INFLUENCE OF ARTIFICIAL DAYLIGHT ON GERONTOPSYCHIATRIC CARE OF ELDERLY PEOPLE

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ABSTRACT

The action spectrum for light induced melatonin suppression has been known since 2001. The receptors being responsible for suppression of melatonin caused by the pineal gland were found in the human eye. By using the melatonin suppression it is possible to describe and to influence one part of the circadian processes. Based on the experimental findings of BRAINARD and THAPAN it is possible to define a circadian action function c(λ). With the help of this function GALL built up a circadian metric [1]. With this metric we are able to describe and to measure potential non-visual effects of light.

The goal of the study was to investigate the influences of optimised illumination on the condition of residents in a nursing home. In the Home for the Aged „Haus Ruhrgarten" in Mülheim, Germany, a light ceiling which illuminates the lounge was installed. In this room the illuminance and the colour temperature and so the circadian effects of light can be varied.

The study took place during February and March 2005. 13 residents aged 77 to 99 (average 87.5) took part in the study. Because of certain health problems and illnesses, only six subjects could be evaluated. Positive effects of artificial daylight could be demonstrated.

Keywords: circadian lighting, elderly, care of elderly

1. INTRODUCTION

Artificial light is known to be important for the gerontopsychiatric care of people of higher age. Older people suffer from visual impairments due to opacity of the aged lens, causing reduced transmission in the eye, and rarely venture outdoors.

Therapeutic effects of light on disorientation and depression have been known for quite some time [3, 4, 5]. Previous observations in nursing homes show that high illumination levels and high circadian action factors during daytime as well as longer exposure to light during winter times can lead to better sleep quality at night and less daytime naps. Sleep-wake-rhythm disorders are reduced. People who suffer from dementia tend to show more activity, more vitality, better orientation and better emotional stability, although substantial influence on the disease cannot be expected. However, a higher quality of life due to increased autonomy and improved well-being can be achieved. The amount of necessary care and support can be decreased [3], however research aimed particularly at these effects is missing.

Therefore, the goal was to investigate the influences of optimised illumination in a common room on the condition of residents. For these investigations a questionnaire to assess daily vitality, orientation, emotional stability and other criteria has been developed. Over a period of six weeks three phases of different illumination intensity and colour temperature have been applied.

Figure 1: Light ceiling in the lounge

2. REALISATION

2.1 Control of Light and Circadian Parameters

Figure 2 shows the setup of the light ceiling in the lounge. A DALI-Control-System was used to control the luminous flux of the 3000K and 8000K lamp groups. This way, different light situations could be realised and both, illumination intensity and light colour could be varied. In phase II the illuminance and the circadian action factor a_{cv} [1] were extensively increased. The illuminance

was 35 times higher and the circadian action factor was 3 times higher than in phase I and phase III. Therefore the circadian irradiance was 105 times higher.

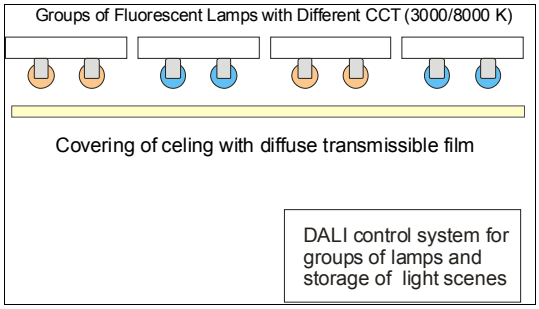

Figure 2: Adaptive illumination concept of the lounge

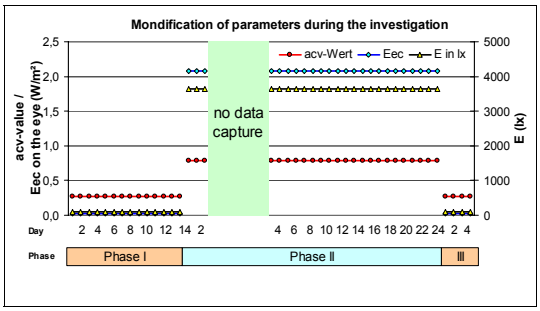

Figure 3: Variation of parameters during the study

Phase	E_{Eye} (lx)	a_{cv}-value	$E_{ec\ Eye}$ (mW(m²)	E_{Desk} (lx)	CCT (K)
I	50	0,27	19,8	100	2840
II	1800	0,79	2080	3650	6170
III	50	0,27	19,8	100	2840

Phase	Parameter of light ceiling (%)			
	8000 K	3000 K	8000 K	3000 K
I	0	1,69	0	1,79
II	100	1	100	1
III	0	1,69	0	1,79

Table 1: Supplied light situations in phase I, II and III (* Activation of 8000 K- und 3000 K-Lamps)

During the study the light situation has been varied according to figure 3 and table 1. The parameters of the light ceiling were kept constant in each phase. The parameters of phase I and III define typical lighting situations in nursing homes.

