More Light! Improving Well-Being for Persons Suffering from Dementia

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Abstract. Daylight regulates the wake-sleep cycle by acting on specific receptors of the retina that are sensitive to the blue component of the spectrum. Especially in the winter months, the amount of daylight exposure is insufficient for adequate control of the circadian rhythm in many people because they increasingly stay indoors. This is particularly true for elderly or mobility-impaired persons, as well as for residents of care homes, where prevailing levels of illuminance and colour temperature are frequently too low. This not only has negative consequences for the residents' cognition, but also impairs their sleep-wake rhythms. Starting from the hypothesis that suitably designed, biologically effective artificial lighting can compensate for the lack of daylight and lead to regulation of the wake-sleep rhythm, a study comprising approximately 60 participants investigated whether an improvement in the mental and emotional condition of the residents can be achieved. Appropriate lighting was installed in four wards of two Caritas Socialis care homes in Vienna and from October 2012 until April 2013: basic illumination (static, 300 lux, 3000 K) and intervention illumination (dynamic, 800-1200 lux, 3000-6500 K) were alternated (roughly every four weeks). The results indicated that agitated behavior (as measured by the Cohen-Mansfield Agitation Inventory) increased with basic illumination and decreased in the intervention situation. Communicative behavior (observation inventory) was likewise positively influenced, particularly the non-verbal component.

Keywords: Biologically effective lighting · Dementia · Well-being · Field study

1 Dementia and Light/Illumination

1.1 Dementia, Care and Well-Being

Demographic trends have given rise to the increase in the number of dementia patients: age is to some extent the greatest risk factor for dementia [1]. Although many dementia

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patients may initially remain in their own familiar environment, the need for care increases with the progression of the disease. In the late stages of dementia, transfer to a care institution is usually inevitable given the care and assistance requirements [5]. Both informal, caregiving relatives as well as care personnel in the institutions face great challenges in this process. If, in the care and support of those with age-related physical limitations, the compensation of relatives and/or caregivers may become exhausted, such a transfer can easily contribute in a comparatively simple way to the well-being of the patient. These patients can report their well-being relatively simply and immediately to their caregivers and in turn contribute to the job satisfaction of caregivers. This is clearly more complex in the care of dementia patients. On the one hand, the patient may not be able to interpret the caregiving activity, which can cause confusion and anxiety, consequently leading to frustration and aggressive behavior. On the other hand, it is difficult for the caregivers to assess the behavior and mental state of the persons in their care and to arrange their living conditions in such a way that they can feel comfortable. The cycle of reciprocal positive reinforcement is thus frequently difficult with dementia patients.

There is, therefore, a range of approaches to arranging the living and ambient conditions so that dementia sufferers can feel comfortable, although they cannot, or only to a limited extent, communicate this verbally, but tend to react non-verbally or emotionally. These approaches include, for example, various care concepts (e.g. resource activation, basal stimulation, non-pharmacological therapies (occupational therapy, physiotherapy, music therapy) as well as organisational procedures (recurring structures) and last but not least, ambient spatial design [5, 10].

1.2 Dementia and Light/Illumination

The lighting situation is an important aspect of environmental design, and indeed, in several respects is crucial for the elderly, particularly for dementia sufferers. First of all, it means a considerable relief for the elderly when higher illuminance levels can be put into effect. In many existing nursing homes, illuminance levels are too low or so unfavourable that visual orientation is limited and many fine motor activities (crafts, handicrafts) cannot be carried out, or only with great effort.

But yet a further aspect of lighting or illumination can be used to contribute to the well-being of people with dementia. About a decade ago, a receptor in the retina of the eye was detected that responds particularly sensitively to the blue component of daylight and triggers the sleep-wake rhythm through the output of corresponding enzymes [3, 6, 8, 9]. Particularly in the winter months, for many people the amount of daylight exposure is insufficient for adequate control of the wake-sleep rhythm because they increasingly remain indoors. This is also especially true for elderly or mobility-impaired persons, as well as for (dementia-suffering) residents of care homes, where, in addition to levels of illuminance frequently being too low, colour temperatures with a relatively low blue component of the spectrum prevail. That is, the sleep-wake rhythm, which is already frequently disrupted in people with dementia, is more strongly affected by environmental conditions. As a result, the residents sleep less restoratively, which contributes to impairments in mental and physical well-being.

