 9.

The second problem was that participant 1 often missed an audio message, so she had to repeat the message, or ask the researcher for help. Both happened frequently, but even more, when she looked at the device to see where she had to go. Participant 1 was able to read the street-names from the device, and read the street-names on the crossings.

Participant 1 was very accurate in following directions, she only took a detour 2 times during the whole experiment, one of those detours was caused by GPS problems, because the device gave no message.

Figure 9: Snapshots from the experiments with participant 1

4.1.2 Participant 2

Participant 2 uses a walker to move around outside of her home. Mostly she goes outdoors together with other people, and rarely on her own. The only exception is to go to the park when the weather is good, because she hates the rain. Participant 2 does not repeat the messages, but just follows them. Often she tells what she is going to do (I am going to cross the street; I will wait for that car).

The walking condition of participant 2 is good, but only because she uses a walker. According to her own saying she does not go anywhere without it. Because she has no family, she often stays in the residency. While walking without the device her average speed was 3.80 km/h, during the experiment her average speed was 3.21 km/h, a decrease of 15.5% in walking speed.

Participant 2 scored 23 on the MSSE, descriptive data can be found in Table 11.

Gender	Female	**Total time taken**	1:27:21
MMSE	23	**Time in errors**	0:15:44
Average speed	3,30 km/u	**Nett walking time**	1:11:37
Age	?		
Average TLX score	17,13	**Total distance**	3,82 km
Average Satisfaction score	4,2	**PWS**	3,80 km/u

Table 11: Descriptive data of participant 2

The participant experienced three main problems during the experiment. The first was with her walker. When there was no lowered sidewalk to cross the street, she was not able to put her walker on the sidewalk again. The researcher had to help her put the walker on the sidewalk by lifting the front side of the walker onto the sidewalk.

The second problem was experienced only during the familiar voice conditions. The participant had a hard time hearing the familiar voice, because it was very soft. Even after the researcher turned up the volume, she still had some trouble hearing it, so she often stood still to hear it better.

The last problem was experienced during the third route. The device ran out of working memory, so the researcher had to intervene and delete some files. This took about two minutes and thirty seconds.

Participant 2 took five detours during the experiments. Only one of these was due to GPS problems, the other originated by wrong decision making and taking a turn twice. Some photographs of the experiments with participant 2 can be found in Figure 10.

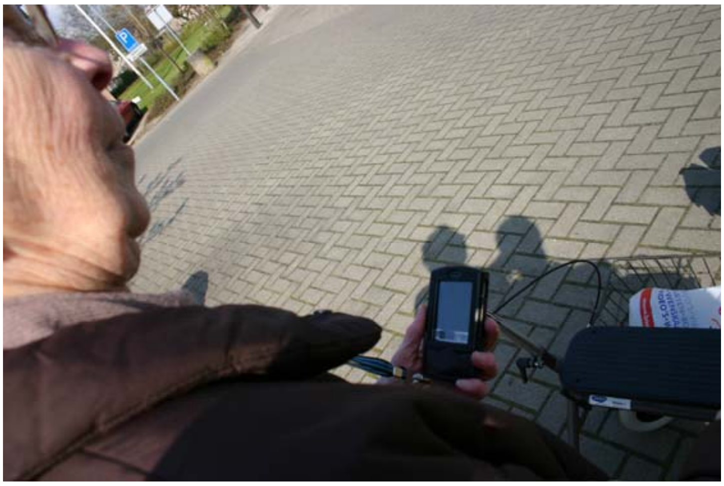
 

Figure 10: Snapshots from the experiments with participant 2

4.1.3 Participant 3

During the interview and experiments, participant 3 talked proudly about the fact that she could still independently enjoy here life in the residency for the elderly. She is an active walker, and often goes walking into the neighbourhood and to the park and supermarkets with a walker. She makes many remarks during the experiments. Most of them are not about navigating but about what she is going to do (wait for a car, cross the street to the other sidewalk).

The walking condition of participant 3 is good, and she does not need any help with her walker. During a normal walk her average speed (PWS) is 3,97 km/u, during the experiments the average walking speed is 4,01 km/h. Due to the small distance to measure the PWS (see section 3.7.1) the difference in walking speed (1,007%) between the PWS and experimental condition is ignored.

The participant scored 20 points on the standardized MMSE, and is therefore the lowest of all participants. Descriptive data on participant 3 can be found in Table 12.

Gender	Female	**Total time taken**	1:15:05
MMSE	20	**Time in errors**	0:17:39
Average speed	4,01 km/u	**Nett walking time**	0:57:26
Age	85		
Average TLX score	8,82	**Total distance**	3,82 km
Average Satisfaction score	4,6	**PWS**	3,97 km/u

Table 12: Descriptive data of participant 3

During the experiment, participant 3 experienced no real problems. Only in some instances, the GPS device malfunctioned and had to be reset by the researcher. In total, the participant took a detour two times; both times this was caused by a combination of unheard messages, street sounds and some confusion. Figure 11 gives an impression of the experiments with participant 3.

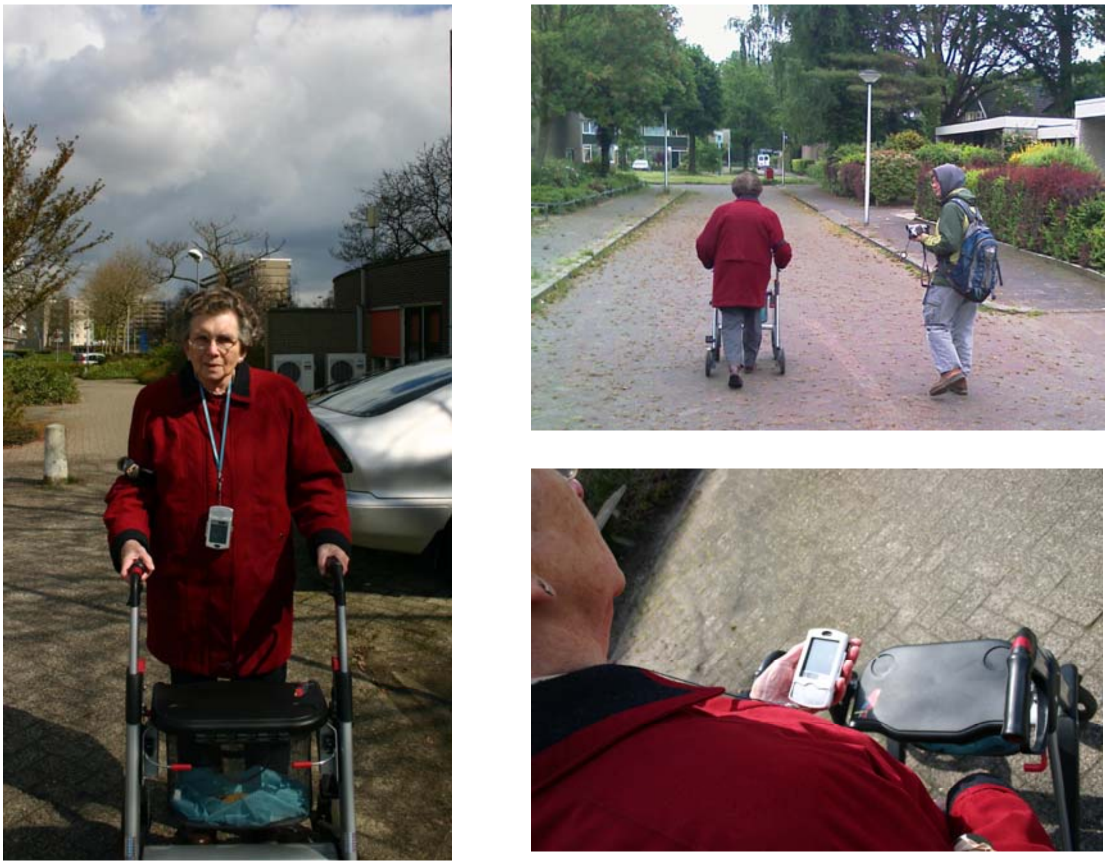


Figure 11: Snapshots from the experiments with participant 3

4.1.4 Participant 4

Participant 4 is the least active of all participants. She goes to the supermarket sometimes, but often stays at home. According to herself, this is not due to a physical condition, but she does prefer not to go out that much. She was not getting distracted by things around her, but aims right for her target: completing the route.

Her walking condition is good and fast. Her PWS 4,32 km/u, even though she used a walker. During the experiment, her average speed was 3,79 km/h (reduction of 12,3%). participant 4 scored 22 points on the MMSE. Descriptive data on participant 4 can be found in Table 13.

Gender	Female	**Total time taken**	0:38:54
MMSE	22	**Time in errors**	0:08:55
Average speed	3,79 km/u	**Nett walking time**	0:29:59
Age	83		
Average TLX score	16,03	**Total distance**	1,87 km
Average Satisfaction score	3,4	**PWS**	4,32 km/u

Table 13: Descriptive data of participant 4

During the experiment participant 4 was getting less and less enthusiastic along the way. This probably was caused by two factors: duration of the experiment, and physical problems.

Before the experiment started the participant was informed about the length of the experiment: 20 minutes for each route, 2 routes a day. Due to some misunderstanding, participant 4 thought the whole experiment would take 20 minutes to complete. After the first route, she expected it to be over already.

Due to problems with hearing capabilities and eyesight, she could hardly operate the navigational device.

Due to these problems, and her lack of feeling with the device it was agreed with the participant not to participate on the second day of the experiments. Participant 4 only walked two routes.

4.2 Differences between participants

In this section, some basic data about the differences between the participants of the experiment is described.

The participants had an average PWS of 3,87 km/h (for an explanation of the preferred walking speed see section 3.7.1). Their average speed on all routes was 3,57 km/h. All participants walked slower while operating the device than during the PWS walk. The only exception is participant 4, she walked with the same speed as during the experiments. This exception could be explained because of the fact that she did not like participating at the end. She really wanted to go home, so she walked faster on the second route (her way home).

During the experiment, all participants (except participant 4) encountered GPS problems with the device. Frequently the device did not know anymore which direction it was heading. We expected that this problem was mostly caused to the slow speed of the participant. After the experiment, the researcher completed two routes on foot, by bike and by car. During the route on foot the same problem occurred. We expect that the GPS module in the device we used is only accurate with a speed of at least 10 km/h. Sometimes wrong recalculations were made or wrong messages were given to the participants due to this problem. Participants 1 and 3 both had eight GPS problems, participant 2 had GPS problems five times, and participant 4 did not encounter GPS problems. Table 14 gives an overview on the number of times this problem and other values were registered during the experiments.

Event	**Participant**			
	P1	P2	P3	P4
Number of completed routes	4	4	4	2
GPS Error	8	5	8	0
Navigation error	3	5	4	5
Navigation question of participants	12	6	15	8
Remark of participant during route	12	7	18	3
Audio messages given to participants	54	60	54	26
Number of detours	2	5	2	2
Number of times device was checked by researcher	5	2	2	2
Number of times physical assistance was given by researcher	1	1	0	0
Number of audio and device problems (non GPS)	1	3	0	3
Missed audio messages by device	11	5	9	4
Number of times audio messages were repeated by participant	2	4	3	3
Number of completed routes	4	4	4	2

Table 14: Overview of registered values during the experiments

4.3 Route differences

Participants 1, 2, and 3 walked all four routes spread over two different days, participant four only walked routes C and D (see Figure 3) There were some huge differences in the amount of time it took a participant to complete each route. In addition, some time was spent on errors. With time spent on errors, we mean the amount of time a participant walked in the wrong direction or had to wait for the researcher to restore the device during a GPS problem.

On average it took the participant about 20:55 minutes to walk route A, 13:07 minutes to walk route B,17:07 minutes to walk route C, and 14:50 minutes to walk route D (see Table 15). According to the time taken for each route, it took participants more time to complete longer routes.

	Distance		P1			P2			P3		
			total	error	nett	total	error	nett	total	error	nett
A	1,16	km	0:24:15	0:04:40	0:19:35	0:32:44	0:06:58	0:25:46	0:20:05	0:02:40	0:17:25
B	0,79	km	0:20:00	0:04:24	0:15:36	0:15:02	0:02:15	0:12:47	0:16:15	0:05:17	0:10:58
C	0,97	km	0:24:32	0:05:58	0:18:34	0:22:05	0:04:15	0:17:50	0:17:45	0:02:45	0:15:00
D	0,89	km	0:19:00	0:01:50	0:17:10	0:17:30	0:02:16	0:15:14	0:21:00	0:06:57	0:14:03
Total	3,81	km	1:27:47	0:16:52	1:10:55	1:27:21	0:15:44	1:11:37	1:15:05	0:17:39	0:57:26

	Distance		P4			Average		
			total	error	nett	total	error	nett
A	1,16	km				0:25:41	0:04:46	0:20:55
B	0,79	km				0:17:06	0:03:59	0:13:07
C	0,97	km	0:21:34	0:04:30	0:17:04	0:21:29	0:04:22	0:17:07
D	0,89	km	0:17:20	0:04:25	0:12:55	0:18:42	0:03:52	0:14:50
Total	3,81	km	0:38:54	0:08:55	0:29:59	1:12:17	0:14:48	0:57:29

Table 15: Distance and time taken for the four routes

There were no big differences between the participants and between the routes in order of time participants spent in error time. In the longer routes, the participants also spent more time in errors than in shorter routes. The average amount of error time for participants was 14:48 minutes, with a minimum of 08:55 minutes for the two walked routes of participant 4, and a maximum of 17:39 minutes for participant three on all four routes.

The time it took participants to complete all the routes varied between 57:26 minutes and 1:11:37 minutes, keeping into account that the amount of time for participant 4 had to be doubled because she did not walk all routes.

4.4 General observations

As seen in the previous sections, various data was collected that does not directly contribute to answering the research questions. However, we think it is essential to address these findings, as they eventually might influence the conclusions of this study.

During the experiments, a large problem was the unreliability of the GPS device. Because of the slow walking speed of the participants, the GPS device sometimes lost its fix (the exact location of the device). When this occurred, the navigation software began to recalculate the route to the endpoint. Sometimes this resulted in a change of the route or skipping of an audio message. During the recalculating of a route, some participants saw the change on the screen and asked a question about it.

During two routes (A and C), the device and participants often skipped a certain crossing. Sometimes the device just did not give the message, and sometimes participants did not react to this crossing. This crossing was close to another one that led to the same road, only a small lawn separated the two roads. The mistake is therefore not very surprising. A graphical overview is shown in Figure 12.

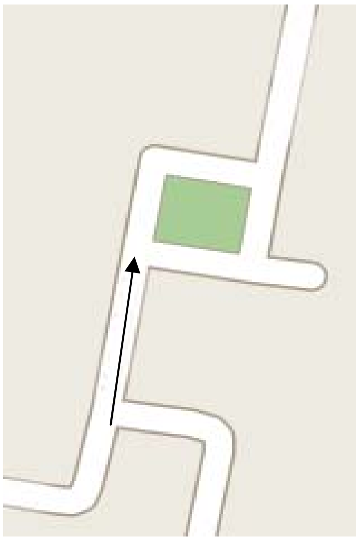


Figure 12: Frequent GPS and participant error location

Although not determined beforehand as a measurement, it was noticed by both researchers (and confirmed when checking with the video recordings) that participants halted about twice as much when a warning sound was given before the audio message. This indicates that participant paid extra attention to the audio messages that were given after the audio warning.