Figure 4 shows the illumination intensity of the different lamp groups vs. daytime in phase II. The illumination parameters according to table 1 were supplied over a period between 10:15 am and 12:30 pm and over a second period between 4:15 and 6:00 pm in the afternoon. In order to avoid glare the increase of illumination level and colour temperature was started after the residents came into the room. The slow increase was accepted by the residents very well.

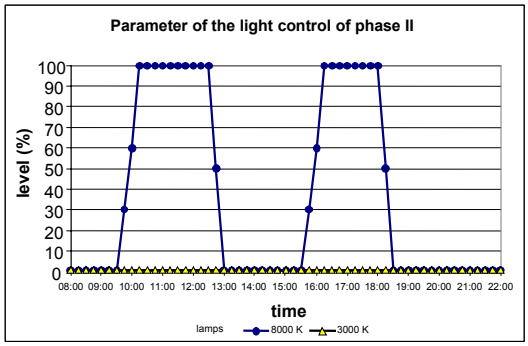

Figure 4: Parameter of the light control of phase II

2.2 Data Ascertainment

The 13 test persons (1 male, 12 female) in the study were between 77 and 99 years old (average 87.5 years). Because of certain health problems and illnesses, only six subjects could be evaluated in phase I and II. Phase III took only 4 days. This phase was not considered in the results because the effect of light may be retarded.

Every day, a questionnaire was completed by a nurse. She asked questions, and assessed the criteria and items based on her observations (table 2). For the interpretation data from 6 test persons (average age 84.8, one male, five female) were used.

2.3 Data Evaluation

For the six people under test, their daily responses to the different criteria were analysed over time. Furthermore average values for every day and every phase were calculated. A factor analysis showed a good correlation between several items, which could combined to factors (table 2, last column).

The Figures 5 - 8 show the progression of some of these factors vs. time in phase I and II. In phase II we see higher vitality in the newspaper session, better orientation, less sleep during daytime, especially at the end of the phase II, and a better sleep at night. The results from phase I and II were compared statistically using SPSS 12.0. The significance of the average difference was examined. The level of significance has been labelled according to table 3.

Criteria	Item	Factor
Vitality	Eating (Autonomy)	Vitality
	Drinking	
	Motility (Rating of motility)	
	Newspaper Session (Attention and conversation)	Newspaper Session
Orientation	Time (Orientation of season, day, time)	Orientation
	Location (Orientation of room and location)	
	Situation (Awareness of personal status)	
	Person (name, age, birthday)	
Emotional Stability	Restlessness	
	Aggressions	Affective stability F1
	Fear	
	Sadness	
	Dissatisfaction (Verbal and non-verbal expressions)	
	Social Isolation	Affective stability F2
	Satisfaction (Verbal and non-verbal expressions	
	Good mood (Collection of possible influences of windows and outdoor stays)	
Sleep habit	Sleep during daytime (Number of naps during daytime, without siesta)	Naps
	Sleep quality at night (Personal rating and rating of the night watch, number of sleepless phases, additional medication)	Sleep quality at night

Table 2: Overview of the criteria and items in the questionnaire

p > 0,05	not significant	n.s.
p <= 0,05	significant	*
p <= 0,01	very significant	**
p <= 0,001	highly significant	***

Table 3: Symbols for the level of significance used in figures 5-9

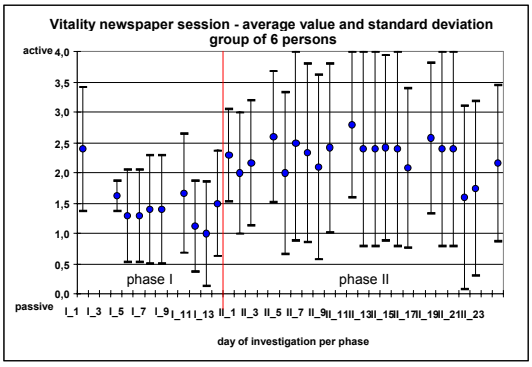

Figure 5: Item "Newspaper session", average value in phase I and II (p < 0,001)

