



# DESIGN4 HEALTH

Extract of the  
**Proceedings of the 3rd European  
Conference on Design4Health**  
**Sheffield 13-16th July 2015**

Editor: Kirsty Christer

ISBN: 978-1-84387-385-3

## **Tangible Memories: Exploring the use of tangible interfaces for occupational therapy in dementia care**

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### **Abstract**

*In the care of people with dementia (PwD), occupational therapies are taking on a more and more important role. Only a few pilot projects could be identified which report on positive effects of computer-assisted therapy or technology-based memory care for PwD, mostly based on tablet PCs or touch screen computers. So far, the use of tangible interfaces such as surface computing and interactive objects is entirely unexplored. The goal of the presented research is to explore the application of surface computing and tangible interfaces for PwD. Three application prototypes were designed, implemented and tested during a two-week trial period with the use of a surface computer in an elderly care facility in order to examine the usability and the impact on people with dementia. A total of 14 participants with dementia were included in the evaluation. Among the participants, all stages of dementia were represented. The applications led to enjoyable conversations between caregivers and residents and encouraged wallowing in memories. For the majority of participants fun and joy were clearly visible. The results show considerable effects in terms of increasing interaction of the participants compared to conventional touch-screen applications.*

**Keywords:** Dementia, computer-aided occupational therapy, memory care, Surface Computing, Tangible Interaction, Usability & User Experience

## Introduction

### Background

The number of older people with dementia increases. According to the WHO, there are currently around 35.6 million people worldwide suffering from dementia, and it is expected that the number will double by 2030 (WHO, 2012). The increasing prevalence of dementia results in an increasing proportion of demented home residents and thus the demand for care of this group grows steadily. In the care of people with dementia (PwD), occupational therapies are taking on a more and more important role. These aim to activate people and promote social interaction. While both public and private media, such as photographs, audio or movies are getting more and more available as digital media, information technology is rarely being used in dementia care. In the literature, a few pilot projects were identified which report on positive effects of computer-assisted therapy, technology-based memory care or reminiscence therapy for PwD. They are mostly using touchscreen computers as a technical basis (e.g. Sixsmith et al, 2007; Astell et al, 2009; Topo et al, 2004). So far, the use of tangible interfaces such as surface computing and interactive objects is entirely unexplored.

### Purpose and questions addressed

The goal of the presented research is to explore the application of tangible interfaces to support activities in the occupational therapy of PwD. The aim of this work is to design and prototypically implement multimedia applications, which are less focused on therapeutic effects as e.g. cognitive training, but rather aim to improve the wellbeing of PwD. A Surface Computer based on Microsoft Pixelsense technology, supporting multi-person multi-touch interaction and object recognition, is being used. For this purpose, biography-related applications which are intended to promote the well-being and social interaction of PwD were designed and prototypically implemented in a user-centred design process. These applications are based on biography-related data so that the content can be tailored to the individual user. Based on the interaction with the applications, situations should be created that allow PwD to remember important and enjoyable experiences and increase well-being. . The applications as well as the surface computer are tested during a two-week trial period in an elderly care facility with residents with dementia in order to examine their suitability for the given context and to determine the potential of the surface computer for use in the occupational therapy of PwD.

The following questions are being addressed in the work:

(1) How can existing activities in occupational therapy for PwD be transferred to interaction technologies such as the surface computer?

(2) How must applications be designed so that they increase especially the well-being of PwD and promote memories? Wellbeing means in this context the evocation of positive emotions such as joy and fun and a positive mood.

(3) Are both the surface computer as a technology and the applications designed suitable for the given context?

(4) Has the surface computer an additional value compared to other technologies?

(5) Is the surface computer suitable for both individual and group activations?

(6) Which factors affect the use of the surface computer in the elderly care facility? The results of the study should help to identify new opportunities for occupational therapy and thereby promote the use of innovative solutions in the field of occupational therapy for PwD in practice.

## Approach

### Methods & Design

This work is based on an extensive literature review on projects or studies that are addressing the topic of computer-assisted activation for people with dementia, with a special focus on memory care and reminiscence therapy. Existing studies show that multimedia stimulus can improve activation of PwD, and that the usage of personalized media improves the results. Astell (2009) and Maki and Topo (2009) describe design principles for the development of technologies for PwD that informed the design process.

