Jing Gu, Yu Zhang, Jun Hu
Department of Industrial Design, Eindhoven University of Technology, Eindhoven, The Netherlands

Design for Elderly with Dementia: Light, Sound and Movement

Abstract
In this paper we present an interactive lighting and sound art installation designed for the elderly with dementia living in a confined area in an elderly care center. Inspired by lighting and music therapies for dementia, as well as the social and cultural activities of healthy elderly, the installation creates sensory stimulation and natural atmosphere, aiming at bringing joy and happiness to dementia elderly in a dull corridor. The technical details are briefly introduced, followed by evaluation results.

Keywords
Lighting, sound, music, interactive, installation, elderly care, dementia

1 Introduction

Nowadays, the number of dementia elderly is increasing and the pressure put on caregiving is demanding. Research has indicated that the Behavioral and Psychological Symptoms of Dementia (BPSD) are associated with the increased burden of care, which has increased rates of institutionalization of patients [1]. The dementia elderly who live in the care centers have limited access to other people and outside environments. A large part of the life of the dementia elderly is restricted by the lost cognitive ability and decayed memories. Such liabilities determine the passive roles dementia elderly play in learning activities. Care centers thus provide manually organized activities with clear goals to benefit the recovery of cognitive abilities. However, the manually organized course-like activities cannot extend to a larger scale of daily activities. Emotional and mental wellbeing are not fully taken care of in such settings. Although dementia elderly suffer from some cognitive liabilities, they are eager about happiness and well-being, for which activities in care centers need to be carefully designed and organized.

One of the local care centers of de Vitalis WoonZorg Groep in Eindhoven, expressed their interests in designing a meaningful activity in a corridor through which the dementia elderly stroll from their bedrooms to the common room and cafe. Most of the elderly there are in second to fourth period of disease in their late eighties. The corridor connects bedrooms and common room in which the dementia elderly spend most of their time. The corridor is relatively dark for dementia people where no natural light sheds in and the lighting system keep static and constant. The space is perceived to be dull and boring.

The definition of happiness can be vague and is extremely personalized feeling related to personal background and cognitive ability of emotion. Most researches on dementia define practices that would have a positive effect on dementia elderly's physical and

physiological performance. However, when it comes to design, more investigations into contextual and characteristics of a certain group of people are needed. This project started with looking into the concept of meaningful activities for dementia and its connection to the feeling of happiness. A meaningful activity for the dementia elderly should allow them to experience a sense of wellbeing, a sense of belonging and sustained identity, a sense of continuity of their lifestyle, and their very sense of self [2,3]. Meaningful activities may lead to hedonic and eudemonic happiness depending on whether the activity contributes to a pleasurable life or a meaningful life [4].

The project continued with getting inspiration from the lighting and music therapeutic methods for dementia as well as social and cultural activities of healthy elderly, in order to design such a meaningful activity for the dementia elderly at Vitalis. Several concepts were created and evaluated with experts, leading towards the final concept that was prototyped and evaluated. Next in this paper, after a literature review on meaningful activities for dementia, these design concepts are presented. The final concept and its prototype are described in more detail, followed by evaluation results and the conclusion.

2 Meaningful Activities for Dementia

In therapies for dementia, different methods have been used in practice. In elderly care institutions, many different methods are used as well, in order to create activities that are to certain extent helpful or meaningful for the dementia elderly.

Lighting has been used in many therapies for dementia. In general it is found that daily exposure to bright sunlight is an effective anti-depressive [5]. A prolonged exposure to daytime lighting improves the stability of the rest-activity rhythm in the elderly with dementia [6]. Different colored lights might have different effects, for example, blue lights help to let body to produce the feel-good hormone that would contribute to a sense of wellbeing [7].

The dementia elderly may still be touched by music spontaneously be able to sing along with lyrics thought to be forgotten, or even remember how to play an instrument. Music stimuli may have positive effects on mood and cognitive functioning, including reduced anxieties, increased verbal fluency and spatial reasoning [8].

Reminiscence therapy goes beyond one sense, providing stimulation through multiple sensory channels, such as sound, movement, smell, flavor, changes in light and color etc. Doing so could induce vivid and strong reminiscences [9].