During the experiments, we noticed that participants almost never looked at the screen. Looking at screen could be identified by bowing of the head, or holding up the device. Almost all participants only looked at the screen when a message was not understood or heard.

We also saw that the researcher had to interact frequently with the participants. Therefore a researcher influence check was conducted, which is described in the next section.

4.5 Researcher influence check

During the experiments, the researcher needed to be in close proximity to the participant. In this way, he could answer questions, guard whether the experiment was progressing correctly and safely and make accurate observations. The downside of this close proximity however, was that the researcher would probably have a big influence on the experiment and the behaviour of the participants. Therefore, a post-hoc check for researcher influence has been set up.

Because researcher influence was expected after the experiments, a post-hoc check was planned. One month after the original experiment (in order to prevent repetition effects) two participants walked again two routes each (C and B). During this post-hoc check, the researcher did not intervene at all during the walks, except to ask the TLX Questionnaire.

Because the researcher did not intervene during the experiment, minor deviations were allowed, but registered to make an accurate comparison. During the check, we only used unfamiliar voices and the same two routes in order to have a similar set of data to compare between the two participants.

	Average score per route during experiments	Average score per route during post-hoc check
	n=14	n=4
Walking time	0:16:26	0:16:22
Deviations	0,85	1
Repeated messages	0,86	1
Assistance provided	1,57	0,25
Assistance requested	1,57	0
Navigation questions	2,92	0
GPS errors	1,5	1
TLX Score	13,72	12,43
Satisfaction score	3,63	3,85

Table 16: Results of experiments vs. post-hoc check

After completing this post-hoc check, the data was compared to the data of the experiments. The time to complete, the number of deviations, the number of repeating audio messages, cognitive workload and satisfaction did not differ much from experiments. Therefore, we can cautiously conclude that there is no reason to assume that the researcher did have influence on the results of the experiments. An overview of the results of the second round can be found in Table 16.

5 Results

In this chapter, we present the results of the experiment, focusing on the research questions. First in section 5.1 we look at the differences between familiar and unfamiliar voices, than in section 5.2 to the use of warning sounds. After that, we discuss the results of the workload questionnaire in section 5.3. Finally, in section 5.4 we present the results of the satisfaction questionnaire.

5.1 Use of familiar and unfamiliar voices

In order to answer the first research question we need a clear view of the differences between the unfamiliar and familiar voice conditions (Table 17 until Table 23).

First we look at the achievements of each participant on all routes, and compare the routes of the unfamiliar voice conditions (U, UE) with the familiar voice conditions (F, FE). Following Table 6 and section 3.7.4, we first look at the average time taken (Table 17) to complete the routes. For the unfamiliar voice conditions, we discard the results from participant 4, because otherwise a fair comparison is not possible between the conditions. Participant 4 did not complete any routes with the familiar voice conditions.

In the unfamiliar voice conditions (U, UE), the average walking time on all routes was 16:53 minutes, in the familiar voice conditions (F, FE) it was 16:27 minutes. The difference between these conditions is only 26 seconds and therefore too small to give any clues on the total walking time of 1 hour and 42:16 minutes in the unfamiliar voice conditions and 1 hour and 38:42 minutes in the familiar voice conditions.

Looking at the number of deviations participants took (Table 18) during the experiments, we see that participants took more deviations (about 33%) in the unfamiliar voice conditions (an average of 1 deviation on every route) than in the familiar voice conditions (an average of 0,67 on every route). As discussed in section 4.3 however, most of these deviations were caused by GPS errors resulting in missing audio messages, and therefore we cannot state that this difference is caused by difference in type of voice.

The number of messages that the users wanted to repeat (Table 19) was in all conditions very low. In the unfamiliar voice conditions, they repeated an average of 1 message during each route, in the familiar an average of 1,5 messages, a difference of 33 percent in favour of the familiar voice conditions.

In the familiar voice conditions, participants asked in average considerably more navigation questions (3,33) than in the unfamiliar voice conditions (2), as can be concluded from Table 22. This however is most likely caused by the larger number of GPS errors (Table 23) in the familiar voice conditions (2 on average in the familiars conditions compared to 1,5 in the unfamiliar voice conditions). Remarkable, however, is that participants requested less assistance (Table 21) in the familiar voice conditions (1,33 on average) compared to the unfamiliar voice conditions (1,67 on average), and that the researcher also provided less assistance (Table 20) in the familiar voice conditions (1,33 on average) compared to the unfamiliar voice conditions (1,83 on average). For an explanation of these categories, we refer to section 3.7.

Condition	Participant P1	Participant P2	Participant P3	Participant P4	Average per condition	Average for combined conditions
U	0:19:35	0:12:47	0:15:00	0:12:55	0:15:04	
UE	0:17:10	0:25:46	0:10:58	0:17:04	0:17:45	
F	0:15:36	0:17:50	0:17:25		0:16:57	
FE	0:18:34	0:15:14	0:14:03		0:15:57	
U & UE*						0:16:53
F & FE						0:16:27
U & F						0:15:53
UE & FE						0:16:58
Average	0:17:44	0:17:54	0:14:21	0:15:00		

* For the Unfamiliar voice condition average participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Table 17: Walking speed of participants during experiments

Condition	Participant P1	Participant P2	Participant P3	Participant P4	Average per condition	Average for combined conditions
U	1	0	0	0	0,25	
UE	1	3	1	2	1,75	
F	0	2	0		0,67	
FE	1	0	1		0,67	
U & UE*						1,00
F & FE						0,67
U & F						0,43
UE & FE						1,29
Average	0,75	1,25	0,50	1,00		

* For the Unfamiliar voice condition average, participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Table 18: Number of route deviations made by participants during experiments

Condition	Participant P1	Participant P2	Participant P3	Participant P4	Average per condition	Average for combined conditions
U	1	1	0	1	0,75	
UE	2	2	3	2	2,25	
F	3	1	0		1,33	
FE	2	0	0		0,67	
U & UE*						1,50
F & FE						1,00
U & F						1,00
UE & FE						1,57
Average	2,00	1,00	0,75	1,50		

* For the Unfamiliar voice condition average, participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Table 19: Number of repeated messages during experiments

Condition	Participant P1	Participant P2	Participant P3	Participant P4	Average per condition	Average for combined conditions
U	1	2	1	3	1,75	
UE	0	6	1	0	1,75	
F	0	1	1		0,67	
FE	4	0	2		2,00	
U & UE*						1,83
F & FE						1,33
U & F						1,29
UE & FE						1,86
Average	1,25	2,25	1,25	1,50		

* For the Unfamiliar voice condition average, participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Table 20: Number of times assistance was provided by researcher during experiments

Condition	Participant P1	Participant P2	Participant P3	Participant P4	Average per condition	Average for combined conditions
U	6	0	1	2	2,25	
UE	0	3	0	2	1,25	
F	3	1	2		2,00	
FE	1	0	1		0,67	
U & UE*						1,67
F & FE						1,33
U & F						2,14
UE & FE						1,00
Average	2,50	1,00	1,00	2,00		

* For the Unfamiliar voice condition average, participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Table 21: Number of times assistance was requested by participants

Condition	Participant P1	Participant P2	Participant P3	Participant P4	Average per condition	Average for combined conditions
U	3	1	1	3	2,00	
UE	2	3	2	5	3,00	
F	5	1	4		3,33	
FE	2	1	7		3,33	
U & UE*						2,00
F & FE						3,33
U & F						2,57
UE & FE						3,14
Average	3,00	1,50	3,50	4,00		

* For the Unfamiliar voice condition average, participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Table 22: Navigation questions by participants during experiments

Condition	Participant P1	Participant P2	Participant P3	Participant P4	Average per condition	Average for combined conditions
U	1	1	0	0	0,50	
UE	0	4	3	0	1,75	
F	1	0	4		1,67	
FE	6	0	1		2,33	
U & UE*						1,50
F & FE						2,00
U & F						1,00
UE & FE						2,00
Average	2,00	1,25	2,00	0,00		

* For the Unfamiliar voice condition average, participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Table 23: Number of GPS errors during the experiments

In summary, we see that in almost all measures the familiar voice conditions scores lower/better than in the unfamiliar voice conditions. The unfamiliar voice conditions only scores better in the number of navigation questions and the number of GPS errors. The differences between these scores however were very small. Remarkable however is that the participants did never recognize the familiar voice until they were told whom it was they heart. Added to this, the participants asked considerable more navigation questions in the familiar voice conditions than in the unfamiliar voice conditions. Therefore we can do nothing else than conclude that although the familiar voice conditions scored slightly better, it is impossible to determine that it was because of the familiarity of these voices.

5.2 The use of warning sounds

Now we have given an overview of the results on the effectiveness of familiar voices, we need to move on to the results on the effectiveness of warning sounds. This second research question can be answered with a clear view on the differences between the voice only conditions and voice with warning sounds conditions (Table 17 until Table 23).

First of all, we look at the achievements of the participants in the conditions, and make a comparison between the voice only and voice with warning sounds conditions. As in the previous section, we start with looking at Table 6 and section 3.7.4. In contradiction to the previous section however, we include the results of participant 4, because she completed both a route in the voice only condition and in the voice with warning sounds condition. However, because of the similar results between the routes as explained in section 4.3, we can still use the data from the routes and compare them to each other.

In the voice only conditions (U, F), the average walking time on all routes was 15:53 minutes, in the voice with warning sounds conditions this was 16:58 minutes. The difference between these conditions is 1:05 minutes (6%) it is hard to draw any conclusions from this. As can be seen in the tables, during the experiments the routes were not used the same number of times between the different conditions.

When looking at the number of deviations (Table 18) during the experiments, we can conclude that participants made more deviations in the voice with warning sounds conditions (an average of 1,29 deviations per route) than in the voice only conditions (an average of 0,43 deviations per route). This however could possibly be explained by the number of GPS errors during the experiments (1,87 GPS errors on average in voice with warning sounds conditions compared to 1 GPS errors on average in voice only conditions). It is therefore impossible to be sure that these differences in deviations were caused by the use of warning sounds.

In all conditions users rarely used the option to repeat the audio messages they missed (Table 19) during the experiment. In the voice only conditions participants repeated on average only one message during each route. In the voice with warning sounds conditions this was 1,57 times.

During the voice with warning sounds conditions participants asked more (Table 22) navigation questions (3.14 on average) than in the voice only conditions (2.57 on average). A direct cause of this difference is the difference between the number of GPS errors (Table 23) in the voice with warning sounds conditions (2 on average) and the voice only conditions (1 on average). Because of these GPS errors we also see that the number of times assistance was given by the researcher (Table 20) was higher in the voice with warning sounds conditions (1,86 on average) compared to the voice only conditions (1,29 on average). This difference however could not be found in the number of times the participant requested assistance (Table 21). For the voice only conditions, this is 2,14 times on average and for the voice with warning sounds conditions this only 1 time on average.

Summarized, when comparing the voice only conditions with the voice with warning sound conditions we see that in all measures the voice with warning sound conditions score higher/worse than in the voice only conditions. This is remarkable because we expected it to be the other way around. Important to note however, is that in the voice with warning sound conditions there were more GPS errors than in the voice only conditions, therefore we cannot be certain that the use of warning sounds contribute negatively to the achievements of the participants. Looking at the data however we suspect that the use of warning sounds does not contribute positively to the experiments.

5.3 Experienced workload

In the previous two sections, we looked at the data of the measures that were registered during the experiments. However, in order to give an answer for the third research question, we need to look at the answers participants gave on the TLX questionnaire.

First of all, we see that the four conditions do not differ much and vary between 12,84 and 14,34 points (Table 24). Comparing the differences between the participants however we see that participant 3 scores low on all routes (8,82 on average) compared to the other participants (14,04; 17,13; 16,03 on average). Compared to participant 2, participant 3 scores almost 50 percent lower on average. This could be caused by the fact that participant 3 was already very active in her daily life (see section 4.1.3) compared to the others even though she had the lowest score on the MMSE Questionnaire.

When we look at the combined warning sounds conditions (compare U&F with UE&UF) in Table 24, we see that two of the participants score higher on the warning sound conditions, and only one scores lower when warning sounds conditions are used. On average, however, the use of warning sounds still gives a slightly lower score on experienced workload for the participants.

Contradicting to these results are the observations during the experiments. In the voice with warning sound conditions participants halted more times while walking than in the voice only conditions. These halts always took place directly after the device played the warning sound. The number of halts was not officially measured or prescribed on the observation form. However, it was a visual observation, on which both researchers agreed, that was unmistakeably there. This observation was seen right away and therefore not registered on the observation forms by the researchers.

P#	Condition					Average on combined conditions			
	U	UE	F	FE	Average	U&UE*	F&FE	U&F	UE&FE
1	11,47	16,76	15,59	12,35	14,04	14,12	13,97	13,53	14,56
2	16,47	17,94	16,47	17,65	17,13	17,21	17,06	16,47	17,8
3	10,29	8,53	7,94	8,53	8,823	9,41	8,235	9,115	8,53
4	17,94	14,12			16,03	16,03			
Average	14,04	14,34	13,33	12,84		13,58	13,09	13,74	13,7

* For the Unfamiliar voice conditions participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Note: The averages under the combined conditions are of all the individual scores, not of the averages of each participant!

Table 24: Differences and averages in TLX Scores between conditions

On the combined familiarity conditions (compare U&UE with F&FE), we see that all participants score lower on the familiar voice conditions (13,09) than on the unfamiliar voice conditions (13,58). The differences between participants are smaller than between the warning sound conditions. The averages on the combined conditions, however, are bigger than between the voice only (13,74) and voice with warning sounds conditions (13,70).

Problematic is the meaning of the results between the familiar and unfamiliar voices. As mentioned earlier, not one of the participants did recognize the voice in the familiar voice conditions.

5.4 Satisfaction

To get a clear understanding of what users think about the different types of auditory navigation, we asked them to report their satisfaction after each route. The results of these questionnaires can be found in this section. An explanation of the scores can be found in section 3.7.3.

When looking at the data in Table 25 we see that satisfaction between the four conditions did not differ much and varied from 3,4 to 3,8. With this data we can at least state that the participants were overall satisfied with the system. When looking at the participants, however, we see that participant 1 scores very low on satisfaction compared to the others. A possible explanation for this could be that participant 1 said during and after the experiment that she thought she did not need such a system.

P#	Condition					Average on combined conditions			
	U	UE	F	FE	Average	U&UE*	F&FE	U&F	UE&FE
1	2	2,6	1,8	2,4	2,2	2,3	2,1	1,9	2,5
2	3,6	4,4	4,4	4,4	4,2	4	4,4	4	4,4
3	4,6	4,8	4,8	4,2	4,6	4,7	4,5	4,7	4,5
4	3,4	3,4			3,4	3,4			
Average	3,4	3,8	3,67	3,67		3,67	3,67	3,51	3,74

* For the Unfamiliar voice conditions participant 4 was left out, as she did not complete any route with a familiar voice. A valid comparison could therefore not be made when including participant 4.

