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A point in the right direction: A simple navigation device for people with dementia

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Abstract

Dementia is one of the major societal challenges of the near future. Over the next few decades the population of people with dementia is estimated to double, with all kinds of consequences. For them to maintain a high quality of life, the design of new intelligent solutions to support them is needed. One major problem is orientation in public spaces, which prevents people leaving their house. To address this problem we designed a compass that points them in the right direction.

An iterative design process was followed during which prototypes were created and evaluated with experts and users. After this process, a field study was performed with eight participants using a working prototype. Within this field study the participants were asked to use the compass to find two unknown places in their neighbourhood and then walk home.

The results from the test show that most participants managed to fulfil the tasks; however, there were still moments of confusion. Furthermore, the chosen metaphor, a compass, seemed viable for navigation: participants were capable and willing to follow the device. Additionally, new requirements were found for the device such as improved wearability and a need for more feedback. However, conflicting information should be avoided. Also, related to safety, the device should not draw too much attention away from the environment. Our future ambition is to make a standalone prototype, which could be used by users with dementia over a longer period of time.

Keywords: Dementia, Design, Navigation, User-centred design, Living Lab

Introduction

Dementia is characterized by gradual deterioration of cognitive abilities such as: memory loss, impaired language, personality changes and attention difficulties (Prince *et al*, 2013). The most common form is Alzheimer's disease, accounting for about 70% (Prince *et al*. 2013). The amount of dementia patients worldwide is expected to double by 2050 (Kinsella & Wan, 2009). This creates a huge societal challenge, both in the sense of costs connected to the care of dementia and the quality of life. The design of new technological interventions can be one approach to address this challenge and improve the quality of life of people living with dementia and their caregivers. However, too often people with dementia are not personally involved in such design processes (Topo, 2009). In this paper we focus on a single application area, navigation and way finding, and see how we can design for and with people with dementia. Both the design process and a case study with a working prototype will be described.

Way finding problems can appear already early in the dementia disease. The severity of these spatial disorientation problems increases as the disease progresses. In the early stages they may only get lost in unfamiliar areas, yet later on persons with dementia even get lost in well-known places (Passini, Rainville, Marchand, & Joannette, 1998). Way finding relies heavily on memory strategies. This means that persons with dementia is more likely to get lost on the return journey, when memory- rather than landmark-strategies are more heavily relied upon (Liu, Gauthier, & Gauthier, 1991). In order to find their way people with dementia start to increasingly rely on outward cues. Sheehan, Burton, & Mitchell (2006) suggested that traditional methods and designs such as visual aids and signs might help. However, in the study by Passini *et al*. (1998) it was shown that people suffering from dementia were more likely to get confused by such conventional aids (signage, street names etc.). As such new solutions should be sought. Silverstein and Parker (2002) emphasize that the quality of life among elderly increases significantly if the ability to get out and use the local outdoor environment is maintained. To illustrate the impact of way finding problems, we quote one of our participants during our field study:

"I once lost my way home from the shop it was terrifying. Now I do not go anymore."
– Participant, person with dementia

We propose a solution for navigation: the 'homing compass', this concept is developed through an iterative design process, which is described in this paper. In the discussion we reflect upon the design, the evaluation and the potential for the societal challenge.

Design process

In the design process we aimed at designing, together with the user and experts a more suitable navigation solution. Currently, these are mostly localization systems for caregivers. Ideally, the

solution proposed should aid people with dementia directly and provides reassurance. It should guide them home in a safe manner free from fearful moments. To get a first direction we have applied general design methodologies like idea generation, selection and conceptualization. In this 'iteration 0' people with dementia and experts were not directly included yet. However, after this we heavily involved experts, and later the users, to confirm the direction and co-design the development of the concept. Because we design for people with dementia the device should not look too technical, like for example, a smartphone (Robinson *et al*, 2009). As such we wanted to find something recognizable for way finding; we found a compass matching this prerequisite. Furthermore, it suggests it brings you home.

Iteration I: Design direction

The main purpose of this first iteration was to find if it was a suitable direction. Second, we focussed on the look and feel of the device. Many different, non-working prototypes were created and then evaluated via co-creation with experts. We didn't want to involve users yet as this phase was still too conceptual. The direction was generally received positively, but often caution was expressed on whether it would work for late stage dementia. Other concerns related to persons with dementia having difficulty to learn new things.

"They have taught themselves how to use technology, but when they get dementia it is the late-learned skills that disappear first." - Expert, Geriatric doctor

Nevertheless, in general the experts saw potential. The design needs to maintain simplicity and still be recognized. The learning curve should be very short. Furthermore, it should be introduced as early as possible in the disease, because as such a trustful relation may be built with the device.



Figure 1 Some of the interfaces and models build to discuss with three experts.

Iteration II: Focus group

In this iteration we decided to involve people with dementia using a focus group method. This was experienced as being a successful method for this target group (Quereshi *et al*, 1998, reviewed in Wilkinson, 2002). For the focus group we set two main goals: first, to establish if the target group would see need for the device and, second, to establish whether they were able to understand such a simplistic way of navigation. The participants were selected in collaboration with a Mental Healthcare (GGzE). In total four people with dementia and three informal caregivers joined the focus group. In the focus group we showed pictures and let the users experiment with the interactive model (figure 2). When presented with the compass many of the participants expressed a positive opinion, but also expressed that it might not be suitable for them yet. There was a general desire for simplicity and extra buttons were deemed to be confusing, but secondly a lot of extra features were suggested as options, which is seemingly contradicting. Contrary to the suggestions given by the experts in the previous iteration, many of the participants would have liked a map or street names as an extra form of information, saying that this would increase their understanding of the compass. Furthermore, the value of the product was mainly seen when wearable. Moreover, the technology should work better than current GPS systems, which generally do not take small streets into account. A lot of attention in the focus group was paid to it being weather- and fall-proof, since the risk of accidents increases with dementia. Despite the risk of losing objects most participants preferred a smaller size than the existing prototype (about 10 cm). Finally the home icon was confusing; it suggested the device was pointing away from home.