On the website of Opening Knowledge there are many examples of people applying similar strategies in their social and cultural activities in protecting themselves from dementia [10]. Playing piano requires fine motor skills that improve the circulation to the brain, and the "brain work" reduces the risk of dementia (Fig.1). Music activities would decrease loss of hearing holding the development of dementia to some extent, and study shows that daily music-based dance sessions helps patients with dementia significantly (Fig.2). A more active lifestyle with physical activity or exercise helps to prevent a whole number of diseases, including dementia. Physical exercise may increase temporary arousal; stimulating cognitive capability (Fig.3). The results demonstrate the feasibility of achieving higher levels of well-being and diversity of activity for people with dementia. Participants benefited regardless of level of dependency or cognitive impairment. These positive effects might be brought about by the important role of activity interventions related to individual interests. The stimulation of meaningful activities seems to be a powerful intervention both at home and in institutions. [2]

Fig. 1: Hungarian-born Pianist Charles Brunner plays the piano to recapture the Guinness World Record for longest keyboard playing Brunner broke the record of 103 hours and 8 seconds. (Image from Opening Knowledge)

Fig. 2: British DJ Ruth Flowers, 69 years old, mixes music at a recording studio in Paris. (Image from Opening Knowledge)

Fig. 3: A woman balances the "Yue Ya Chan" (Crescent Moon Spade), a traditional Chinese pole weapon, on her head as she exercises in a park in Xián, Shaanxi province. (Image from Opening Knowledge)

3 Design Iterations: Lessons Learned from Early Concepts

The project went through three iterations. First two iterations resulted in two design concepts (Fig.7 (a-b)). The concept1 which named Kaleidoshare (Fig.7 (a)) is an object hung on the wall of the corridor, it encourages the dementia elderly to become actively engaged in reliving and sharing their past with others in the present either verbally or non-verbally. As a means of psychological support, reminiscence therapy helps generating a feeling of self-worth and the expression of individual identity. Based on reminiscence therapy, reminders such as personal belongings and familiar music are already confirmed to bring the patients who impair with cognition great satisfaction. Reminiscence therapy is a process practiced to evoke personal memory and experience of the past [12]. When the elderly play with the old disc-like gadget, commonly-interested themes such as children, old-fashioned auto,

