Guiding Lights – Facilitation of Way-finding for People with Dementia via Spatial Light Cues

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Abstract. The percentage of People with Dementia (PwD) in residential nursing homes is increasing. PwD are facing difficulties in their daily activities, including way-finding. In this paper, we propose light cues as a solution for supporting PwD in orientation and way-finding in the facilities. A study on a spatial searching task with four participants was conducted. Preliminary results indicate a strong effect of the spatial light cues on turning behavior and orientation. It can help PwD in turning towards the right direction without the requirement of operating assistive devices. In the long-term perspective, light cues which are dynamic and adaptable to the context will be embedded in the environment.

1 Introduction

The number of people suffering from dementia of the Alzheimer's type will increase drastically to about 106.2 million in 2050 [2]. Disorientation as one of the symptoms of dementia greatly limits the quality of life of PwD. Existing assistance systems for navigation use technology like mobile phones, projectors and augmented reality [4]. However, those systems are most likely unsuitable for people with severe dementia, who are not capable of using complex technologies [6].

Thus we aim at designing assistive, unobtrusive technology for navigation and orientation applied to an intelligent environment. It should be easily accessible to heavily impaired PwD in their nursing homes.

Our approach is using lighting and colors as implicit guidance cues for PwD. Although Gibson et al. identify color as a helpful cue [3], more systematic research regarding the influence of color on PwD is needed especially when applied to the environment [1]. As Kempter et al. suggested, lighting has a positive effect on the recognition of spatial awareness and visual orientation [5]. In this paper, we present an experiment of color and lighting in orientation and navigation and its first results.

2 Methods

Setting: The study was conducted in a 26-bed residential nursing home. The residential nursing home is divided in two floors which are connected via stairs and an elevator. At each level, all rooms are connected via a long corridor. A dining area, where the meals are served, is located at the end of the top corridor. The facility is staffed by 3 certified nursing assistants. The study was planned to be conducted during a two week-period in October 2014 five times per week but had to be expanded by one week. The study was performed on the lower floor due to better lighting conditions without direct bright sunlight.

Participants: There were 4 participants in the facility, who met the following criteria: *Diagnosis of dementia* following the ICD-10-scheme, *mobile* (able to move by themselves) and an ability to *respond to a verbal request*. The ages ranged between 82 and 94. Due to vision and hearing abilities, they were all able to physically understand spoken language and perceive their environment normally. For each participant, a family member was informed about the purpose, procedure and data security of the study and signed a statement of informed consent.

Procedure: The study was conducted by two experimenters. The first experimenter was responsible for the direct interaction with the participant, whereas the second experimenter stayed in the background and observed. At each trial, the first experimenter and a staff-member talked to the participant and evaluated if the person was in condition to take part in the experiment this day. If the person was too exhausted or too tired, the trial for this person was skipped that day. Approximately 70% of the planned trials had to be postponed and carried out some days later.

At each trial the participant was led to the starting point (see Figure 1) by the first experimenter, where the instruction was given. The task was to find an object that the first experimenter had put on the floor. The right side and the left side of participants were set-up as symmetric as possible. The PwD had to decide which direction (left or right) to go. As way-finding is a process of decision making, if the light cues influence decision making, it could support PwD in way-finding. The participants stood 0.5m in front of the first experimenter and therefore had no bias towards one of the two directions. Each trial for each participant lasted approximately 30 minutes and was recorded with two video-cameras.

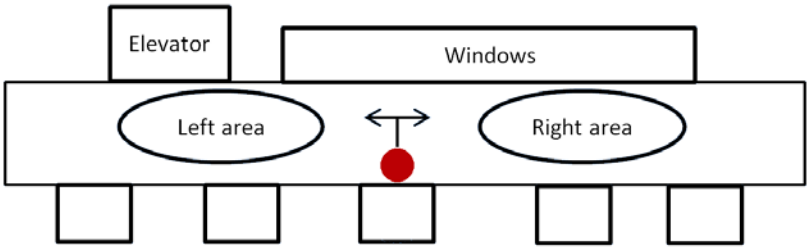

Fig. 1. Experimental Setting

Experimental Manipulation: Three conditions were tested: a baseline without any light cue, a white light cue and a green light cue. Light was produced via light

emission diodes (LED) attached to a strip (1 meter). They were put either on the left side or the right side. All trials were randomized and counter-balanced.

Collected Data: First, the most important variable was *"turning behavior"* (the decision to start searching on the left or right side of the corridor). Second, the "*time-to-decision"* was recorded, i.e. the time from the end of the instruction to the beginning of moving towards one of the two possible directions. Third, the instruction time was measured. This is the time from the beginning of the instructions to the time the participant had understood the task. Fourth, both the first and second experimenter rated the *difficulty* of the entire decision making process of the participant on a 15-point scale (0: impossible; 15: very easy).

3 Preliminary Results

"Turning Behavior": In the baseline condition the participants walked to the right in 50% and to the left in 50% of cases. In both lighting conditions, PwD turned to the correct side 75% of the time.

	Walking Direction in %		Decision Times in sec		Subjective Ratings [0-15]	
	Left	Right	*M*	*SD*	*M*	*SD*
Condition (N = 22)						
Baseline	50	50	40.33	10.02	5.30	5.08
White Left	50	50	51.00	61.56	10.00	2.04
White Right	0	100	57.50	41.11	8.36	4.11
Green Left	75	25	72.50	64.68	7.88	4.46
Green Right	25	75	47.75	52.54	9.00	2.49

Table 1. Walking direction, decision times and subjective ratings

Due to the small sample size, the measurements "*times"* and "*ratings"* cannot be safely interpreted yet. The participants took more time in deciding. But they more likely turned to the direction we guided by light and were more confident after making decision, according to the "*walking direction*" and "*subjective ratings*". The observations and feedbacks from the caregivers showed that the PwD walked to their aim faster and more directional.

4 Conclusion

Preliminary results indicated that the participants had no bias towards one direction when no light was used as a guidance cue, whereas they tended to go in the direction of the light. The turning behavior suggested that the light has a positive impact on way-finding of PwD in severe stages. The instruction and decision times were higher in the lighting conditions. The participants took more time for considering and decid-

ing the turning direction but walked more determined to the location of the placed object.

The drawback of the experiment was the low number of participants as there were few in the facility that met our including criteria. The number of trials was also low because the communication with the participants was difficult and very time consuming. The environment and confounding variables perhaps could have led to an influence on the performance especially regarding the instruction and decision time.

However, the results combined with our observations seem promising and the study should be continued with more participants. Our findings led to the idea of an intelligent system that guides PwD with the help of illuminated handrails. Knowing the position and destination of the PwD the system could illuminate their way. This kind of system would not require the PwD to operate any device. It could be a first step to pervasive computing that helps to improve the quality of life of PwD and fosters their independence and wellbeing. Interesting future topics could be the use of more colors, indirect lighting, different light hues and the effectiveness and acceptance of illuminated handrails. Moreover, the possibilities of intention recognition should be investigated to guide the PwD to their destination (e.g. bedroom, kitchen, garden, or toilet) based on their pattern (history data), current state and activity, and expert opinion (i.e. caregiver, doctor).

5 Acknowledgement

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