Following the literature review, qualitative interviews were conducted with five experts in the field of dementia in order to collect experiences about needs of PwD and to derive or develop ideas for possible multimedia applications. In order to develop a better understanding of the user group, three personas were created which divide the target group into the three stages of dementia, mild, moderate and severe, and validated with the experts. The personas had the aim to design the applications according to the characteristics of the particular degree of dementia. As a starting base for the design of applications, reference books and material collections for OT in dementia were analyzed for activities that could be transferred to a multimedia touch-interaction based application.

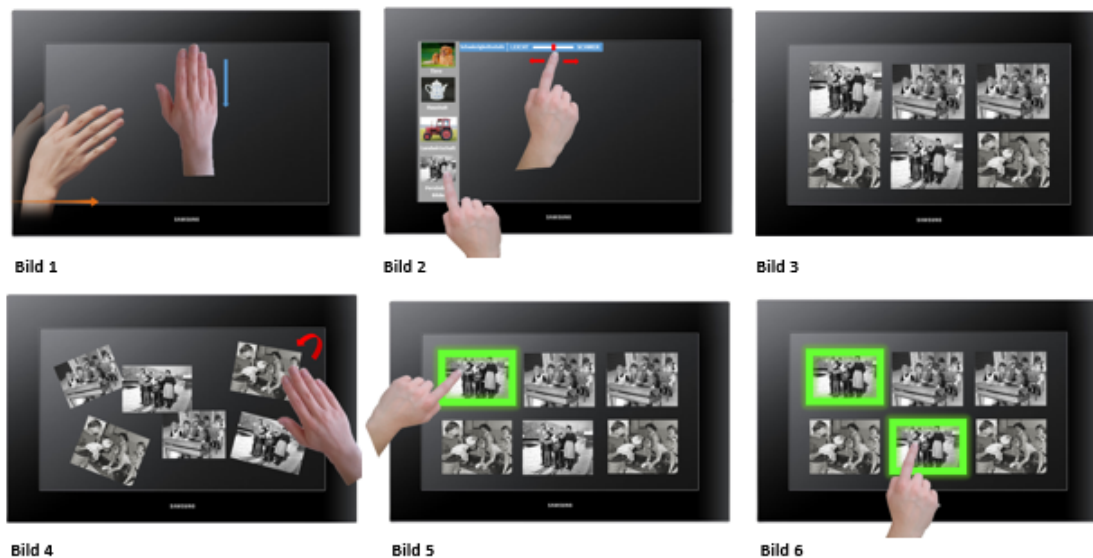


Figure 1: Example of a paper prototype (uncovered pairs game) used in the design workshop

In the subsequent design phase, seven application concepts were developed and visualized by paper prototypes (mockups). In an expert workshop, the design ideas were evaluated regarding their suitability for PwD using the mockups. The aim of the workshop was to allow the participants to act as co-developer in order to assess the pre-designed application ideas as experts of the field of dementia. The participants agreed on three application concepts that should be prototypically implemented in the course of the project. The selected applications were a multimedia book application, a pairs game as well as a multimedia application using object recognition and interaction. The selected concepts were then implemented using the rapid prototyping tool IntuiFace (by IntuiLab S.A., Labège, France) which supports the design of complex interactive applications without software coding.

## Field trial

The prototypically implemented applications were evaluated in a nursing home during a two-week trial period. The sample ( $n = 14$ ) consisted of nine women and five men in the age of 77-93 years. Among the participants all degrees of dementia were represented. For the study, two activation sessions with the surface computer have been conducted with all participants at a one week interval. Each session was accompanied by an occupational therapist. Data were collected by the method of participant observation. This method allowed a personal participation in the "residents-computer interaction" in their natural environment and aimed to examine the user experience of the participants and the usability of the system. In addition, each interaction was logged by the system. After the intervention, the occupational therapists were interviewed in a brief telephone interview regarding their personal experiences.

## Results

The results show significant effects in terms of increasing the well-being of the subjects. The applications encouraged for entertaining conversations between caregivers and residents, and promoted the communication.

### Evaluation of the individual applications

In particular, the contents of the multimedia application have led to a visible increase of well-being of the participants. This was mainly caused by the videos and the multimedia book which proved to be particularly suitable. The memories showed the participants that they still have a lot of knowledge and experience. Particularly topics which aroused the interest of the participants, led to an increased willingness to communicate and to a strengthening of self-esteem. However, it was also observed that the interaction decreases and the participants have taken an increasingly passive role in the activation with the progression of dementia. However, the joy during the activation was clearly visible. Thus, the application showed to be also suitable for PwD in advanced stages. Finally, the interaction with participants by the therapists during the multimedia application proved to be particularly valuable because the participants had the opportunity to directly share their memories. This led to an increased social interaction and communication of the participants.