If, then, artificial lighting can compensate for the biologically active effects of insufficient daylight exposure and thereby stabilise the sleep-wake rhythm, this should lead to more restorative sleep and thus ultimately improve the mental and emotional condition, i.e. well-being of the residents. Since the first results from pilot studies were promising [9], a larger study was launched with about 60 participants in order to achieve more robust results.

2 Design and Implementation of the Field Study

Inherently, the question posed in this study is of the operationalisation of well-being, since the subject group of dementia sufferers investigated was not, or not sufficiently able to provide verbal self-reporting. Therefore, a number of aspects were considered which allowed for conclusions to be made on well-being, whereby mainly two aspect are addressed here:

- Communication: earlier studies [9] had already demonstrated that residents in the lighting situation communicated more with fellow residents, relatives and caregivers. In the present investigation, these aspects are augmented by non-verbal communication such as smiling and physical contact as well as communication with "virtual" partners (imagined counterparts, soft toys, dolls and similar). An increase in communication was interpreted as a gain in social participation with positive effects on well-being.
- Agitation: if agitated behaviour is understood to be a reaction to confusion, frustration and/or anxiety, it may be assumed that a reduction in such behaviour suggests a higher degree of relaxation and well-being.

2.1 Investigation Procedure

As shown, a number of different procedures were used in order to obtain an overall impression of the lighting effects. Care personnel - because of their more intensive knowledge of the subjects - as well as external observers and measuring instruments were employed.

The verbal and non-verbal communication behavior of the residents was recorded by observers, who noted the frequency according to predetermined criteria - such as general communication with fellow residents, relatives, volunteers or caregivers, smiling, eye contact, and the like. The observers were first familiarised with the instrument in a workshop, followed by a supervised observation week in the use of the instrument.

The assessment of agitated behaviour was carried out by care personnel, as they are more intensively in contact with the residents over a longer time period. One team of caregivers per ward was appointed to assess the residents at regular intervals (six times in all) using the Cohen-Mansfield Agitation Inventory (CMAI), after having been prepared for this procedure at a workshop [4].

Moreover, using the observation inventory, further behavioural aspects were determined, such as length of stay and mobility in the illuminated area, participation in social activities (crafts, singing etc.), independence in eating and drinking and expressions of emotional state.

In each case, in addition to the CMAI, the Cornell Depression Scale was applied at the same time. Moreover, on the days prior to the observations, the caregivers on night duty also kept a record during their monitoring rounds (as a rule, three) of whether the residents were found to be asleep or awake or were woken up by this.

As an instrumental measurement method, twelve beds were equipped with sensors for non-contact measurement of sleep and movement, and 40 of the residents investigated were willing to wear Actiwatches (generally 24 h over the entire study period) for recording their movement (actigraphy).

2.2 Illumination Conditions

On all wards, a lighting situation was created for the communal areas, in which the residents could stay under daylight-like conditions during the morning and early afternoon hours. These ceilings were equipped with corresponding flat illumination which enabled the implementation of different lighting situations (Fig. 1).

Fig. 1. Illuminated ceiling in the communal area (Caritas Socialis Old People's and Care Home, Rennweg).

In each case, two different lighting situations were implemented: a basic version with an illuminance of 500 lux and a warm white colour temperature (3000 K), and an intervention situation with a higher illuminance (1200 lux) and a daylight-like spectrum (approx. 6500 K) during the time from 09.00 to 15.00 h, and then from the afternoon (15.00 h) with a reduced light intensity (800 lux) and warm white color temperature (3000 K). The lighting conditions were programmed via a corresponding automated control unit.