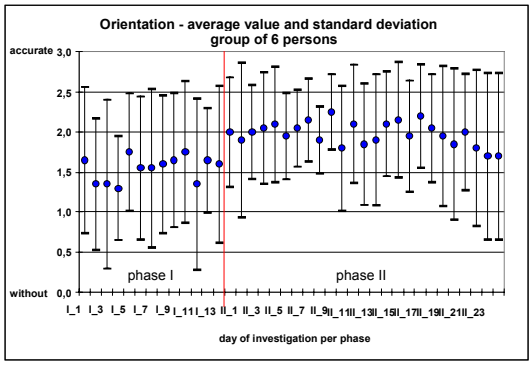

Figure 6: Criteria "Orientation", average value of days in phase I and II (p < 0,001)

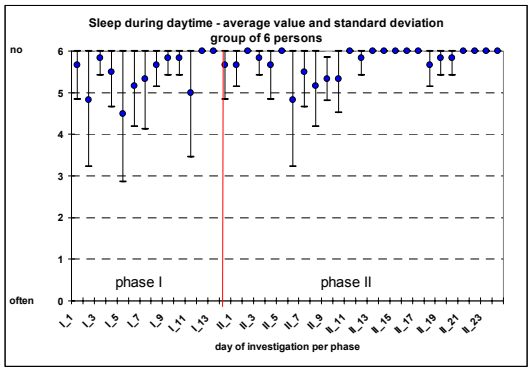

Figure 7: Item „Sleep during daytime", average value in phase I and II (p = 0,025)

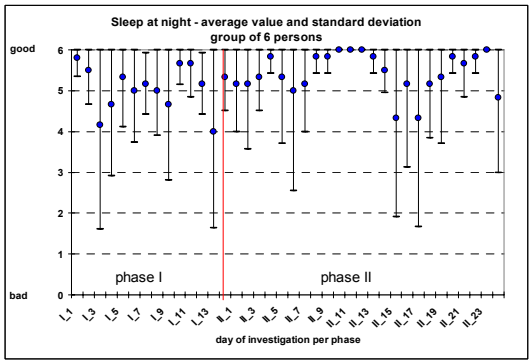

Figure 8: Item „Sleep quality at night", average value phase I and II (p = 0,048, *)

2.4 Results

Figure 9 compares the average values of phase I and II. The significance level of the average difference is labelled by asterisks. The yellow bars in the graph below show the number of occurrences for each parameter stated in the questionnaire. Phase II shows significantly better results in 6 of 7 factors.

Some test persons changed their habit remarkably while others seemed hardly to react to the light situation in phase II. A partial blindness could be the reason for this. Some

items already had large values in phase I and could not improve much further.

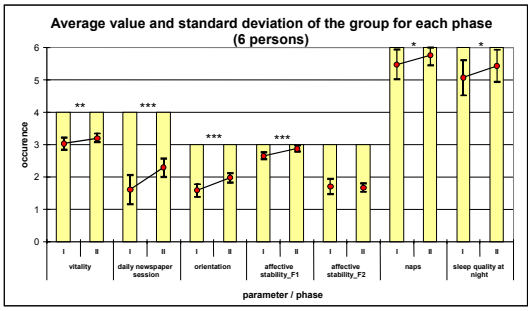

Figure 9: Average value and standard deviation of the group for each phase (6 Persons)

In the group of test persons in phase II vitality significantly increased as opposed to phase I. All subjects but one ate their meals autonomously. While in the common room, the test persons were slightly more likely to take a glass to drink by themselves without being asked. The most distinct improvement was noticeable in the autonomy of everyday tasks.

In the newspaper session the behaviour and participation of the subjects was observed. In phase II listening and interest tended to improve. Most significantly the participation in the conversation improved.

During phase II the test persons were most significantly better able to cope with the tasks of their everyday life. Most of the time, the people knew who they were, they could tell their age correctly and they were aware of the room they were in. Most significantly, the awareness for their situation improved in phase II.

The evaluation of the affective stability of the test persons covered their status of health and their mood. In general the level of stability in phase II increased most significantly. While in phase I conditions of restlessness occurred occasionally, these conditions could not be observed in phase II. The subjects were less aggressive, less fearful, more communicative and less sad than before. Most significantly contentedness and temper improved.

In phase II the number of temporary naps reduced. Therefore the test persons were significantly more awake at daytime. The quality of sleep was subjectively felt as better. The amount of times they woke up at night did not change notably.

3 CONCLUSION

The comparison of their health status before the beginning and after the end of the study does not show any fundamental changes in the gerontopsychatric disease. However, optimized illumination can improve the quality of life of elderly people. For the group of six test persons, tendencies towards better vitality, orientation, affective stability and sleep habit could be shown, some of them being significant. These are likely to be caused by a better quality of illumination at daytime. The interrelation could not be proved, however, because of the small number of test subjects, a missing comparison group and the missing repetition phases. This will be subject to further research.

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