In addition to the multimedia application also the pairs game application showed positive effects on the participants. Memories were promoted, even if not to the same extent as in the multimedia application. The test phase showed that the application is also suitable for people with moderate dementia. However, the support by the care staff must be adjusted to the individual abilities of the PwD. It has also been found that people with moderate dementia are still able to learn new things. Although the participants had initially difficulties with the interaction, which required dragging the memory cards, they managed to accomplish this task with some practice and support, what encouraged them in their abilities.







Figure 2: Interaction of the participants within the applications: multimedia book (previous page left), pairs game (previous page right) and object interaction (above)

The application with the object interaction achieved unique effects. The responses to the application during the test phase were very positive. The object-application had a very positive impact on the mood of the participants due to the use of interactive objects and gave them pleasure and joy. It is especially suitable for people with moderate to severe dementia. In this application, the participants had no reservations interacting with the screen. This is probably because the interaction occurs indirectly via objects instead of using special finger gestures.

## Overall results

The results of the two-week trial show significant effects in terms of increasing the well-being of the participants. This is based on subjective estimations of the observer, which could be perceived in the fun and the joy of the participants during and immediately after the activation sessions.

Furthermore, the results show significant effects in terms of increased interaction of the participants in comparison to other touch screen applications used in the same care home. Some residents who have been regularly activated using therapy software on a touch screen computer, lost their fear touching the screen after the test phase with the surface computer. The surface computer with its natural user interface proved to be very suitable for PwD. The participants intuitively touched the screen. This may be due to the bigger size of the surface and due to analogies to familiar objects such as books or cards. The touch interaction turned out to be a very good input method for PwD. This confirms results by similar studies (e.g. Astell *et al*, 2009: 68; Nayer *et al*, 2014) that focus mainly on early stages of dementia. However, the trial showed that an interaction based on multi-touch surfaces is quite usable even for moderate stages of dementia.

Furthermore the design of the surface computer in form of a table proved to be particularly suitable for demented people, because one could take up a natural posture by sitting at the table, which took away the fear of technology. Moreover, the surface computer is also suitable for people in wheelchairs due to the height of the table. The study participants quickly lost their fear, and almost all interacted actively with the touchscreen with support by the occupational therapists, regardless of dementia stage.

Finally, the evaluation of an activation session with a small group showed positive effects in terms of social interaction and increased communication between the group members. They became a team and supported each other during interaction.

However, the test phase also clearly showed that the success of the applications is not only depending on system design. Several factors could be identified during the evaluation of the applications that influence the usage of the surface computer and the applications in the care facility. Apart from the *usability* and *accessibility* of the applications, the *attractiveness of the content* within the applications strongly influences the usage of the system. The test phase showed clearly that if the contents of the applications did not address the interests of the PwD, the attention and the interest declined very quickly. People showed more interaction with the system if they perceived a *personal benefit* with the usage of the system. Furthermore, the *support by the occupational staff* proved to be one of the most important factors for the use of the surface computer. The caregivers participated in the activation either as a listener or provided assistance to the interaction with the system. Activation without integration into occupational care would certainly not have led to any comparable results, which is why this fact contributed significantly to the success of the test phase. Furthermore, the *location of activation* influences the use of the system. The majority of the participants had to leave their familiar environment for activation at the surface computer due to its low mobility, what may adversely affect the use. Finally, the trial showed that the use of the computer is basically determined by the *physical and mental state* of the residents on the day of testing. PwD didn't agree to participate if they didn't feel well. Especially in a severe stage of dementia the state of the PwD plays a crucial role, because people have to deal with mood swings more often. Therefore, it must be considered at what time of day each person usually is active and how the current mood is.

## Conclusion

While Surface Computing and haptic user interfaces for the therapeutic use in PwD are given little attention in the literature, the study shows that they carry great potential to improve activation and well-being of PwD. Above all, the use of this technology in combination with reminiscence applications showed positive effects on the participants during the test phase. It became also clear that the success of a computer-based intervention is not only depending on system design, but also on the right usage of the system and its integration in the care process. Overall, it was shown



that this technology has the potential to activate PwD, regardless of dementia stage. The implemented application concepts may provide a basis for further developments.

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