Note: The above averages are of all the individual scores (excluding participant 4), not of the averages of each participant!

Table 25: Differences and averages in satisfaction scores between conditions

When looking at the combined familiarity conditions (F&FE), we see that two participants score lower on satisfaction in the combined familiar voice conditions (F&FE) than in the combined unfamiliar voice conditions (U&UE). Only one participant scored higher on the combined familiar voice condition (F&FE). On average the use of familiar voice or unfamiliar voice does not differ at all (both 3,7 points).

Keeping in mind that participants never recognized the familiar voices, this data is not very surprising. Especially because the familiar voice was not recognized and it still scored the same on satisfaction for the participants, we could at least reason that the familiar voices were good enough for the participants to use. However with the limited number of participants it is impossible to ground this statement.

Finally when looking at the difference between the combined warning sound conditions we see that two participants score considerably higher on the combined voice with warning sound conditions than on the combined voice only conditions. Only one participant scored slightly lower on the combined voice only conditions. Consecutive on this data we see that on average participants liked the voice with warning sounds conditions better than the voice only conditions.

Contributing to this finding are the remarks of the participants during the experiments (see section 5.2) that they did find the warning sounds helpful, and that it prevented them from needing a look at the display.

6 Conclusion

Writing a conclusion about a study with conflicting results is always hard. However we think that some general conclusions can be drawn from the experiments we conducted, both for answering the research questions and for some general conclusions based on the observation of our experiments.

6.1 Using familiar voices

As mentioned in the results section for familiar voices, it is hard to draw firm conclusions from the results of the experiments. Although participants walked faster and made fewer deviations during the familiar voice conditions, they did never consciously recognize the familiar voice. Most deviations were caused by errors of the GPS module, and participants were often distracted by their surroundings.

Although not significantly different, the use of familiar voices led to participants repeating less messages, requiring less assistance, and needing less interference from the researcher. Looking at the results we see that participants overall score better in the familiar voice conditions than in the unfamiliar voice conditions. Therefore we expect that there is a small positive benefit in using familiar voices in navigation systems for people with mild dementia. The use of familiar voices contributes to the efficiency of such a system for people with mild dementia.

Answering sub RQI (What is the effect of the use of familiar voice on the quality of way finding in a navigation system for PwDs?) we see a positive effect on the use of familiar voice. Way finding becomes lightly more efficient then when using unfamiliar voice when looking at the results of this study.

When looking at the research of Winkler & Cowan (2005), we can contribute to their findings that a familiar voice indeed resides in the memories of persons and triggers their reactions in a different (physically more direct) way than unfamiliar voices.

6.2 Using warning sounds

As with the use of familiar sounds, in the warning sounds conditions it is also hard to draw firm conclusions. Remarkable in the results is that the use of warning sounds almost always results in worse achievements of the participants than when no warning sounds are used. This can be seen especially when we compare the number of deviations, the number of times messages were repeated and the number of navigation questions that are asked by the participants to the researcher. Although the differences are small, we expect that there is a negative effect on the use of warning sounds when looking to the achievements of participants. Therefore using warning sounds in a navigation system may seem to have a negative effect on the quality of way finding for people with mild dementia.

We expected that there would be a positive effect on the use of warning sounds, and hoped that it could contribute to the use of earcons in other areas than studies by Brewster. However no legitimate effort can be made for this.

So, when answering RQII (What is the effect on the use of structures audio warnings (earcons) on the quality of way finding in a navigation system for PwDs?) we can state that the effect, considering the results of this study, is negative. The use of warning sounds results in less accurate way finding. However, as this is an exploratory study the conclusions are not very firm.

6.3 Load on working memory

In order to answer the third research question, we once again look at the results in section 5.3. As mentioned in this section the average differences between the conditions are really small. However, we see that participants mostly do experience a lower workload on working memory in familiar voice conditions. They do not experience a lower workload while warning sounds were used.

Answering RQIII (Which type of auditory guidance in navigation systems contribute to a lower cognitive workload for PwDs?) we see that familiar voice does contribute to a lower cognitive workload and audio warning. The use of warning sounds does not contribute to a lower load on working memory for persons with dementia.

6.4 Satisfaction

To answer the final research question, we look at the data from section 5.4. Differences between the satisfaction scores differ between participants, they tend to answer questions differently. Some participants always seem to score relatively low, while others always score very high.

When looking at the use of familiar voices, we see that participants like the familiar voice better, but only when no warning sounds are heard. The other way around the same conclusion can be drawn: people like warning sounds (and think they are helpful), but only when an unfamiliar voice was heard.

When answering RQIV (Which type of auditory guidance in navigation systems do PwDs prefer?) we see a preference for audio warnings and familiar voice, but only when one of the modalities is used. A combination between familiar voice and audio warnings is not appreciated, according to the results of this study.

6.5 General findings

As discussed in section 4.4, besides answering the research questions, we also found some other findings that can be interesting for future experiments or software developing.

First of all problems occurred with the GPS module in the devices. At walking-speed the signal became very unreliable for accurate way finding. Due to the unreliability of the GPS users can get disoriented or confused. Possible solutions should be inventoried as soon as possible.

Another big issue is the use of the visual navigation part. Most of our participants almost never looked at the screen, and this modality is therefore of secondary importance, especially for users with walkers. Primary for a successful use of navigation systems by PwDs is the use of a suitable type of sound. The primary use of sound however should be introduced very carefully, as it gives a new perspective on the use of navigation systems. Further research is needed in order to guarantee logical and usable types of sounds.

6.6 Auditory guidance

When we look at the answers on the four sub questions of this study we see that they sometimes contradict each other.

The use of familiar voice in a navigation system for PwDs is advisable regarding the efficiency and difficulty of the system. However for the satisfaction of the participants it does not differ.

The use of warning sounds in a navigation system for PwDs is not advisable when an efficient and easy system is needed. However when a system should be developed with which users should be as satisfied as possible we do encourage the use of these warning sounds.

6.7 Guidelines

In this section we describe the guidelines for designing a navigation system for PwDs. The guidelines are divided into four sections: the use of familiar voice, the use of warning sounds, the developing of a navigation system, and conducting experiments. The guidelines are derived from our own findings, expectations and literature.

- *Voices*

- Use own jargon; caregivers should make their own natural sentences. The use of pre-defined sentences prevents recognition by PwDs.
- Exercise; let caregivers exercise their sentences. They need to be crystal-clear and clean of mispronunciations.
- Short; sentences should be short and in natural language. Prevent use of too many verbs.
- Commanding; sentences should the PwD get started, forcing them a little does not hurt them.

- *Warning Sounds*

- Use structured sound; make sure there is a tune, melody, or other recognizable pattern in the used warning sounds.
- Pre-test usable sounds; only use sounds that are pre-tested by the target-group.
- Neutral; make sure sounds do not trigger already existing memories.

- *System*

- No pre-warning; while walking a pre-warning of what is to come is not strictly necessary. PwDs do act when necessary. Giving them a warning in advance does distract them from their task.
- Super solid; only the key functionalities should be available. Additional screens, warnings, buttons and information does only distract PwDs from their task.
- Primary focus on audio; PwDs mainly use the audio component of the navigation system. The visual interface is needed, but only as a backup when the audio message is not understood.

- *Experiment*

- Test!; The developed system should be pre-tested extensively. There is no room for flaws in the system. It only leads to interruptions, distraction and confusion.
- Informed consent; PwDs and their caregivers should sign for using audio, video, and photos for your use.
- Advantages; tell PwDs and caregivers that they can gain advantage on using this system. I n the future it is likely that such a navigation system for PwDs will become available to them.

7 Discussion

7.1 Content and future studies

Even though the results of this study sometimes seem contradictive to each other, we do think that a contribution has been made to research on several topics. During an exploratory study like this, there are always many new questions that present themselves during the process

Although audio warning sounds were never used in a comparable (navigation) system we see that people like hearing them. However, because there are strong indications that they have a bad influence on the achievements and a heavy load on cognitive working memory we have to be very careful in using them.

In addition, we saw that a familiar voice in navigation systems did contribute to the effectiveness of such a system. Participants did never recognize the familiar voice, and there is a very likely explanation for this: they did not expect it. For people at this age, and especially with mental problems it is highly unlikely that they knew that it is possible to put the voice of someone familiar into such a device. In addition, they were probably so occupied during the experiments with actually following cues of the device, that they did not put any mental effort into anything else then completing their assignment.

Although they did not recognize the voice there are several possible reasons why it had a positive effect. It is possible that subconsciously they still recognized the voice and unintentionally put more effort in completing the assignment. This prospect however is pure speculation and could only be confirmed when more studies are conducted that pay special attention in cognitive workload during familiar and unfamiliar conditions in experiments by persons with dementia. Future research should therefore include this subject.

Finally, there is the conclusion that users almost never look at the screen during experiments. They let them guide themselves largely on auditory guidance. Although it could be reasoned that this is mostly because participants used walkers, this is not entirely true. The participant without a walker navigated more on auditory guidance than with the visual interface. Therefore, in further research much more effort should be put into developing auditory guidance than in visual guidance for persons with dementia. When, however, we look at it with a broader scope, we even expect that this could benefit normal navigation system users, as they are mostly occupied looking at the road and other traffic while driving.

Future studies should also use a larger set of participants and look further into the use of specific types of warning sounds. In pre-studies participants should compare several types of warning sounds and classify them on their usability in several types of navigation systems (primary warning sound oriented, primary voice oriented, visual oriented without voice or visual oriented with warning sounds)

With using an existing system (TomTom 6 SDK), we created both the to opportunity conduct a real experiment (no wizard of Oz), and prevent the need to have a new system developed by some programmers (there were no resources for developing such a new tool). However, it also brought the problem of using TomTom. TomTom was developed as a car-navigation system, so it does not see any difference between a street and the adjoining pavement. While on a map it may seem as the same thing, in the real world they do not always follow the exact same path.

In addition, the algorithms TomTom used to calculate speed and direction are not suitable for walking. When the average speed is beneath 10 kilometres per hour, the system gives back a less reliable location and direction.

When looking into the future we expect some major developments in landmark oriented navigation systems. The first steps can already be seen in Google Earth's 3D buildings layer and in the 3D photographed buildings included in IGO 8. Therefore, we think that in a few years solutions that are far more suitable can be developed for PwDs. In addition, the developments in Assisted GPS (gathering GPS data via cellular network information and the internet), Galileo (the new, more accurate GPS network of European countries), high-speed mobile internet, and hardware developments for mobile devices will ensure a much more suitable platform for navigation systems for PwDs.

7.2 Method and pragmatic problems

In this study, we saw that even though we interviewed experts on studies with PwDs we still ran into some surprises.

Especially during the search for participants, we discovered how hard it was to gather people that are prepared to participate in the study, but are also mentally and physically capable. For the search of participants we used our network of professionals in the Enschede area, connections in healthcare companies, and organisations for day-care in the city of Enschede, but still it was difficult to find enough participants. Even though prospected participants are old and often have mental and physical impairments, they are often very active with various activities. In addition, they are often a little afraid to use such an (in their opinion) expensive and modern system. However when they do participate and familiarize themselves with it they often like it a lot.

Using the MMSE questionnaire was in this context a 'pain in the ass', as it excluded almost half of our prospect participants from participation. We still think however that it is important to use the MMSE as an inclusion criterion, given the fact that it is widely used in the psychological and medical world. Research conducted without this kind of standardized inclusion criteria should be examined very critical.

During the process of writing this report, we sometimes had our doubts on the use of the TLX questionnaire and satisfaction questionnaire. It seemed (after the first rounds of experiments) that participant answered the questions a little too positive. In our case, however this is not a very large problem, as we only compared to data between the participants of our study, and not to other studies.

In addition, the use of a 'home-made' satisfaction questionnaire may seem to cause some subjective results. However, we think that with collaborating with experts, and letting them check our questionnaire on biased questions, we did develop the most usable and suitable questionnaire for this study.

When looking at the more pragmatic issues of this study we have some advice for future research. In our opinion, only researchers with knowledge about dementia and its consequences should conduct this type of experiments. PwDs differ from the majority; they behave differently, react differently and need a special type of attention during their participation in studies. A positive and cheerful attitude is essential to keep them going, and strong communication skills are needed to gather third parties and encourage participants.

Although this was a very exploratory study into the use of auditory navigation for people with mild dementia, until now it is the only one conducted. In the European COGKNOW Project, from which this study originated, it is the only field study in which PwDs walked semi-independently with a navigation system. It is therefore a rich contribution to the research data gathered by the COGKNOW project. With the results of this study, further development of navigation systems for persons with dementia can commence.

8 Acknowledgement

As many people know, graduating is often a difficult, slow and challenging process, especially where you are dependent of various external sources. It is however also during this process that one often learns a lot about the fun side of doing research. Especially in my case, where making progress often means meeting people with all different kinds of backgrounds, discussing your ideas, and learning from their experiences in the past. I discovered that scientific research attracts me more than I thought before I started the study. However crucial for my success and progress is the visible presence of the pragmatic goal for which I started this study in the beginning: keeping people with mild dementia social active and less independent from their caregivers and close relatives.

I know that there is no way in which I can prevent to thank some persons first, and others later. Be let me assure you that I am equally thankful for everybody in this list, and all the others that helped me along the way whom I forgot to mention. This said, I would first like to thank Marike Hettinga of the Telematica Institute. Without her continues pragmatic opinions during the whole study, I would have lost the way to the finish a long time ago. Her experience as a researcher in Telecare projects, the joy- and fruitful brainstorm sessions, and our numerous coffee and tea moments turned out to be crucial for the results of this study.

In addition, I would like to thank the participants, nurses and management staff of ‘De Posten’ in Enschede. Without the participants, no experiment would have been conducted. The nurses and management staff gave me the change to search for suitable participants within their dormitory.

Next, I would like to thank Thea van der Geest, who acted as my scientific supervisor from the University of Twente, and the continuously changing members of the afstudeerkring. Their advice and critic for this study was highly appreciated.

Then Eli Goldberg: (For whom I am glad to hear that he accepted a position with Microsoft Research) for all the assistance during the experiments, and giving me insights in the culture of numerous Silicon Valley companies.

In random order, I would like to thank everybody at the Telematica Institute who helped me setting op the experiment, supplying equipment, providing technical insights, and gave me an enjoyable time around the coffee table: Maurice Markslag, Henri ter Hofte, Marije Teerling, Niels Snoeck, Dirk-Jan van Dijk, Ferial Moelaert El-Hadidy, the ladies from the reception and the IS-group.

Last but not least, I would like to thank my girl and love of my life Leanne for the continues support and encouragement she gave me the past 12 months.

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APPENDIXES

Appendix A Pre-study: expert interviews

In the literature study much information has been found on possible solution for PwDs. In these studies however, almost no information was mentioned on what kind aspects are important during these experiments. This information is necessary for a successful experiment, and thus for a successful answering of the research question.

In order to gather information from various expert interviews will be used. The interviews will be in a format that lies between a structured and unstructured open interview model. This means that the general topics and main questions are pre-defined in an interview scheme, but the interviewer is free to decide to what extent he will ask questions about a certain topic. The sequence of the main questions is pre-determined, but the interviewees were asked to exaggerate widely on the topic based on his experience and knowledge. Interrogation techniques are used to get as much information from a certain question as possible.