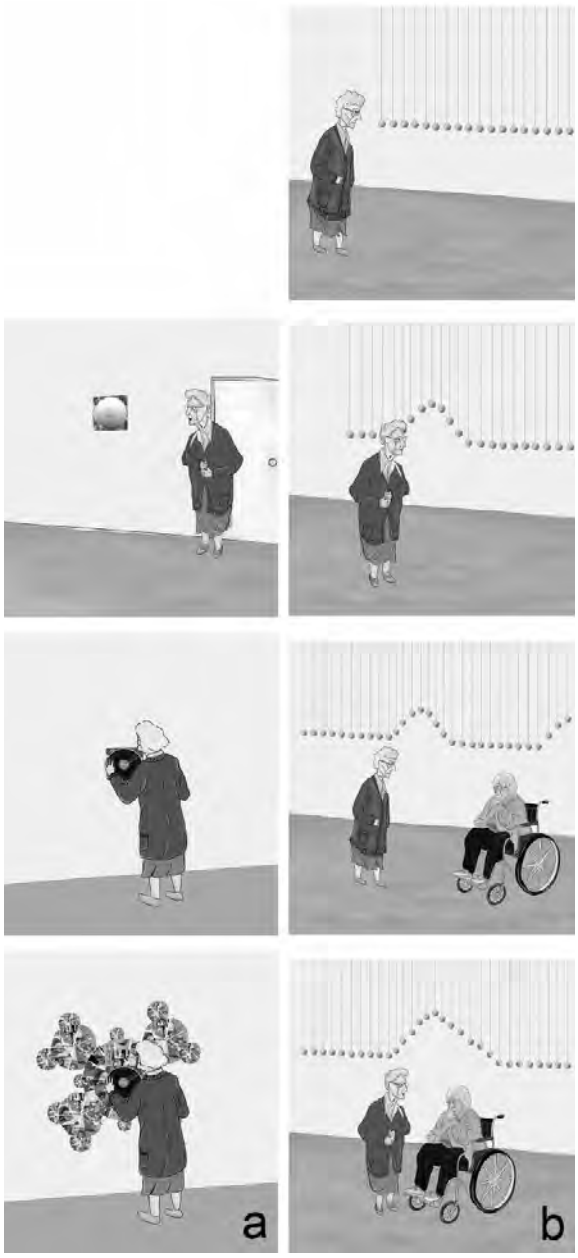

Fig. 10 (a-b): concept1: Kaleidoshare and concept2: Dancing-Ball

scenery would appear on the wall of the corridor. As most of them have trouble to recognize the characters in the picture, such way of common emotional arousal would be preferable to start a short conversation and response among the elderly who encounter each other at the corridor. Next to it, when the elderly rotate the disc, they can feel the speed of the rotation and the feeling of control under their

fingertips. The Kaleidoscope gives glittering bits and pieces of life, and thus when the elderly play with the disc, they can feel actually they are making something beautiful and meaningful to their lives.

However after evaluating the concept with the experts and some elderly, it does not seem to be comfortable for the elderly to stand in front of the wall for a time that might be too long. If the context is moved to sitting place, common room would be more suitable for the concept.

The concept 2 is named Dancing-Ball (Fig. 7(b)). The "dancing balls" would form a mountain shape according to the position of the elderly and the peak reflects the walking manner. The elderly can see that the movements of the whole system are in accordance with their own movements. Because of the different pace and walking manner, everyone would have a different pattern. When two elders come together, there will also be a transaction of the wave.

The evaluation of this concept turned out that it was hard for the dementia elderly to relate the concept to the things they were familiar to. They were curious actually about the things they are familiar to but would like to organize them and work with the concept design in a different way – the concept was too complex for most of them to comprehend.

Based on the first two concepts, the final concept's focus is to bring forward something that offer responses from the surroundings to the elderly, to let them set free to have a feeling of outside world when walking in a confined corridor, and to provide a stage to evoke the liveliness with attention, thinking and responses.

4 The Final Concept

Inspired by the above mentioned methods and the feedback from the concepts from the first two iterations, the final design concept is to bring in light and sound in an installation to help the elderly to get rid of dull and passive feelings of the confined corridor area at Vitalis. According to the experiment of the first iteration, manual facilitate is needed to understand pictures for the thirds or fourths period of dementia elderly. Vitalis prefer voluntary activities that dementia elders could experience on their own when they retour the corridor habitually. Considering the circulation function of the corridor, installation should improve the experience for dementia elderly to pass it by.
The light and sound are designed in a way to reminiscence the interaction with outdoor nature which is missing in the confined indoor place. By interacting with the installation, the dementia elderly perceive the stimuli that resemble their memories of natural lighting and the sound of water drops with calm background sound of a brook, the experience they miss in the care center. It will be examined in the following test that whether the installations relive outdoor activities in their previous years and whether the elderly are actively involved in.

4.1 Concept

The concept is to augment the corridor in the confined area with the light and sound from the outside world in response to their movement and touch to help the dementia elderly get rid of dull and passive timeless feelings. The concept is based on reminiscence therapy and implementing lighting and sounds to give stimuli of memorized events. In the interaction, the dementia elderly perceive the response from the nature and they have an active role in making interesting lighting patterns and the sound of water drops. The interaction mimics throwing stones in the river with lights blinking up one by one as the elderly standing in front of the installation. When several elderly present, flowing lighting effect and roaring sounds hints the stirring of ripples.

Sound memory as proved in research, has a strong effect on mood and cognitive functioning until the very late stage of dementia. The feeling of the natural sound of water drops is familiar to everyone in their memories from their childhood when wandering in the wild.

Lighting gives people solid feeling of the elapse of time and the feeling of liveliness. In a dim corridor where the dementia elderly would spend hours every day to walk through, more exposure to light has been proved to be effective in preventing depression and improving rest-activity rhythm.

4.2 Scenario

The design implements the following scenario: Rob is an elder who suffers at Vitalis. One of the walls of the dull corridor is now decorated with a row of lights covered in curved fabrics (Fig. 4).