Figure 2 Left: Final design proposal based on expert input. Right: The interactive model

Iteration III: Final Design

Based on the expert input from 1 on 1 interviews and the focus group session with users a final design was proposed. The main functionality of the 'Homing compass' is in being a simple navigation system that points homewards via an arrow. Additional features, such as a map, auditory feedback and alternate route selection were removed from the device. The design's look and feel was kept as much as possible to an original compass by using familiar materials like wood and metal. The working prototype (figure 3) was built using the Arduino platform with additional sensors and actuators attached with the goal for users to use and experience the device on their own.

Design evaluation: Setup

Because at that stage we had not yet done real-life testing, there were still some unverified assumptions. The nature of dementia (loss of attention, memory loss etc.) makes it almost impossible to ask retrospective questions. Additionally, there is also a tendency among elderly people with dementia to overestimate their own abilities (Farias *et al*, 2005), as already seen in the focus group. Therefore, alternative approaches need to be used to evaluate the existing assumptions. We aimed to do this in a field test with end-users in their natural context, with the working prototype (figure 3).

Eight couples participated, each consisting of an informal caregiver and a person with dementia. Each participant with dementia was in the early (to mid) stages of dementia. The field experiments adhered to the principles of Living Lab research by conducting the research in a realistic context with real users (Brankaert, den Ouden & Brombacher, 2014). Moreover, the participants are still co-creators, and therefore this step can be seen as another iteration to influence the design. The study was setup as follows: the participants were instructed to use the device as they desired to find a



Figure 3 the final prototype used to evaluate the concept in a field test.

certain location in their neighbourhood. After that they had a second random nearby location they had to find, and from this location they were pointed home.

They were informed that the device pointed directly towards a location and therefore they still had to make their own decisions. The informal caregivers walked beside the person with dementia and were instructed to assist as little as possible. A closing interview was held at home as a semi-structured interview that lasted approximately 20-40 minutes depending on the participants.

Design evaluation: Results

Seven out of eight participants managed to successfully navigate home. Three participants were very positive, and expressed a desire to use the design in the future. Two found the device too simple and reported no need for it and two participants saw a benefit but still had many remarks to add to the device and would not use it as is. Finally, one user experienced a lot of trouble with the device.

The fact that almost all participants managed to reach their destination targets does imply that, with limited directional information, people with dementia can be led towards a particular point or direction. However, caution needs to be expressed with this statement. During walking confusing moments did occur, especially when the device seemed ambiguous in its navigation direction, or when it was moving uncontrolled in random directions. This ambiguity often occurred at places where the choice of direction not immediately obvious. For example: the device would point straight ahead at a T-junction or through a block of houses. In these cases the participant was required to make a choice where to go. Some easily took the initiative to make such a choice, while others needed some encouragement.

The mechanics of the device were not always directly understood. Even after the participants were explicitly explained the workings of the device, many still assumed that it worked as a generic GPS system with street-by-street navigation system. Furthermore, some caution should be expressed in usability in context for people with dementia. The participants could use it very well, but were sometimes distracted too much from their surroundings. One of the caregivers expressed a worry that the person with dementia might trip since their attention was focused on the device. Another participant did not recall where they had crossed a street, as their attention was completely focused on the device.

Overall, the participants were positive about the device, especially when they were aware that the device was pointing home (final task). We saw some users only occasionally checking the device at this stage, to assure themselves of their direction. This final observation is key to how the design should work, and confirms there is potential to further develop the concept.

Discussion

This paper addresses the design processes, including a field evaluation, of a compass-like navigation device that enables people with dementia to find their way back home. Current navigation solutions are often solely a tool for the caregiver. In this study we have seen that people with dementia are very capable, even while having all kinds of problems, to participate in a co-design process and to operate such a device. However, more effort from the researchers was required to achieve this.

Caution should be taken with extrapolating the results of this study to a business case. Aside from the direct observations during walking, this study consisted mostly of self-report with a researcher and healthcare professional present. This influences what is said (the participants are eager to help, might be embarrassed about their performance or want to please the researcher). However, in this stage of the development we do not recommend giving the compass to people with dementia to use it on their own yet. The presence of the informal caregiver and the healthcare professional during the field study also has a positive influence. People with dementia might feel more comfortable with familiar people around them, and more stakeholders observe the interaction with the device. However, this is set-up a step away from reality, and their opinions might be disregarded. The ideal study would be held with the person with dementia operating the device as intended. This would provide information about their actual relationship with the compass. However, this can only be done once a person is trained in using the device, and the device is sufficiently robust.

In future studies long term use patterns should be investigated to find out whether the compass will be used and not forgotten, something currently not evaluated. Additionally, some technological improvements are needed for future iterations. More accurate localization technology is needed that also communicates via Internet so the device can actually be localized

and street-by-street navigation becomes an option. Furthermore, the arrow movement was sometimes a little bit abrupt which invoked confusion. Finally, touching on a more common issue with technology and dementia, the battery life and charging options need to be improved. For some of these requirements new things should be developed, such as a small docking station, and maybe a connection with the Internet, so routes can be found and added. This would also allow for extra functionalities such as communication with the informal caregiver. However, they should only be added if there was no disturbance in the main functionality of the device, which is to allow a person with dementia to find their home safe and sound. For a target group such as people with dementia sobriety and simplicity remains key.

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