The method chapter of this study starts on the next page.

1 METHOD

1.1 Objective

The interviews have three main objectives. The first objective of these interviews is to gather information about possible constraints and problems that can be expected while conducting experiments with PwD’s. The second objective is to add to the knowledge found in the literature about designing a auditory navigation system for PwD’s. And the third objective is to gather information on analysing data gathered through this kind of experiments.

1.2 Main questions

For every one of these objectives some main questions have been formulated. These questions were drawn up from gaps in the knowledge gathered by the literature study. In the literature no information was found on small practical problems during the experiments. The main questions for the basis for the interview scheme are:

I. What are the risks when using PwDs in field experiments?
II. How should caregivers be instructed and informed before an experiment in which the PwD is participating?
III. Which problems can be expected when giving PwDs mobile devices?
IV. Which precautions should be taken when taking PwDs outdoors?

V. Which conditions should the visual interface for a navigation system for PwDs meet?
VI. Which aspects are important while letting PwDs follow spoken instructions?

VII. Which problems can be expected when analyzing data from these kind of studies?

First some questions are going to be asked about the design of an experiment using PwDs and the role of the PwDs, caregivers and third parties during those experiments (main question I-IV). Secondly, some questions are going to be asked on the topic of designing a mobile navigation system for PwDs (main question V-VI). At last some questions are going to be asked about problems during analysis of data from the experiments (main question VII).

Question one implies all the risks that can be discovered while using PwDs in field experiments. It can be defined as a nominal variable with the following range of answers: ‘all possible (combinations) of risks while using persons with dementia during a field experiment. The second question adds the variable of instructing and informing caregivers. This will result in a nominal scale with all the types of instructions and information that will calm caregivers and give them the possibility to contact the experiment leaders. The third question adds the variable of using mobile devices by PwDs. This nominal scale will result in a list of possible problems and ways to prevent them during the experiment. Fourth, the influence of the outside world in mentioned. The nominal answers this question gives will result in a list which probably can be combined with question 1,3 and 4.

The fifth question is of a total different aspect, and targets how the visual interface should look like. This should result in a list with all possible kinds of requirements for the interface. The sixth question should result in a comparable list like the one from question 5, only now for the auditory interface.

At last question seven should give an overview in possible difficulties that can be expected when analyzing results from experiments with PwDs.

1.3 Technical variables

At the start of the interview some technical variables have to be gathered. Some basic information has to be gathered. The following technical variables will be gathered:

- interview number;
- start time;
- end time;
- total duration;
- date;
- presence of third parties;
- name of interviewer;
- gender of interviewer;
- occupation of interviewer;
- affiliation of interviewer;
- name of interviewee;
- gender of interviewee;
- occupation of interviewee;
- affiliation of interviewee.

1.4 Respondents

The questions show that several characteristics should be gathered. Looking at the scope of the research experts in the following areas are needed:

- expertise on a navigation/prompting system (for people with cognitive impairments);
- expertise on an audio-only navigation system;
- expertise on field-trials with PwDs.

1.5 Instructions interviewer

To ensure that every interview is conducted in the same way, and every interviewee is given the same information, the following set of instructions for the interviewer is formulated.

I. Use the given order of questions.
II. Check the recording device (Notebook / Tape recorder / Digital recorder)
III. Convert every recording to MP3, Rename every recording to "COGKNOW_date_#interviewee-number_interviewee-name_part.mp3" (like: "COGKNOW_01122007_#4_Martijn-Hendrikx_1.mp3")
IV. Write down results of the interview within 24 hours after completion.
V. Note the start time and end time of the interview.
VI. Make sure that there will be no distraction during the interview (cell phones turned off, door closed)
VII. Arrange some drinking water for the interviewee and interviewer.
VIII. Introduce interviewer and give introduction with the following information
    a. Organization conducting the research: Telematica Instituut & University of Twente;
    b. Obtained name and contact details via/from: person/organization;
    c. Who else is interviewed; total of three persons. Experts on navigation, auditory support
    d. Objective of interviews: To gather information on conducting experiments with PwDs and developing visual and auditory interfaces for PwDs;
    e. The questions can be answered based on their professional opinion and will include the topics of designing an experiment with PwDs and designing a navigation system prototype for PwDs;
    f. The interviews will deliver input for the design of the prototype and experimental conditions.
    g. The experiment will take place in March.
    h. Ask permission to record the interview; it will only be used to transcribe the interview.
    i. The duration of the interview will approximately be 1 hour.
    j. Does the respondent have any questions or problems?

1.6 Arranging questions

The questions can be divided into three themes. First some questions will asked about the design of the experiment itself, both for the PwDs and de caregivers. Secondly the design of the navigation system will be reviewed. At last attention will be paid to analysis of data gained from this kind of experiments.

<u>Theme I: Designing an experiment for PwDs</u>

- What is the most important aspect to take into account when conducting field experiments with people with a cognitive disability (for example: mild dementia)?

PwDs

- What are the risks when using PwDs in field experiments?
    - Will they panic while participating?

- Are they easily distracted?

- Which problems can be expected when giving PwDs mobile devices?
  - Will they be able to operate a device after give instruction?
  - What kind of operations can they handle?
  - What will be absolutely impossible?

- Which precautions should be taken when taking PwDs outdoors?
  - Should they wear recognizable cloths?
  - Should a caregiver be within close proximity?
  - What about traffic?

Caregivers

- What is in your opinion the role of a caregiver in the experiment?
- How should caregivers be instructed and informed before an experiment in which the PwD is participating?
  - Which kind instructions should they receive?
  - Should they be informed on all the aspects of the experiment beforehand?
  - Should they be within close proximity?

Other roles/parties

- Which other parties should participate in the experiment?
  - professionals

<u>Theme II: Designing a supportive system for PwDs</u>

Visual interface

- Which conditions should the visual interface for a navigation system for PwDs meet?
  - Which kind of menu-structure lies within their ability to operate?
  - What amount of information can be shown on a PDA-screen?

Auditory interface

- Which aspects are important while letting PwDs follow spoken instructions?
  - When should instructions be given (on a crossing or in advance)?
  - How should instructions be formulated?

- Which other modalities do you find important for a system like this?
- What are important factors when combining modalities into one system?

Theme III: Analyzing data from an experiment wit PwDs

- Did you have any problems with the analysis of data from these kinds of experiments?
- Which gaps in scientific knowledge in this research area do you find most problematic?
- What would you change in your experiment if you had to it all over again?

2 Interview scheme for Expert Interviews

EXPERT INTERVIEW AUDITORY NAVIGATION IN THE EU COGKNOW PROJECT

Case# : ..
Time : .. . .. - .. . .. Date : .. / .. / 2008 Location :
Duration :

Presence of third parties : Y / N
If yes, who? ____

	Interviewer	Interviewee
Name :	____________________	____________________
Gender :	M / F	M / F
Occupation :	____________________	____________________

INSTRUCTIONS FOR INTERVIEWER

1. Use the given order of questions.
2. Ask bold questions latterly to the respondent in a calm and friendly way.
3. Check the recording device (Notebook / Tape recorder / Digital recorder)
4. Convert every recording to MP3, Rename every recording to “COGKNOW_date_#interviewee-number_interviewee-name_part.mp3” (like: “COGKNOW_01122007_#4_Martijn-Hendrikx_1.mp3”)
5. Transcribe the interview within 24 hours after completion.
6. Note the start time and end time of the interview.
7. Make sure that there will be no distraction during the interview (cell phones turned off, door closed)
8. Arrange some drinking water for the interviewee and interviewer.
9. Introduce interviewer and give introduction with the following information
   - Organization conducting the research: Telematica Instituut & University of Twente;
   - Obtained name and contact details via/from: person/organization;
   - Who else is interviewed; total of three persons. Experts on navigation, auditory support
   - Objective of interviews: To gather information on conducting experiments with PwD’s and developing visual and auditory interfaces for PwD’s;
   - The questions can be answered based on their professional opinion and will include the topics of designing an experiment with PwD’s and designing a navigation system prototype for PwD’s;
   - The interviews will deliver input for the design of the prototype and experimental conditions.
   - The experiment will take place in March.
   - Ask permission to record the interview; it will only be used to transcribe the interview.
   - The duration of the interview will approximately be 1 hour.
   - Does the respondent have any questions or problems?

Timestamp: .. . ..

Start the audio recorder:

PART I: DESIGING THE EXPERIMENT

- What is the most important aspect to take into account when conducting field
- experiments with people with a cognitive disability (for example: mild dementia)?

1.1 PwD's
- What are the risks when using PwD's in field experiments?
  - Will they panic while participating?
  - Are they easily distracted?

- Which problems can be expected when giving PwD's mobile devices?
  - Will they be able to operate a device after give instruction?
  - What kind of operations can they handle?
  - What will be absolutely impossible?

- Which precautions should be taken when taking PwD's outdoors?
  - Should they wear recognizable cloths?
  - Should a caregiver be within close proximity?
  - What about traffic?

1.2 Caregivers
- What is in your opinion the role of a caregiver in the experiment?
- How should caregivers be instructed and informed before an experiment in which the PwD is participating?
  - Which kind instructions should they receive?
  - Should they be informed on all the aspects of the experiment beforehand?
  - Should they be within close proximity?

1.3 Other roles/parties
- Which other parties should participate in the experiment?
  - professionals

PART II: DESIGNING THE SYSTEM

2.1 visual
- Which conditions should the visual interface for a navigation system for PwD's meet?
  - Which kind of menu-structure lies within their ability to operate?
  - What amount of information can be shown on a PDA-screen?

2.2 auditory
- Which aspects are important while letting PwD's follow spoken instructions?
  - When should instructions be given (on a crossing or in advance)?
  - How should instructions be formulated?

- Which other modalities do you find important for a system like this?
- What are important factors when combining modalities into one system?

PART III: AFTER THE EXPERIMENT

- Did you have any problems with the analysis of data from these kinds of experiments?
- Which gaps in scientific knowledge in this research area do you find most problematic?
- What would you change in your experiment if you had to it all over again?

ROUND UP
- Thank interviewee for participation, ask is he/she would like to be kept informed about the study.
- Ask if there are any questions.

Timestamp: .. ..

3 Results Expert Interviews

3.1 Overview

This chapter describes the gathering of data through expert interviews. Asking experts about their experiences on conducting experiments with people with (mild) dementia has contributed to the knowledge on conducting these kinds of experiments. The interviews had three main goals; first to gain knowledge on doing experiment with PwDs. Secondly on designing a mobile auditory navigation for people with mild dementia. And last on analysing data gathered through this kind of experiments.

The knowledge and experience from experts gave practical information that could not be found in literature. The information on possible constraints and problems that can be expected while conducting field experiments with PwDs, and on designing a mobile auditory navigation for people with mild dementia.

In section 4.2 the design of the expert interviews is described, followed by an overview of the respondents in section 4.3. The results of the interviews are discussed in section 4.4. At last, in section 4.5 the results are translated to a set of guidelines for the experiment. These guidelines contribute to the experiment design in the next chapter.

3.2 Design of expert interviews

The interviews were held in closed room where the interviewer and interviewee would not likely be disturbed by third parties; also no third parties were invited to be present during the interviews. At the start of the interview the interviewee was asked if he had at least one hour reserved in his agenda, because this would be the minimum time required to conduct the interview. The interviewees were asked if they mind if a digital audio recorder would be used to record the session. None of the interviewees had any objections. The recordings were used to transcribe the results into this chapter.

The sessions were shortly introduced by describing the objective of the study and the COGKNOW-project in general. In addition, a layout of the interview was given, and the interviewees were told which topics would be discussed during the interview.

3.3 Respondents

Several experts matching the criteria mentioned chapter 3.2.4 were approached and asked if they wanted to participate in an expert interview on the topic of an auditory navigation system for people with mild dementia. Due to time constraints only two experts were interviewed.

The first interviewee was an expert on prompting systems for young people with cognitive impairments. He did his PhD on this topic, and is currently working as senior researcher at a German research institute. During the development of this system he had hands on experience with designing and developing such a system, and also with doing field studies with young people with cognitive impairments.

The second interviewee was a senior researcher of an academic hospital in The Netherlands. This person participates in the COGKNOW-project as a human factors researcher, and led several field studies and workshops within the project. She also participated in other EU-projects on developing solutions for PwDs. As a medical trained researcher her expertise was on leading experiments with people with cognitive impairments.

3.4 Results from interviews

The interviews lasted for approximately 1 hour. However, the first interview lasted almost 1.5 hour because of the enthusiasm of the interviewee. The interview had to be stopped after 90 minutes because the room was needed for other purposes. The order of topics was consistent in all interviews. In this section answers are clustered according to the three interview topics.

3.4.1 Designing an experiment for PwDs

At the start of the interviews attention was paid to what the interviewees found the most important aspect to take into account when conducting (field) experiments with people with a cognitive impairment. Both interviewees responded that doing research or experiments with people with cognitive impairments is very different from doing research or experiments with normal people. Often they will even forget the appointment, or forget where they are going to when they are on their way to the experiment. Important in this case is to give them an informative sheet they can bring with them. On this sheet the place and time of the experiment can be printed along with the name and telephone number of the experiment leader.

Beforehand you have to take into account the characteristics of their illness in various aspects of your study: when you approach them, ask them for their permission, helping them understand what the study is about, and what their task is. These aspects are things like awareness of their illness, language problems, recognizing items, short-term memory problems and problems with orientation in place, time and persons. Because they have difficulty in understanding why they participate in the study the experiment leader has to make it very clear in an easy explanation what they are going to do. This has also to be done by letter.

PwDs and other cognitive impairments often have difficulties in keeping focused on the subject. You cannot do an intensive study for several hours; you have to keep it short. Adding to their cognitive problems often there are also physical problems that limit people in their ability to move freely.

Because of the differences between people, not every participant will experience the given tasks the same. Some participant will find a task very easy, or even childish. It is important to explain to those people that they have to finish the task, because other people will presumably have problems with the task, and you want to give every participant the same set of tasks. In addition: if someone cannot complete a certain task it is never the fault of the participant. Any failure is always the fault of the system, and if something just does not work out for them, they can always signal the experiment leader. However, the experiment leader should be cautioned in interacting too much with the participants. Letting them fail a certain tasks give much richer data.

During the experiment you have to watch closely in order to be certain that participants understand what they have to do, nonverbal-symptoms are very important in this stage. People are often very good in disguising their problems. Often they confabulate (filling in gaps of memory by fabrication) to make a stronger story, and they will give indirect answers to questions.

When giving participants a mobile device to work with, problems with sight can be expected. Screens on mobile devices are relatively small, and especially older PwDs do not have very much experience with them. Therefore participants should bring along their reading glasses in order to operate the device successfully. To check if they really can see what is on the display, a short and simple task should be done before the real experiment. With doing this task participants can acclimate with the technology and can familiarize themselves with the controls.

PwDs often also have physical problems, especially people with Lewy Body Dementia (like Parkinson’s disease with dementia). These people often need extra equipment, like a walking stick or rollator. Because of these problems participants can have difficulties handling the device. Buttons should therefore be big and clear. Dementia also limits the ability to process multiple stimuli simultaneously. Therefore it can be hard for the participant to understand different stimuli. These stimuli should not be given simultaneously to the participant, but one after another.