At daytime, glowing blue lights gives a refreshing feeling for Rob and the others passing by (Fig. 4(a)). During the night, the light is soothing yellow. The sound of a brook starts whispering gently, which reminds Rob of the fresh air and possibly an exciting outdoor travel experience in his childhood (Fig. 4(b)). Rob hears a chain of water drop sounds coming with the lights one by one. He is fascinated and finds it interesting. He is curious about the lighting and sound effects, and wonders he might be able to interact with it (Fig. 4(c)). When Rob comes close, the first light glows brighter. It glows in response to Rob's position (Fig. 4(d)). Rob touches the light and the touch seems to be sensed. It lights up with solid color with the sound of a water drop. As he walks faster and closer, the sound of the whispering brook becomes louder. The memory of refreshing and playful natural environment comes back (Fig. 4(e)). There comes the other elderly person, Marjolijn, walking in the same direction as Rob. The lights start to flow between Rob and Marjolijn, and the brook sounds running faster. Marjolijn walks closer to the lights slowly, and the lights near her become brighter yet glow slower (Fig. 4(f)). When Marjolijn walks towards Rob instead, the lights flow in the manner of joining together.

The lighting augments the encounter of people and the sounds change as a response to the movements of the elderly just as what happen outdoors (Fig. 4(g)). We expect the multi-user interaction would also improve the feeling of social connectedness [11].

4.3 Prototype

The prototype of concept was implemented and tested with the dementia elderly and the caregiving experts at Vitalis. The prototype implements the interaction between two people in the distance, and the effect of touching. Infrared distance sensors are used to detect the speed and direction of the movement, and cap sensors are used to detect touch. When there is elderly walking closer towards the first light, it becomes brighter with the background sound of water start whispering. Lights flashed one by one gradually with water drop sounds. Once the elder touches the colorful plastic area, the corresponding lights lit up with water drop sounds. When there comes another elder, lights between them would flash with roaming water sound.

4.4 The User test and Results

The final prototype was opened for user test at 3.30pm, on 20th December 2012 at Vitalis (Fig. 5). Instead of hanging out in the corridor, the prototype was set on a long table in the living room where 8 elders with dementia sitting at another table 2 meters away could see and experience when others play with the prototype.

However, the prototype was only displayed for a relatively short period of time. Moreover the actual concept covered one side walking space in the corridor, and full size of the concept would have an effect on the circulation function in the corridor, which was later discussed with experts from Vitalis.

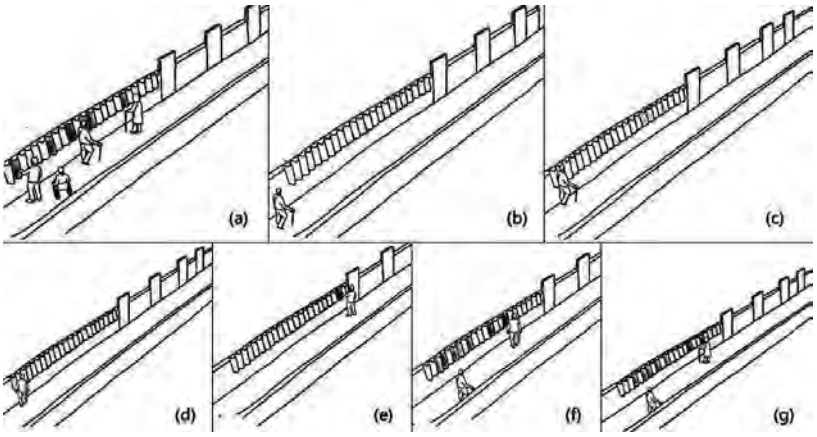

Fig. 4: Scenario

Fig. 5: The final prototype used in the evaluation

Mood board

Creating mood boards would be a useful way to reflect the user's emotion and attitude towards certain concepts or products. However creating such a mood board could be time consuming and, especially for the dementia elderly, very challenging. Instead, the participants in the evaluation were asked to make choices from a restricted selection of images for certain aspects. This supports a more formalized analysis.

On the basis of this prototype, the participants were asked with the following questions:

- Which image resembles your mood while playing with the lighting?(Fig. 6(a))
- Which image represents what you are thinking of while playing with the lighting?(Fig. 6(b))
- Which image can recall the memory you once had while playing with the lighting?(Fig. 6(c))

The care givers were asked to observe the dementia elderly also and were asked to answer the following questions:

- Do you think the dementia elderly like the lighting, and in which ways? And how about Sounds?
- Do they behave relaxed or interested or agitated? (positive or negative), and in which ways?
- Does the design make the dementia elderly more active? In which ways?