At last participants can have individual physical or mental problems; in this case a caregiver can help to provide this kind of information. There is usually a caregiver belonging to a PwD. These caregivers can provide a lot of information on problems to be expected, and on gathering information on daily activities of the person with dementia (PwD). Caregivers often play an important role in the life of the PwD. Therefore special attention should be paid to them.

Caregivers should be informed on the experiment the PwD is participating. He also should sign an approval form before the PwD can participate in the experiment. The caregiver needs to feel that his partner is in good hands.

3.4.2 Designing a supportive system for PwDs

Subsequently, attention was paid to the designing of a system that could be used during the experiment, and the auditory navigation system that could be developed for people with mild dementia. First the visual design was discussed, secondly the auditory interface, and at last other modalities were discussed.

The explicit statement both interviewees made immediately was that the system should be easy, not complex, understandable, recognizable, and should not contain too much information at simultaneously. Letting PwDs learn a digital system can be very hard, because they do not have knowledge on these kinds of systems. Using photographs often works well with people with cognitive impairments, because people below a certain cognitive level have much more problems recognizing icons than recognizing photos. Especially when the photos are clear and do not contain to much irrelevant background. Unfortunately it is not always technically feasible to use photographs, the best next thing to use is a picture or arrow but written text should be avoided.

According to both interviewees using a less options and buttons as possible is a good thing. This again can be allocated to the fact that these people do not process large loads of information simultaneously.

Because of errors that could be made with the system it is best to toasterize the whole system. In this way people can only start the experimental application, and do nothing else with the device.

Audio is a good addition to a visual interface, and is often easy to understand for PwDs. A big problem however can be, again, the simultaneous processing of all this information. In the opinion of the interviewees audio messages from the device should be clear, comprehensible and short. The language used should not be in commando-style, but also not too informal. Otherwise the participant will feel … or do not feel obliged to follow up the instructions. A good rule of thumb is not to use many verbs in the messages. One of the interviewees made a check in his tool that counted the verbs that were used. If more than two verbs were used in one sentence, the tool would display a warning that the message was not good. In addition, a list of applicable words for people with a certain cognitive level was used. If too many of the words in a certain prompt were not in that list, a warning would be shown.

While developing the system timing of the messages can be an issue. It should be made sure that the audio message will not play before or after the participant sees the visual interface.

The use of other modalities, like vibration, should be possible. However, there is a chance that participants will panic when the device vibrates. In addition, it asks extra processing capability from the PwD.

3.4.3 Analyzing data from an experiment with PwDs

Concluding the interviews attention was paid about how the data from experiments was used. One of the interviewees responded that making audio recordings during the experiments was very helpful, and that he would do it always, even outdoors. In addition, it is important to think about what you want to be automatically be measured by your tool, as time is needed to build it into the application.

After asking what the interviewees would change in their experiments if they could do it al over again they responded several remarkable items. First the interaction with the participants during the experiments should be minimal, as a researcher you often want to explain or help the participants too much. In addition, the tools you use should be foolproof; participants always find ways to do unexpected things. During experiments attention should be paid to nonverbal aspects. A lot of information can be missed when participants are not watched closely.

3.5 Guidelines for field experiments with PwDs

As mentioned earlier in this chapter, the results from the interview contribute to the design of the study in the next chapter. Because the results of the interviews are divided in three areas, the guidelines will also be split up in three parts. Result from area III however are included in areas I and II, because they have to be considered before the experiment will take place.

Design of the experiment

- Provide participants with a information-sheet conducting all necessary information of the experiment (where, when, contact person);
- Take into account the way how to approach participants, helping them to understand what their task is and what the study is about;
- Ask permission to make photographs and to participate in the study;
- Time the experiment, do not make it too long for the participants;
- Keep physical problems into account; (problems with walking, eyesight, shaky hands)
- Do not assist the participant too fast in completing a task, letting them fail will give much richer information;
- Verify that participant understand a task by asking specific question about it;
- Ask the caregiver for specific personal problems he aspects for the participant;
- Make the caregiver feel secure about the situation of the participant;
- Make Audio recordings of participant and experiment leader during the experiments, it can speed up analyzing data a lot.

Design of the system

- Make the system as easy as possible. Understandable, recognizable, and small amount of information are the keywords for success;
- PwDs can not process too much information simultaneously, especially not when given through multiple modalities at once;
- Limit the number of options and menus as much as possible;
- Make the system foolproof, do not let other applications on the device disturb the experiment;
- Make sure audio messages are clear, comprehensible and short
- Language used in audio messages should be clear, not in commando-style, but also not too informal;
- Do not use too many verbs in audio messages;
- Timing of audio messages should be pre-tested.

Appendix B Task Load Index

ERVAREN WORKLOAD TIJDENS VELD EXPERIMENT (V 2.0)
Gebaseerd op Hart & Staveland's NASA Task Load Index (TLX)

NAAM:	________________	ROUTE:	A / B / C / D
PARTICIPANT#:	___	CONDITIE:	U / UE / F / FE
DATUM:	___ / _______ / 2008		

Intro: Ik ga u nu enkele vragen stellen over wat u aan het doen bent. Bij elke vraag geef ik u vijf mogelijke antwoorden om uit te kiezen.

1. Hoe zwaar vond u de taak lichamelijk?

Helemaal niet zwaar	Niet echt zwaar	Normaal	Aardig zwaar	Heel zwaar

2. Hoe zwaar vond u de taak geestelijk?

Helemaal niet zwaar	Niet echt zwaar	Normaal	Aardig zwaar	Heel zwaar

3. Hoe vond u het tempo van de taak?

Veel te langzaam	Aardig langzaam	Normaal	Aardig snel	Veel te snel

4. Hoe goed vond u dat u de taak deed?

Heel slecht	Behoorlijk slecht	neutraal	Behoorlijk goed	Heel goed

5. Hoe hard hebt u moeten werken?

Helemaal niet hard	Niet echt hard	Niet hard / niet zacht	Een beetje hard	erg hard

6. Hoe onzeker voelde u zicht tijdens de taak?

Heel zeker	Aardig zeker	Niet zeker / onzeker	Aardig onzeker	Heel onzeker

7. Hoe vervelend vond u de taak?

Helemaal niet vervelend	Niet echt vervelend	Neutraal	Aardig vervelend	Heel vervelend

.

Appendix C Satisfaction Questionnaire

Satisfaction Questionnaire (after experiment)

Helemaal mee oneens – een beetje mee oneens – neutraal – een beetje mee eens – helemaal mee eens

		Helemaal mee oneens					Helemaal mee eens
1	Ik wil dit systeem vaker gebruiken.	1	2	3	4	5	
2	Ik voelde mij zekerder op straat met dit systeem.	1	2	3	4	5	
3	Ik vond dit systeem prettig om te gebruiken.	1	2	3	4	5	
4	Ik kon met dit systeem de route makkelijk lopen.	1	2	3	4	5	
5	Ik voelde mij veiliger op straat met dit systeem.	1	2	3	4	5	

Appendix D TomTom Voice Commands

50	Na	Keer om
80	Vertrek	Verderop rechts aanhouden
100	Aan het einde van de weg	Verderop rechtsaf
200	Daarna	Links afbuigen
300	Links afslaan	Houd links aan
400	Scherpe bocht naar rechts	Scherpe bocht naar links
500	Bestemming bereikt	Verderop links aanhouden
600	Ga rechtdoor	Verderop linksaf
700	Probeer om te draaien	Verderop omkeren
800	Rechts afslaan	Rechts afbuigen
Meter		houd rechts aan

Appendix E Observation form

TECHNICAL DATA				GENERAL REMARKS
NAAM: ___________________	ROUTE: A / B / C / D	START TIME: .. ..:.. ..		
PARTICIPANT#: ___	CONDITIE: U / UE / F / FE	STOP TIME: .. ..:.. ..		
DATUM: ___ / ________ / 2008		TOTAL DURATION: .. ..:.. ..		

		Legenda			
		Assistance	…	Error	…
		Deviation	…	Time	…

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
1	O	O	O	O	O	.. ..:.. ..	
2	O	O	O	O	O	.. ..:.. ..	
3	O	O	O	O	O	.. ..:.. ..	
4	O	O	O	O	O	.. ..:.. ..	
5	O	O	O	O	O	.. ..:.. ..	
6	O	O	O	O	O	.. ..:.. ..	
7	O	O	O	O	O	.. ..:.. ..	
8	O	O	O	O	O	.. ..:.. ..	
9	O	O	O	O	O	.. ..:.. ..	
10	O	O	O	O	O	.. ..:.. ..	
11	O	O	O	O	O	.. ..:.. ..	
12	O	O	O	O	O	.. ..:.. ..	
13	O	O	O	O	O	.. ..:.. ..	
14	O	O	O	O	O	.. ..:.. ..	
15	O	O	O	O	O	.. ..:.. ..	
16	O	O	O	O	O	.. ..:.. ..	
17	O	O	O	O	O	.. ..:.. ..	
18	O	O	O	O	O	.. ..:.. ..	

Appendix F Observations and observation coding

TECHNICAL DATA	Dag 1 – Route 1	Route 1	GENERAL REMARKS
NAAM:	ROUTE: **A** / B / C / D	START TIME: 13:13	
PARTICIPANT#: 1	CONDITIE: **U** / UE / F / FE	STOP TIME: 13:37	
DATUM: 1 / 4 / 2008		TOTAL DURATION: 24:15	

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
1	X					1:40	P1: Moet ik hier nou al af of niet? E: Pas als die iets zegt. P1: Oh.
						2:35	S: Na 50 meter rechts afslaan, daarna links afslaan.
						2:52	S: Rechts afslaan, daarna links afslaan.
2	X	X				3:18	P1: Na 50 meter, maar dat is toch geen 50 meter? Dat kleine eindje. E: De eerste keer zei die 50 meter P1: Dan denk ik dat ik naar die hoek moet E: Wilt u nog eens kijken wat ie zegt? P1: Als ik nou rechtdoor loop en het is niet goed dan zegt ie wat? E: Dat weet ik niet. P1: Nou inmiddels, dat pijltje dat stond zo en nou is die die kant op. E: Ja, ik mag u daarover geen aanwijzingen geven, maar u was wel goed. P1: rechtdoor? E: Nee, u had al wel 50 meter gehad P1: Dus hierheen. EIND 4:18
						4:29	S: Probeer om te draaien
						4:55	S: Links afslaan
						6:37	S: Probeer om te draaien, daarna aan het einde van de weg rechts afslaan.
						6:42	P1: Probeer om te draaien…
						6:49	S: Rechts afslaan, daarna aan het einde van de weg rechts afslaan.
3			X			6:52	Kleine afwijking, mvr ging rechts en werd gecorrigeerd door systeem (omdraaien, daarna rechts)
						7:26	S: Rechts afslaan
4	X					9:00	P1: Er staat wel een pijltje links, maar dat zegt niks, dus ik zal daar maar heen lopen. O: P1 is bij bocht in de weg
						11:36	S: Aan het einde van de weg links afslaan, daarna links afbuigen
						11:57	S: Links afslaan, daarna links afbuigen
5					X	12:55	P1: Zulke mooei blauwe bloempjes. E: Inderdaad
						12:58	S: Links afbuigen
						13:54	S: Na 50 meter rechts afslaan, daarna links afslaan.
						14:06	S: Rechts afslaan, daarna links afslaan.
6						15:00	TLX afnemen van 15:00 tot 18:05
						15:08	S: Links afslaan
7					X	19:30	P1: Die heeft ook geen slecht leven, dat hondje E: Dat dacht ik ook al P1: lacht.
						19:34	S: Aan het einde van de weg rechts afslaan.
8				X	X	20:08	S: Probeer om te draaien, daarna aan het einde van de weg rechts afslaan. O: P1 trekt zicht er niets van aan.
						20:16	S: Rechts afslaan
9	X					20:50	P1: Ben ik verkeerd soms? E: Nee, dat betekent dat u er bijna bent. (Finish vlag is in beeld) P1: Oh.
10	X					23:10	S: Na 50 meter bestemming bereikt. P1: Dat verstond ik nou net niet. (Vrachtwagen rijdt voorbij) E: Dan mag u nogmaals in het zilveren vierkantje klikken. S: Na 50 meter bestemming bereikt. P1: Na 50 meter bestemming bereikt, dan dacht ik dat ik het daar heen was, daar woon ik ergens. E: U gaat niet naar huis toe, u moet de route aflopen. EIND: 23:45
11	X					24:08	P1: Waar is dat ook alweer voor dit? E: Is het goed als ik u dat straks vertelt?
						24:15	S: Bestemming bereikt FINISH
12						25:02	SQ

TECHNICAL DATA	Dag 1 – Route 2	Route 2
NAAM:	ROUTE: A / **B** / C / D	START TIME: 13:45
PARTICIPANT#: 1	CONDITIE: U / UE / **F** / FE	STOP TIME: 14:05
DATUM: 1 / 4 / 2008		TOTAL DURATION: 20:00

GENERAL REMARKS
Mevrouw heeft last van haar teen en stop daarom onderweg even 1 minuut (punt 6)

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other	0:10	
						0:10	E: Dan mogen we die kant op gaan lopen
						0:58	P1: Dan gaan we daarheen hè? E: Dan moet u even op het apparaatje kijken. P1: Ja, zo.
1	X					1:24	P1: Waarvoor is dit dan nou weer? Waarvoor is dit apparaatje dan nou weer? E: Dit is een ander apparaatje.
						1:43	P1: Ik ben wel nieuwschierig hè? E: Dat is helemaal niet erg. P1: lacht
						1:55	P1: Oei, daar ging ik (struikelt bijna)
						2:15	S: Na 50 meter rechts afslaan
2	X					2:50	P1: Na 50 meter rechts afslaan, ... , ik dacht dat het al gebeurd was. E: Nee, dit is het tweede deel, daarna zijn we klaar S: Rechts afslaan.
3				X		3:05	P1: Na 50 meter, dan zou ik zeggen dat het nu is. E: Drukt u nog eens. P1: het pijltje staat nu daar heen E: U kunt de boodschap nog eens herhalen S:Rechts afslaan P1: Rechts afslaan, ja dat is daarheen. EIND: 3:35
						4:47	S: Aan het einde van de weg links afslaan, daarna aan het einde van de weg rechts afslaan
4					X	5:08	P1: Pas getrouwd, haha (Pas getrouwd bord in een tuin)
5				X		5:28	P1: Nou moet ik het even weer horen S: Aan het einde van de weg links afslaan, daarna aan het einde van de weg rechts afslaan.
						5:45	S: links afslaan, daarna aan het einde van de weg rechts afslaan.
						6:28	S: Rechts afslaan, daarna links afslaan
						7:22	S: Links afslaan
6					X	8:04	P1: Nou moet ik even zitten. E: Bent u moet? U mag rustig even zitten, dat is niet erg. P1: U wacht wel even toch? E: Natuurlijk O: P1 checkt ondertussen de straatnaam op het apparaat en de bewegwijzering. P1: Nou vooruit dan maar, gaan we weer. EIND: 9:04
						9:45	S: Aan het einde van de weg links afslaan, daarna links afslaan.
						10:05	S: Links afslaan, daarna links afslaan.
						11:05	S: Links afslaan
7						13:04	TLX tot 15:23
						15:50	S: Aan het einde van de weg, rechts afslaan
						16:18	S: Rechts afslaan
						17:45	S: Aan het einde van de weg, rechts afslaan
8	x					17:57	P1: Ik moet nog verder hè? E: U moet nog die kant op, even de aanwijzingen volgen.
						18:10	S: Rechts afslaan, daarna bestemming bereikt.
9				X		18:40	P1: Dan zou ik denken links afslaan, maar dat zegt ie niet. E: U moet nog even de route aflopen, weet u nog wat het apparaat zei? P1: Rechts afslaan, daarna bestemming bereikt. E: Ok, dan moet u dat nog even doen. P1: Ik zal nog even drukken S: Rechts afslaan, daarna bestemming bereikt. EIND: 19:05
						19:34	S: Probeer om te draaien P1: Bestemming bereikt moet ik eerst hebben P1: Nee! E: Wat zei u? P1: Bestemming bereikt, en nu moet ik omdraaien. E: Nou gelukkig zijn we er (GPS Fout), volgens het gebouw ziet het apparaat het even niet.
10						20:00	S: Bestemming bereikt FINISH
						20:15	SQ

TECHNICAL DATA	Dag 2 – Route 1	Route 3
NAAM:	ROUTE: A / B / **C** / D	START TIME: 13:10
PARTICIPANT#: 1	CONDITIE: U / UE / F / **FE**	STOP TIME: 13:35
DATUM: 4 / 4 / 2008		TOTAL DURATION: 00:24:32

GENERAL REMARKS

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
						4:29	S: Aan het einde van de weg, links afslaan
						4:44	S: Links afslaan
1		X	X			6:30	E: Mag ik u even onderbreken, ik wil even naar het apparaatje kijken. Ik heb het idee dat hij het niet goed doet. P1: Hij praat niet hè? E: Nee, hij praat niet zo veel inderdaad. S: Keer om 07:00 E: Wilt u even teruglopen naar het vorige kruispunt? P1: Ja, dat is goed. O: E werkt op apparaat om deze correct in te stellen S: Keer om 08:04 E: Blijft u hier maar staan. P1: Ja S: Rechts afslaan S: Rechts afslaan 08:25 E: U mag nu weer die kant op gaan lopen. P1: ik moest nu wel eerst links af, en dan straks rechts. P1: Doet ie het nu? E: We steken nog even het kruispunt over S: Probeer om te draaien, daarna links afslaan (2x) E: U mag nu die kant op gaan lopen, dan moet het goed komen P1: Ok. EIND: 9:30
2		X	X			10:00	S: Links afslaan P1: Nou zegt ie links afslaan. Dat zou zeggen dat ik weer terug moet. E: Gaat u maar gewoon die kant op. EIND: 10:20
						10:35	S: Probeer om te draaien, daarna rechts afslaan P1: Probeer om te draaien, daarna rechts afslaan E: Ik weet niet wat er momenteel mis is met het apparaat S: Rechts afslaan P1: Hij doet het niet goed. E: Hij geeft het nu goed aan, u kunt altijd op het knopje drukken om het te herhalen.
3		X				11:50	E: Mevrouw, wat stond er nu op het apparaatje? Kunt u de boodschap nog een keer herhalen? S: Rechts afslaan. P1: Recht afslaan, dus hier tussendoor, dan gaan we hierheen.
4				X		12:30	S: Probeer om te draaien, daarna aan het einde van de weg, links afslaan. P1: Moet ik nu omdraaien E: Loopt u maar even een stukje verder.
						13:20	E: Ik zal het apparaat nog even 1x controleren. S: Probeer om te draaien
5		X				14:00	E: Hij werkt nu helemaal goed, u kunt verder. EIND: 14:10
6					X	14:30	S: Rechts afslaan, daarna aan het einde van de weg links afslaan P1: Nu moet ik rechts afslaan, o en aan het einde weer links O: P1 loopt goed.
						14:55	S: Links afslaan, daarna links afslaan
						15:54	S: Links afslaan
7					X	16:00	P1: Links afslaan, dan moet ik daar weer heen, grappig, grappig
						17:43	S: Aan het einde van de weg links afslaan
8	X					17:50	P1: Is dit nou weer de volgende, ik moest zonet links af, en nu zeggen ze weer links af aan het einde van de weg. E: Dat kan, u moet gewoon doen wat het apparaat zegt. P1: Nee, want ik dacht...
						18:11	S: Links afslaan
						19:12	S: na 50 meter, rechts afslaan, daarna, links afslaan.
9						19:30	TLX tot 21:58
10						21:58	S: Probeer om te draaien P1: Nou zeggen ze probeer om te draaien. E: Begint u maar met lopen
						22:50	O: Buurkind vraagt wat we aan het doen zijn. P1: Zeg maar dat als hij later student is hij dit ook doet. E: Ik heb net gezegd dat we gewoon aan het lopen zijn. P1: haha, ok
11						23:15	S: Aan het einde van de weg links afslaan P1: Daarheen dat kan niet, dus we gaan links
						23:45	S: Links afslaan, daarna bestemming bereikt
12					X	24:40	O: P1 gaat op de weg lopen
13						24:32	S: Bestemming bereikt E: We gaan even aan de andere kant van de weg staan. FINISH

TECHNICAL DATA	Dag 2 – Route 2	Route 4
NAAM:	ROUTE: A / B / C / **D**	START TIME: 13:42
PARTICIPANT#: 1	CONDITIE: U / **UE** / F / FE	STOP TIME: 14:00
DATUM: 4 / 4 / 2008		TOTAL DURATION: 19:00

GENERAL REMARKS

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
						0:43	S: Rechts afslaan, daarna links afslaan P1: Rechts afslaan...
						1:20	S: Links afslaan
1				X		1:30	P1: Zou ik hier nou links af moeten? E: Dan moet u even de boodschap herhalen als u dat wilt weten S: Links afslaan P1: Links afslaan
2				X		4:13	S: Na 50 meter links afslaan
						4:50	P1: Daar, klein eindje tot ongeveer daar. Toen zeiden ze links afslaan. E: Dan moet u even de boodschap herhalen als u dat wilt weten S: Na 50 meter links afslaan P1: Dit zal wel ongeveer 50 meter zijn, dat ga ik maar proberen.
3					X	5:45	P1: Ik mag wel weer eens flink gaan wandelen. Ik kom der goed mee weg.
						6:36	S: Links afslaan, daarna rechts afslaan
						7:38	S: Rechts afslaan, daarna links afslaan
4					X	8:25	O: P1 kijkt naar straatnaam
5				X		8:42	S: Na 50 meter links afslaan
						8:55	S: Links afslaan
						9:56	S: Aan het einde van de weg, rechts afslaan
						10:16	S: Rechts afslaan
						11:54	S: Na 50 meter rechts afslaan P1: 50 meter, geen idee
						12:16	S: Rechts afslaan
6					X	12:30	P1: Poeh poeh. (10 sec.)
7						13:40	TLX tot 15:30
						17:10	S: Aan het einde van de weg, links afslaan
						17:25	S: Links afslaan, daarna bestemming bereikt.
8						17:54	S: Bestemming bereikt E: Zo, we zijn er weer. P1: Ja, ik zie daar al de posten. FINISH

TECHNICAL DATA	Dag 1 – Route 1	Route 1
NAAM:	ROUTE: **A** / B / C / D	START TIME: 10:08
PARTICIPANT#: 2	CONDITIE: U / **UE** / F / FE	STOP TIME: 10:40
DATUM: 15 / 4 / 2008		TOTAL DURATION 0:32:44

GENERAL REMARKS
7x geholpen rollator op stoep te tillen.

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
1				X	X	0:40	S: Probeer om te draaien, daarna rechts afslaan. E: Pardon, ik zal het apparaat even voor u herstellen, het apparaat heeft in het begin af en toe moeite om op gang te komen.
						3:02	S: Na 50 meter rechts afslaan, daarna links afslaan
						3:15	S: Rechts afslaan, daarna links afslaan
2	X	X				3:25	E: Wat zei u? P2: Links aflaan? E: Als u het niet zeker weet kunt u altijd de boodschap even herhalen. P2: Ja
						4:05	S: Na 50 meter links afslaan
3					X	4:40	S: Probeer om te draaien, daarna, aan het einde van de weg links afslaan.
4						5:15	O: Rollator omdraaien
5						5:30	S: Rechts afslaan E: Mvr. mag ik u even storen? O: Problemen met GPS Eind: 6:40
						6:57	S: Links afslaan
6		X			X	7:30	O: P2 gaat rechtdoor
7			X	X		8:22	S: Probeer om te draaien
						8:33	S: Na 50 meter rechts afslaan
						8:48	S: Rechts afslaan
						10:00	E: Zal ik u even helpen? (met de rollator op de stoep krijgen) P2: Soms hebben ze wel van de troitoirs waar je zo op kunt P2: Het is nog lekker weer, zonnetje erbij
						10:25	S: Aan het einde van de weg links afslaan
						10:42	S: Links afslaan
8						12:35	E: Mag ik u even storen, u mag wel even op de stoep gaan staan. U mag even blijven staan. O: GPS probleem 14:25 > E: U mag weer die kant op gaan lopen, het apparaat was even in de war. EIND: 14:36
						15:15	O: E checkt boodschap (S: Na 50 meter rechts afslaan)
9				X		15:40	S: Rechts afslaan E: Ik moet u helaas weer storen, hij heeft er een beetje een hard hoofd in vandaag. P2: Doet ie het niet goed E: Nee, maar het is niet erg hoor, dat noteer ik allemaal. O: GPS problemen (route herberekend) E: Nu is het weer goed S: Aan het einde van de weg links afslaan, daarna links afbuigen E: U mag nu weer verder. P2: Maar zonet zij hij rechts afslaan E: Dat klopt, dat was een foutje, nu zegt hij... S: Aan het einde van de w eg links afslaan, daarna links afbuigen EIND: 16:54 GPS
						17:24	P2: Is er nog verschil daar lopen of daar (twee smalle voetpaden). E: Nee, dat mag u zelf weten.
						20:33	P2: Das een mooie wandeling!
						20:55	S: Aan het einde van de weg links afslaan, daarna links afbuigen.
						21:12	S: links afslaan, daarna links afbuigen.
10			X		X	21:57	S: Probeer om te draaien, daarna aan het einde van de weg links afslaan
						22:15	S: Links afslaan, daarna links afbuigen
						23:00	S: Links afbuigen
11						23:55	TLX tot 26:00
12		X				26:00	E: Ik zal even kijken wat het apparaat zegt. O: GPS controle E: U mag gewoon verder lopen EIND 26:28
						26:40	S: Na 50 meter rechts afslaan, daarna links afslaan
13				X		27:05	P2: Moet ik hier nou al of kan ik rechtdoor lopen? E: Dan moet u even op het apparaatje kijken O: P2 herhaalt boodschap S: Na 50 meter rechts afslaan, daarna links afslaan P2: Ja, omdat er twee af zij hè!
14				X		27:45	S: Aan het einde van de weg links, daarna aan het einde van de weg rechts afslaan.
						28:05	S: Links afslaan, daarna aan het einde van de weg rechts afslaan.
						29:33	S: Aan het einde van de weg, rechts afslaan
15						32:25	S: Na 50 meter bestemming bereikt. P2: Oh!
16						32:44	S: Bestemming bereikt FINISH

TECHNICAL DATA	Dag 1 – Route 2	Route 2
NAAM:	ROUTE: A / B / C / **D**	START TIME: 10:46
PARTICIPANT#: 2	CONDITIE: U / UE / F / **FE**	STOP TIME: 11:03
DATUM: 15 / 4 / 2008		TOTAL DURATION: 0:17:30

GENERAL REMARKS
FE Stem is erg zacht, hierdoor blijft mvr stilstaan

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
1					X	0:50	S: Aan het einde van de weg rechts afslaan, daarna links afslaan P2: De stem is zacht, moeilijk te horen Tot 1:15
2				X		1:50	P2: Hij deed heel zacht, hij zij rechts af, maar wat ie toen zij weet ik niet. O: E helpt apparaat harder te zetten S: Rechts afslaan, daarna links afslaan Eind: 2:20
						2:25	S: Links afslaan
						4:55	S: Na 50 meter links afslaan
						5:15	S: Links afslaan
3					X	5:30	P2: Ik ga hier oversteken
						6:20	S: Aan het einde van de weg links afslaan, daarna rechts afslaan
4					X	6:45	O: P2 zegt hallo tegen bekenden.
						6:48	S: links afslaan, daarna rechts afslaan.
						7:40	S: Rechts afslaan, daarna links afslaan.
5					X	8:05	P2: Moet ik hier rechts het is zo'n klein weggetje? E: Maar het is wel een weggetje, dan moet u even op uw apparaat kijken. P2: En daarna links af. Ja.
						8:40	S: Links afslaan
						9:35	P2: Ik wou daar links er over, maar er komt een auto aan, er was een afrit. O: P2 steekt iets eerder over.
6					X	10:00	S: Na 50 meter rechts afslaan. O: Veel lawaai vanaf straat, toch werd de boodschap gehoord.
						10:20	S: Rechts afslaan.
						11:40	S: Na 50 meter rechts afslaan.
						12:06	S: Rechts afslaan.
7						12:43	TLX tot 14:04
						16:33	S: Aan het einde van de weg, links afslaan
						16:53	S: Links afslaan, daarna bestemming bereikt
8						17:30	S: Bestemming bereikt FINISH

TECHNICAL DATA	Dag 2 – Route 1	Route 3
NAAM:	ROUTE: A / B / **C** / D	START TIME: 10:04
PARTICIPANT#: 2	CONDITIE: U / UE / **F** / FE	STOP TIME: 10:26
DATUM: / 4 / 2008		TOTAL DURATION: 00:22:05

GENERAL REMARKS

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other	0:20	
						5:22	O: S doet 'pling'(geheugen bijna vol) S: Links afslaan, daarna rechts afslaan
1	X					5:50	P2 Daarna rechts af dus? E: Wat zij u? P2: Linksaf, daarna rechtsaf. Had ik zo misschien door moeten lopen ofzo? E: Het maakt niet uit welk stoepje u neemt hoor. P2: oh.
2			X			6:25	O: P2 gaat tweemaal links (links op stoep en overkant weg)
						6:40	S: Probeer om te draaien.
3		X				7:05	E: Mag ik even op uw apparaatje kijken S: Probeer om te draaien E: U gaat de verkeerde kant op P2: Ik ga de verkeerde kant op? Oh! Moet ik omdraaien? E: Ik zal even uw apparaat nakijken voor de zekerheid. O: S doet 'pling' (geheugen is vol) E: Het gaat even fout P2: Ik kan het ook haast niet horen. S: Probeer om te draaien. E: Momentje. Het apparaat is vol. P2: Deed ik iets verkeerd? E: Nee absoluut niet O: Geheugen PDA vol, opgeschoond en verder lopen. EIND: 9:35
						9:40	S: Probeer om te draaien
						9:45	S: Aan het einde van de weg links afslaan, daarna rechts afslaan
4				X		10:00	O: P2 herhaald boodschap S: Links afslaan, daarna rechts afslaan P2: ik dacht ik moet even wat indrukken want door het lawaai van die kinderen kon ik het niet horen.
						10:35	S: Rechts afslaan
						12:15	S Aan het van de weg rechts afslaan, daarna aan het einde van de weg links afslaan
						12:35	S: Rechts afslaan, daarna aan het einde van de weg links afslaan
						13:08	S: Links afslaan, daarna links afslaan
						14:02	S: Links afslaan
5					X	15:00	P2: Ik ga er daar op. O: P2 steekt de weg over.
						16:05	S: Aan het einde van de weg links afslaan
						16:20	S: Links afslaan
6					X	17:35	TLX tot 19:00
						20:40	S: Aan het einde van de weg links afslaan
						20:55	S: Links afslaan, daarna bestemming bereikt
7						22:05	S: Bestemming bereikt FINISH