During the interview, the participants were also asked to describe why they choose certain pictures in order to prospect their thinking.

Fig. 6 (a-c): pictures help to present dementia to prospect their thinking

Reflections

In general, the prototype did bring come joy and happiness to the dementia elderly as expected. The Elderly loved to keep trying and interacting with different behaviors of the installation. They loved to see the glowing and flowing light effects and to hear the curious water drop sounds after they had touched the lights. The experts commented it as "pleasant; the elderly love it; they are not bored any more in the corridor; this provides them with minutes of escape."

During the practice, several behavior patterns are observed: the elderly keep interact with the blue circles of the installation. Interaction among multiple elderly is not active as expected because the elderly cannot perceive the interaction solely on perceiving sound volume and blinking rates.

The elders were fond of the interaction with stimuli such as light and sounds. The installation gave them stimuli for minutes of attention which allowed them escape from the reality into another place in a pleasing way, which was considered by the care givers to be active and healthy. However, the elderly cannot fully relates the sounds and lighting to the throwing stones event when interact with multiple elderly. Thus the voluntary engagement of multiple elderly is not as active as that of the only person.

Except for reminiscence on object, it is possible to relive the events for reminiscence based on lighting and sounds. Lighting and sounds create a low-fidelity environment and yet effectively vibrate interaction of elderly's past activities. In addition to lighting frequency, the elderly are facilitated by color of lights to grasp instantly what the scenario is.

5 Conclusion

Dementia elderly in the care house spend hours every day to pass through the corridor because basically their footprints are limited to bedrooms, common rooms

and corridors. Mostly, they view the corridor as outside world where they pass through every day many times.

The concept of the lighting and sound installation for the elderly with dementia was directly inspired by the therapeutic methods and preventive social and cultural activities. The prototype of the concept was evaluated and it achieved the goal of bringing joy and happiness to the dementia elderly. Dementia elderly are fond of the stimuli that light and sounds brought up and the natural atmosphere it creates. It gave them several minutes' escape to other place every time they go through the corridor. Direct response to the body movements and respond to touching also attracts them to play with it.

However the scale of the prototype is much smaller than the designed dimension. A more comprehensive user study with a full scale implementation would make the claim stronger.

References

1. W. Black, and O. P. Almeida, "A systematic review of the association between the behavioral and Psychological Symptoms of Dementia and burden of care," Statistics, vol. 1999, no. 1999b, 2001.
2. M. Vernooij-Dassen, "Meaningful activities for people with dementia," 2007.
3. A. Phinney, "Family strategies for supporting involvement in meaningful activity by persons with dementia," Journal of Family Nursing, vol. 12, no. 1, pp. 80-101, 2006.
4. P. Desmet, "Design for happiness; four ingredients for designing meaningful activities."
5. P. R. Boyce, Human factors in lighting: CRC Press, 2010.
6. J. Van Hoof, M. Aarts, C. Rense et al., "Ambient bright light in dementia: effects on behaviour and circadian rhythmicity," Building and Environment, vol. 44, no. 1, pp. 146-155, 2009.
7. L. Volicer, D. G. Harper, B. C. Manning et al., "Sundowning and circadian rhythms in Alzheimer's disease," American Journal of Psychiatry, vol. 158, no. 5, pp. 704-711, 2001.
8. L. Buettner, "Therapeutic recreation in the nursing home. Reinventing a good thing," Journal of gerontological nursing, vol. 27, no. 5, pp. 8, 2001.
9. H.-F. Hsieh, and J.-J. Wang, "Effect of reminiscence therapy on depression in older adults: a systematic review," International journal of nursing studies, vol. 40, no. 4, pp. 335, 2003.
10. J. Tulloch, "Protect against dementia," http://knowledge.allianz.com/, 2012.
11. D. Le, M. Funk, and J. Hu, "Blobulous: Computers As Social Actors.," in CHI 2013 workshop: Experiencing Interactivity in Public Spaces (EIPS), Paris, 2013.
12. The Benevolent Society: Reminiscing Handbook for Those Working with Older Adults,2005