TECHNICAL DATA	Dag 2 – Route 2	Route 4
NAAM:	ROUTE: A / **B** / C / D	START TIME: 10:31
PARTICIPANT#: 2	CONDITIE: **U** / UE / F / FE	STOP TIME: 10:46
DATUM: 17 / 4 / 2008		TOTAL DURATION: 00:15:02

GENERAL REMARKS

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other	0:20	
						0:15	S: Aan het einde van de weg links afslaan. P2: Dat kan ik nou nog eens mooi horen
						0:35	S: aan het einde van de weg links afslaan
						0:55	S: Links afslaan
1		X				1:40	E: Mvr. Mag ik even controleren of alles goed gaat? O: E checkt scherm met aanwijzingen E: Ok, loopt u maar door GPS check
						2:25	S: Na 50 meter rechts afslaan
2		X		X		2:30	P2: Al dat lawaai S: Rechts afslaan E: Zal ik even bij u kijken? P2: Ja. Ik had het door al het lawaai niet gehoord. S: Rechts afslaan EIND: 2:40
3				X		2:55	S: Rechts afslaan
						3:09	S: Links afslaan
4						3:35	E: Mvr, mag ik u nog even storen? P2: Is er wat fout? E: Het apparaat reageert niet goed S: Aan het einde van de weg rechts afslaan, daarna bestemming bereikt. ... E: Dan mag u van mij die weg in slaan. O: Route fout, herberekenen tot 4:15
						4:52	S: Aan het einde van de weg links afslaan, daarna aan het einde van de weg rechts afslaan.
						5:20	S: Links afslaan, daarna aan het einde van de weg rechts afslaan.
						6:05	S: Rechts afslaan, daarna links afslaan.
						6:50	S: Links afslaan.
						8:35	S: Aan het einde van de weg links afslaan, daarna links afslaan.
						9:25	S: Links afslaan.
5						10:25	TLX tot 11:30
						12:30	S: Aan het einde van de weg rechts afslaan.
						12:45	S: Rechts afslaan.
						14:15	S: Aan het einde van de weg rechts afslaan.
						14:30	S: Rechts afslaan, daarna bestemming bereikt.
6						15:02	S: Bestemming bereikt. FINISH

TECHNICAL DATA	Dag 1 – Route 1	Route 1
NAAM:	ROUTE: A / B / **C** / D	START TIME: 13:11
PARTICIPANT#: 3	CONDITIE: **U** / UE / F / FE	STOP TIME: 13:29
DATUM: 14 / 4 / 2008		TOTAL DURATION: 0:17:45

GENERAL REMARKS

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
						1:50	P3: Hij wacht wel even. (auto kruist het voetpad)
						4:33	P3: Ik zit net te denken S: Aan het einde van de weg, links afslaan, daarna rechts afslaan. P3: Links afslaan, dat is die kant op.
1		X				4:50	E: U mag gewoon de wegen volgen (mvr. wil een smal voetpad inlopen). P3: Dus linksaf? E: Als u het niet zeker weet kunt u de boodschap herhalen. P3: Maar ik weet het wel. Jawel, ik kom hier vaker.
						5:30	S: Links afslaan, daarna rechts afslaan. P3: Links afslaan, dus dat moet hier. ... links afslaan.
						6:15	S: Rechts afslaan.
2					X	6:50	P3: Dit is toch rechts hè? Ja. O: P3 gaat op de weg lopen.
						7:25	S: Aan het einde van de weg rechts afslaan, daarna aan het einde van de weg links afslaan.
						7:45	S: Rechts afslaan, daarna aan het einde van de weg links afslaan.
						8:15	S: Links afslaan, daarna links afslaan.
						9:02	S: Links afslaan.
3					X	9:50	P3: Zit toch nog wel goed hè. E: Dat kan ik u niet zeggen, dan moet u even op het apparaatje kijken. E: Dan moet u even op het knopje drukken. P3: Maar ik weet het wel, ik ken het hier wel, de rekkenbrink. Hier weer om hè?
4					X	10:47	P3: Nog steeds links af hè? S: Aan het einde van de weg links afslaan. P3: Juist ja, aan het einde van de weg links afslaan.
						11:15	S: Links afslaan
						12:25	S: Na 50 meter rechts afslaan, daarna links afslaan.
						12:40	S: Rechts afslaan, daarna links afslaan.
5						12:40	TLX tot 15:05
6					X	15:05	GPS Controle Eind: 15:25
						16:04	S: Links afslaan
						17:05	S: Na 50 meter bestemming bereikt.
7						17:25	S: Bestemming bereikt FINISH (Doorlopen tot kruising: 17:45)

TECHNICAL DATA	Dag 1 – Route 2	Route 2	GENERAL REMARKS
NAAM:	ROUTE: A / **B** / C / D	START TIME: 13:34	GPS problemen
PARTICIPANT#: 3	CONDITIE: U / **UE** / F / FE	STOP TIME: 13:50	
DATUM: 14 / 4 / 2008		TOTAL DURATION: 16:15	

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
						0:55	P3: Moet ik het nu zelf bepalen of niet? E: Hij zegt het gewoon tegen u.
1		X				1:10	P3: Nou... E: Ik zal het even voor u nakijken. E: U mag gewoon even op het knopje drukken. In het grijze vierkantje. S: Verderop linksaf. (foute richting) E: ik zal u even helpen. P3: Ik zit niet zo goed in het vak. S: Na 200 meter rechts afslaan. E: ik zal u voor deze keer even helpen, u mag links oversteken. EIND: 2:17 GPS fout
2				X		2:25	S: Probeer om te draaien O: GPS fout P3: Om te draaien, tja.
3					X	4:00	E: Mag ik u heel even storen. S: Probeer om te draaien. S: Rechts afslaan. E: Nu staat ie goed P3: Dus hier rechtsaf EIND 4:30 (GPS fout)
						5:05	S: Aan het einde van de weg links afslaan, daarna aan het einde van de weg rechts afslaan.
						5:25	S: Links afslaan, daarna aan het einde van de weg rechts afslaan.
4					X	5:20	O: Even kort praatje
5				X		5:45	P3: Het is toch de bedoeling dat ik deze kant op kom? E: Als u het niet zeker weet dan moet u even luisteren. P3: Ik dacht dat ik hoorde E: U kun dan op het knopje drukken S: Links afslaan, daarna aan het einde van de weg rechts afslaan. P3: Ik had het toch wel goed! E: Mooi! P3: Ja, maar dat moet ook. EIND: 6:25
						6:40	S: Rechts afslaan, daarna links afslaan. P3: Rechts afslaan, links afslaan, ... rechts afslaan.
6					X	7:10	P3: Rechts afslaan, en dan weer denk ik links.
						7:30	S: Links afslaan
						8:35	S: Aan het einde van de weg links afslaan, daana links afslaan
						8:55	S: Links afslaan, daarna links afslaan.
						9:20	P3: Even stopie af, dan linksaf.
7					X	9:40	P3: Het gaat nog wel gemakkelijk hoor.
						9:45	S: Links afslaan. P3: Hier links af.
8				X		10:30	P3: En wat wordt nou, moet ik hier links? E: Als u het wilt weten moet u het even herhalen S: Aan het einde van de weg rechts af slaan. (mvr. draait zich om) P3: Dan moeten we daar heen. E: Het apparaat is al net iets verder dan u, waar dacht u eerst dat u heen moest? P3: Dat weet ik niet. E: U mag doen wat het apparaatje zegt. P3: Hij zegt nu. S: Aan het einde van de weg, rechts afslaan. P3: Kijk dan moet ik keren, als ik daar gekomen ben. E: Ok dan mag u daarheen. (verkeerde richting) S: Probeer om te draaien, daarna rechts afslaan. P3: Probeer om te draaien. E: Mvr weet u nog wat het apparaatje zei? Herhaalt u nog eens S: Aan het einde van de weg links afslaan. EIND: 12:10
9			X				Detour
10						12:20	TLX tot 13:40
11					X	13:40	O: Praatje tot 14:30 (ik loop zelf ook veel, kom je nog eens mensen tegen, praat je nog eens mee.)
12				X		14:30	S: Aan het einde van weg links afslaan.
						14:40	S: Links afslaan.
						15:05	P3: Kijk, kijk je nu weer zo tegen de posten op.
						15:45	S: Na 50 meter, bestemming bereikt. P3: Na 50 meter bestemming bereikt, dat komt goed uit.
13						16:05	S: Bestemming bereikt. P3: Mooi, dan zijn we er weer. FINISH

TECHNICAL DATA	Dag 2 – Route 1	Route 3
NAAM:	ROUTE: **A** / B / C / D	START TIME: 10:46
PARTICIPANT#: 3	CONDITIE: U / UE / **F** / FE	STOP TIME: 11:06
DATUM: 16 / 4 / 2008		TOTAL DURATION: 0:20:05

GENERAL REMARKS

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
1				X		0:20	S: Aan het einde van de weg rechts afslaan
2	X					0:35	S: Probeer om te draaien.
3		X				0:55	P3: Ik hoor dat ze zegt probeer om te draaien. E: Mag ik dan even op uw scherm kijken. E: Loopt u maar gewoon door, het gaat goed. EIND: 1:00
						2:30	S: Na 50 meter rechts aflsaan, daarna links afslaan
						2:40	S: Rechts afslaan P3: Dus ik moet hier dus rechts afslaan? E: Als u het niet zeker weet kunt u het herhalen. P3: Ik meen dat ze zei hier rechts afslaan P3: Hier rechts afslaan.
4					X	3:45	S: Links... (route wordt herberekend) P3: Nu hoor ik het niet goed. E: U kunt de boodschap herhalen door op het knopje te drukken EIND: 4:20 GPS fouten (s: Probeer om te draaien)
						4:20	S: Links afslaan P3: Links afslaan, dan moet ik die kant op, links afslaan.
5					X	5:00	P3: Moet ik nou hier op of niet? E: U mag op de stoep gaan lopen, wat u zelf wilt.
						6:00	S: Aan het einde van de weg, rechts afslaan.
						6:18	S: Rechts afslaan P3: Dat is hier, hier de hoek om.
						10:20	S: Aan het einde van de weg links afslaan. Daarna links afbuigen P3: Links afslaan
						10:40	S: Links afslaan. Daarna links afbuigen
6	X					10:55	P3: Als ik het goed begrepen heb zegt ze nu rechts achter? E: Wat zei u nou? P3: Als ik het goed begrepen heb zegt ze nu rechts achter? E: Als u het niet zeker weet kunt het even herhalen. P3: Das misschien wel goed. Rechts achter heb ik gedaan, en ik dacht nog een keer.
7					X	11:35	P3: Als ik het goed heb nu nog een keer links.
						11:40	S: Links afbuigen. P3: Tis wel goed, links.
						12:00	P3: Weer links.
8						12:30	TLX tot 14:30
9					X	14:45	P3: Dat ding rammelt zo.
						14:50	S: Rechts afslaan, daarna links afslaan.
						15:25	S: Links afslaan
						15:55	P3: Dan ga ik hier de stoep af, dat rammelt niet zo.
						16:35	S: Aan het einde van de weg, rechts afslaan.
						16:55	S: Rechts afslaan
10					X	17:25	P3: Ik zie al waar we uit komen, ik zie het al. Ik weet hier ook wel goed de weg overal hoor!
11					X	18:00	P3: Daar is De Posten! E: Inderdaad. P3: Ik weet het hier allemaal goed hoor! Ik heb hier al heel veel gelopen.
						19:35	S: Na 50 meter, bestemming bereikt.
12						19:45	S: Bestemming bereikt P3: Na 50 meter bestemming bereikt, en dat klopt ook nog wel. FINISH (tot kruispunt doorlopen: 20:05)

TECHNICAL DATA	Dag 2 – Route 2	Route 4	GENERAL REMARKS
NAAM:	ROUTE: A / B / C / **D**	START TIME: 11:14	
PARTICIPANT#: 3	CONDITIE: U / UE / F / **FE**	STOP TIME: 11:35	
DATUM: 16 / 4 / 2008		TOTAL DURATION: 0:21:00	

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other	0:35	
						0:45	S: Aan het einde van de weg rechts afslaan. P3: aan het einde van de weg rechts afslaan, ja
						1:05	S: Rechts afslaan, daarna links afslaan. P3: Dus hier gaan we er hier af.
						1:40	S: Links afslaan P3: Links afslaan
1					X	2:00	P3: Ja, ik heb links afgeslagen. E: Ja. P3: Ik heb links afgeslagen E: Zullen we nog even op het apparaatje kijken, even zien wat ie zegt? S: Probeer om te draaien, daarna links afslaan. E: Hij maakt even een foutje, we gaan een stuk die kant op. P3: Ja, ok S: Links af slaan. P3: ja, dan moeten we die kant weer op. EIND 2:30
2					X	3:10	Kort praatje (ik ken iemand die daar woont, ik ken de buurt zo goed) EIND: 3:25
3					X	4:45	S: Na 50 meter, links afslaan O: P3 blijft even stilstaan P3: Ik denk dat ik wel iets verder kom dan 50 meter.
						5:15	S: Links afslaan P3: Ja, hier moeten we links, bij de Woldenbrink.
4						5:20	O: Loopt tussenpad voorbij. (goed!)
						6:15	S: Aan het einde van de weg links afslaan, daarna rechts afslaan.
						6:30	S: Links afslaan, daarna rechts afslaan.
						7:25	S: Rechts afslaan, daarna links afslaan
5	X					7:55	P3: Zou het hier ook mee in verband staan. E: Wat zegt u? P3: Rechts afslaan zegt ze, en dan weer links afslaan. E: Dan moet u even op het apparaatje kijken wat ie zegt. P3: Woldenbrink. E: U kunt in dit vierkantje drukken. S: Probeer om te draaien P3: Zegt ze probeer om te draaien, nu weet ik het niet zo goed meer. P3: Het lijkt me die kant op, Eulebrink staat er op, dan moeten we die kant op. EIND: 8:42
6					X	8:55	S: Na 50 meter links afslaan P3: Na 50 meter links afslaan, ow dat lijkt me moeilijk hier! P3: Na 50 meter links afslaan. S: Probeer om te draaien, daarna rechts afslaan S: Links afslaan P3: Weer links af, links af en dan weer rechts, dus ik moet er hier af. En hier er in.
7						10:15	S: Aan het einde van de weg rechts afslaan. P3: Aan het einde van de weg rechts afslaan. Dat dacht ik al, dat zit wel goed! P3: Rechts afslaan
						10:42	S: Rechts afslaan. P3: Rechts afslaan, das deze kant op. Ja, rechts afslaan.
8					X	11:00	S: Probeer om te draaien. P3: Wat zegt ze nou? Dat ik niet zo goed begrepen. O: P3 blijft stil staan. P3: Dat heb ik niet zo goed begrepen E: Dan kunt u de boodschap even herhalen. Moet u even op het knopje drukken. EIND: Staat stil tot 12:40
9					X	11:40	P3: Ik hoor niets.
10		X				12:40	P3: Huidige positie De Posten E: U mag van mij wel gewoon doorlopen hoor P3: Nou kijk als we nou deze kant op gaan, dan loop je mooi rond.
11					X	13:20	S: Na 50 meter rechts afslaan
12					X	13:30	P3: Na 50 meter rechts afslaan, dat komt me niet goed voor! O: P3 staat even stil P3: Rechts afslaan ja, jah.
13					X	14:20	P3: Kijk, dan zou ik hier af moeten. E: ja, P3: Kijk dan zou ik hier af moeten, rechtsaf zegt ze S: Probeer om te draaien, daarna aan het einde van de weg links afslaan. P3: Probeer om te draaien, daarna aan het einde van de weg. P3: Maar kijk dit staat er steeds: huidige positie de posten, dat is ook zo, je bent hier vlak bij de posten. E: De hele straat heet de posten, u mag gewoon doen wat ie zegt. P3: Wat denkt u er zelf van? E: Dat mag ik u nog niet zeggen, later vertel ik u alles. E: U moet doen wat u het beste ljkt. P3: Nou dan dacht ik de Posten, ja. O: P3 begint weer te lopen, EIND: 15:30
14						16:20	TLX tot 18:20
						18:25	P3: Hier loop ik ook wel vaker, even onder dat dingetje door.
						18:40	S: Aan het einde van de weg rechts afslaan. P3: Wat zegt ze? Aan het einde van de weg rechts afslaan, dat lijkt me niet zo goed.

								E: We gaan nog niet direct naar huis, we volgen nog een stukje route. P3: Ok, dan moeten we eerst rechts, die kant weer op.
							19:20	S: Rechts afslaan
							19:35	P3: Nou, nu ga ik wel de verkeerde kant op.
15		X					19:45	P3: Kijk, maar nou moet ik wel eerst rechts af. E: Ja dat klopt. U moet nog een klein stukje de route volgen. P3: Nou vooruit E: Hij zegt wel wanneer u er bent.
							20:30	S: Na 50 meter, bestemming bereikt P3: Na 50 meter bestemming bereikt.
16							21:00	S: Bestemming bereikt. P3: Bestemming bereikt! En wat wil dat nou zeggen? E: Dat u de hele route heeft gelopen. FINISH

TECHNICAL DATA	Dag 1 – Route 1	Route 1
NAAM:	ROUTE: A / B / **C** / D	START TIME: 10:10
PARTICIPANT#: 4	CONDITIE: U / **UE** / F / FE	STOP TIME: 10:31
DATUM: 14 / 4 / 2008		TOTAL DURATION: 0:21:34

GENERAL REMARKS
Rollator / P4 is beetje moe / kan alles slecht zien

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
						0:10	O: P4 zingt een liedje
						3:45	S: Aan het einde van de weg links afslaan, daarna rechts afslaan.
						4:00	S: Links afslaan, daarna rechts afslaan.
1	X					4:10	P4: Links? E: U moet doen wat het apparaatje zegt. P4: Maar ik hoor het heel slecht. E: Ok, dan kunt u het herhalen. P4: Links? E: Dan moet u even op het apparaatje kijken, ik mag het u niet zeggen. P4: Ik kan dat niet zien hoor. E: Als u het niet heeft gehoord, dan kunt u hier nog een keerop drukken. S: Links afslaan, daarna rechts afslaan.
2				X		4:35	S: Linksaf slaan E: Hoort u dat? P4: Ja, maar wel slecht hoor. EIND: 4:40
						5:10	S: Rechts afslaan.
3					X	5:38	O: P4 wijst/drukt continue op het scherm
4					X	5:50	O: P4 loop midden over de weg
5					X	7:35	E: Mvr? P4: Ik heb niet… E: Nee, ik zie het al. Maakt niet uit, u had het schermpje weggedrukt en geluid uit gezet. P4: Uhm, nou daar naartoe? E: Dan moet u even kijken wat het apparaatje zegt. E: Kunt u nogmaals drukken op het knopje? P4: Hierop? E: Nee, waar u net ook al drukte? P4: Hierop? E: Ja. O: Mvr. houdt het scherm op de kop E: U doet het goed hoor! Niets aan de hand S: Probeer om te draaien, daarna aan het einde van de weg links afslaan. E: Hij zei net probeer om te draaien, dus dat mag u doen. EIND: 9:20
6				X		9:30	P4: Ik heb het niet goed gedaan hoor E: Jawel hoor, hartstikke, alleen het apparaatje zei wat anders. U mag die kant op. P4: Die kant op? Maar het apparaatje zegt wat anders. E: Inmiddels staat het er wel, gaat u maar die kant op, dan vertelt hij vanzelf wat u moet doen O: P4 wou een smalle gang tussen was huizen in lopen. EIND: 9:48
7						9:54	EIND 5/6/7: 9:54
						10:15	S: Links afslaan, daarna links afslaan.
8					X	10:45	O: Mvr steekt weg over
						11:05	S: Links afslaan
						11:15	P4: Dat is ook een linkse straat. E: U mag doen wat het apparaatje zegt, ik ben heel flauw hoor, maar…
9	X					11:30	P4: Ow, oh nee E: U houdt hem op de kop. O: P4 houdt het apparaat op de kop P4: Dat is niet links, dat is toch rechts. E: Maar u houdt hem op de kop. P4: Ow! Hou ik hem op de kop. Oh! E: Zo mag u hem houden. P4: Dan ga ik er hier af. P4: Of moeten we nog verder links? E: U mag doen wat het apparaat zegt P4: Ik ben hier bij links. Dan mag ik hier in. Niet dan? E: Als hij dat zegt, dan mag u dat doen, zo simpel is het. P4: Ik kom hier weg, steek de straat over. S: Links afslaan P4: Dat zie ik niet hoor. Nou heb ik het goed? Nou ik weet het niet hoor. E: Als u het uiteindelijk niet goed heeft dan zegt hij dat vanzelf tegen u. P4: Ja? E: Jazeker, dan zegt hij; mevrouw u doet iets fout. EIND 12:35
10						12:35	O: Taperecorder zakte af
11						13:20	P4: Nou ik neem deze straat hoor. Of het goed is dat weet ik niet. Maar daar loopt alles dood.
						14:04	S: Aan het einde van de weg, links afslaan.
						14:17	S: links afslaan.
12						14:31	E: Dat zijn geen wegen hoor, die tellen niet. P4: Dat is voor de bewoners, niet voor mij.
						15:15	S: Na 50 meter rechts afslaan, daarna links afslaan.
						15:30	TLX tot 18:36

13					X	18:15	??
						18:45	S: Rechts afslaan, daarna links afslaan
14			X			19:25	P4: Op het eind, of hier rechts? E: Dan moet u op het apparaatje even luisteren P4: Nou daar denk ik helemaal niet aan, aan dat ding. O: mvr pakt apparaat in handen P4: Hier begin ik E: U hoeft er niet op te drukken hoor, dat is niet nodig. U hoeft alleen maar te drukken als u de boodschap wilt herhalen. P4: Dus dan kan ik nog rechtdoor. O: P4 houdt apparaat op de kop EIND: 19:37
						20:00	S: Aan het einde van de weg, links afslaan.
						20:20	P4: Hij zegt links afslaan, dat is deze arm. E: Dat klopt, maar dit is nog niet het einde van de weg. Dit is een bocht P4: oh, kijk, daar is ook een einde van de weg. O: mvr loopt door.
15	X					20:40	S: links afslaan, daarna bestemming bereikt.
16						21:34	S: Bestemming bereikt. Finish (loopt door tot kruising, 21:50)

TECHNICAL DATA	Dag 1 – Route 2	Route 2
NAAM:	ROUTE: A / B / C / **D**	START TIME: 10:38
PARTICIPANT#: 4	CONDITIE: **U** / UE / F / FE	STOP TIME: 10:55
DATUM: 14 / 4 / 2008		TOTAL DURATION: 0:17:20

GENERAL REMARKS
Rollator / P4 is beetje moe / kan alles slecht zien

#	Assistance		Deviation	Error		Time	Description
	part.	el.		RAM	Other		
						0:40	S: Rechts afslaan, daarna links afslaan
1		X				1:05	E: Mvr u mag wel op de stoep gaan lopen E: Hoorde u nog wat het apparaat zei? O: P4 houdt apparaat op de kop P4: Moet ik nu niet daar naartoe? E: u moet nog een klein stukje de route volgen.
						2:08	S: Links afslaan
						3:45	S: na 50 meter links afslaan.
						4:00	S: Links afslaan
2		X				4:03	E: Dit is gewoon een oprit van iemand. P4: Ow, ja. Maar dat staat er niet bij. E: Daar heeft u gelijk in. P4: Dan gaan we verder. … 4:25 P4: Daar is ook een weg en dan ga ik daar in.
						5:05	S: Aan het einde van de weg links afslaan, daarna rechts afslaan
						5:20	S: Links afslaan, daarna rechts afslaan
						6:15	S: Rechts afslaan, daarna links afslaan
3					X	7:00	S: Links afslaan O: P4 staat even 2 seconden stl stil
4	X					7:20	P4: Dit is ook een weg, bedoeld u deze of daar verder? E: Dan moet u even naar het apparaatje luisteren. P4: Ja, daar staat ie. E: U houdt hem weer op de kop. P4: goh. E: Maakt niet uit, alstublieft. P4: O, dan moet ik daar naartoe EIND: 4:45 P4: Nou, rijden maar.
						8:30	S: Aan het einde van de weg rechts afslaan.
						8:45	S: Rechts afslaan.
5	X					10:00	S: Na 50 meter rechts afslaan. P4 Ik versta het niet! E: Dan kunt u het apparaatje even pakken. P4: Ik zie dat niet. E: Dan mag u in het zilveren vakje klikken als u het wilt herhalen. O: P4 herhaalt niet P4: Rechts hè? E: Loopt u maar. EIND: 10:35
						10:55	S: Rechts afslaan
6						11:35	TLX tot 14:25
7		X				15:45	P4: Waar moet ik heen? Kijk ik goed? Links, kijk ik goed? E: U mag in het grijze vierkantje klikken om het te herhalen. P4: Nee, we doen nou niet meer. E: Als u wilt horen waar u heen wilt op dit moment. P4: Ik wil naar huis. E: Dan moet u gewoon nog even stukje rechtdoor lopen. P4: Het is nu goed geweest hoor. EIND: 16:20
						16:40	S: Aan het einde van de weg links afslaan.
						16:52	S: Links afslaan, daarna bestemming bereikt.
8						17:20	S: Bestemming bereikt. P4: Zo, dat was een hele klus. FINISH

Appendix G Informed Consent

Telematica
Instituut

Informed consent

Hierbij ga ik vrijwillig akkoord met het op eigen risico meedoen aan het onderzoek van het Telematica Instituut naar audionavigatie op …………… …………….2008. Tijdens dit onderzoek worden er foto's, videos en geluidsopnames gemaakt. Deze worden door de onderzoekers gebruikt voor hun rapportages.

Naam deelnemer: ………………………………………………………………………

Handtekening deelnemer: ……………………………………………………………………..

Hierbij ga ik er vrijwillig mee akkoord dat bovengenoemde op eigen risico meedoet aan het onderzoek van het Telematica Instituut naar audionavigatie op ………… …………….2008. Tijdens dit onderzoek worden er foto's, videos en geluidsopnames gemaakt. Deze worden door de onderzoekers gebruikt voor hun rapportages.

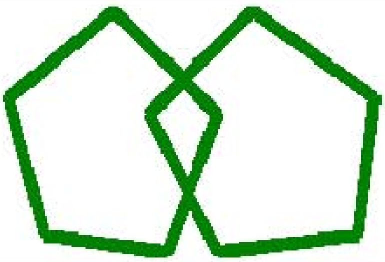
Naam verzorgende: ………………………………………………………………………

Handtekening verzorgende: …………………………………………………………………….

Appendix H MMSE Questionnaire

MMSE

Naam participant :
Datum :
Naam invuller :
V
Ik ga u nu enkele vragen stellen en geef u enkele problemen om op te lossen. Wilt u alstublieft uw best doen om zo goed mogelijke antwoorden te geven.

	noteer antwoord	**Score**
1.	a. Welk jaar is het? b. Welke seizoen is het? c. Welke maand van het jaar is het? d. Wat is de datum vandaag? e. Welke dag van de week is het?	(0-5)
2.	a. In welke provincie zijn we nu? b. In welke plaats zijn we nu? c. Wat is de naam van dit ziekenhuis/deze straat? d. Wat is de naam van deze afdeling/deze kamer? e. Op welke verdieping zijn we nu?	(0-5)
3.	Ik noem nu drie voorwerpen. Wilt u die herhalen nadat ik ze alle drie gezegd heb? Onthoud ze want ik vraag u over enkele minuten ze opnieuw te noemen. (Noem "appel, sleutel, tafel", neem 1 seconde per woord) (1 punt voor elk goed antwoord, herhaal maximaal 5 keer tot de patiënt de drie woorden weet)	(0-3)
4.	Wilt u van de 100 zeven aftrekken en van wat overblijft weer zeven aftrekken en zo doorgaan tot ik stop zeg? (Herhaal eventueel 3 maal als de persoon stopt, herhaal dezelfde instructie, geef maximaal 1 minuut de tijd) Noteer hier het antwoord. of Wilt u het woord "'worst" achterstevoren spellen?. Noteer hier het antwoord.	(0-5)
5.	Noemt u nogmaals de drie voorwerpen van zojuist. (Eén punt voor elk goed antwoord).	(0-3)
6.	Wat is dit? En wat is dat? (Wijs een pen en een horloge aan. Eén punt voor elk goed antwoord).	(0-2)
7.	Wilt u de volgende zin herhalen: " Nu eens dit en dan weer dat ". (Eén punt als de complete zin goed is)	(0-1)
8.	Wilt u deze woorden lezen en dan doen wat er staat'? (papier met daarop in grote letters: "Sluit uw ogen")	(0-1)
9.	Wilt u dit papiertje pakken met uw rechterhand, het dubbelvouwen en het op uw schoot leggen? (Eén punt voor iedere goede handeling).	(0-3)
10.	Wilt u voor mij een volledige zin opschrijven op dit stuk papier? (Eén punt wanneer de zin een onderwerp en een gezegde heeft en betekenis heeft).	(0-1)
11.	Wilt u deze figuur natekenen? (Figuur achterop dit papier. Eén punt als figuur geheel correct is nagetekend. Er moet een vierhoek te zien zijn tussen de twee vijfhoeken) 	(0-1)
	TOTALE TEST SCORE:	**(0-30)**