2.3 Procedure

The investigation was carried out on four wards in two Caritas Socialis care homes in Vienna, two of the wards in Kalksburg, a south-westerly suburb (23rd District) and one ward distributed over two floors in Rennweg in the 3rd District (which was treated as two wards for observation and evaluation, see below).

Both light situations were implemented alternately, starting in October 2012 with the basic version (BL1), November 2012 to early January 2013: intervention situation (LS1), from January 2013 to February 2013: basic variant (BL2) February to March 2013: intervention situation (LS2), March to mid-April: basic version (BLvZ, BLnZ, respectively, before/after time change).

The observations were carried out on Tuesdays to Thursdays, between 10.30 and 13.00 h as well as between 14.00 and 17.00 h. In the period from 15 December 2012 to 6 January 2013 no observations took place. During the nights before the observations the night duty staff recorded, according to specified criteria, whether they found the residents asleep or awake during their rounds.

2.4 Subjects

The investigation started with 58 subjects (approx. 25 % men), of whom approximately two thirds (N = 38) participated in the entire investigation. The average age was 83 years and the subjects were predominantly single.

3 Report and Discussion of Selected Results

From the wide range of data, two aspects are discussed below, which, as detailed at the outset, can be interpreted as indicators of an improvement in well-being.

3.1 Agitation

The CMAI to survey agitated behavior was filled in a total of six times by the specially dedicated teams of each ward. Here, the CMAI subscales "physically aggressive behavior," "physically non-aggressive behavior," "verbal aggression" and "hoarding/hiding," are also combined in one overall value. The data were analysed by means of parameter-free rank analysis of variance (Fig. 2 includes the representation of rank sums) [2].

Except for the subscale hoarding/hiding, all scales show significant reductions (0.05) in agitated behavior in the intervention situations calculated with the CMAI. That is, when the lighting situation is returned to the basic variant, agitated behavior increased again. This is particularly dramatic in the midwinter situation: the lighting situation (LS1) in the second week of January was returned to the basic variant (BL2)

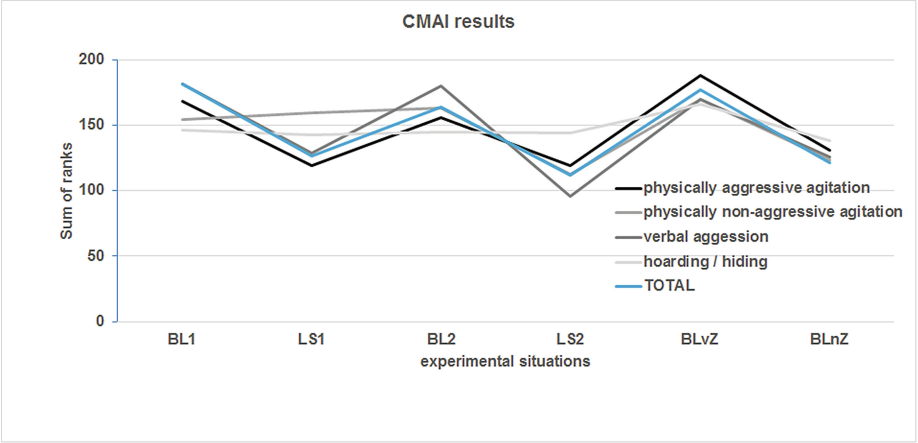

Fig. 2. Results of the subscales and the total value of the CMAI for residents participating over the entire period (BL: Basic lighting situation, LS: Intervention situation; vZ/nZ: before/after time change).

and thus the values in the CMAI rose immediately, while with the onset of next intervention situation the values fell again.

3.2 Communication

Similar results can also be observed when considering the values for communicative behavior, in particular the non-verbal behavior. Especially when the dementia is far advanced, the non-verbal level becomes increasingly significant. For example, it is easier for a dementia sufferer to respond with a smile instead of a verbal response. Even the conversation with an imagined counterpart or with a doll viewed as a child is no less real and satisfying for people with dementia than with a real person, in particular because they largely control the scope of verbal interaction themselves here.

Overall, non-verbal communication behavior demonstrated more clearly that in the lighting intervention situations communication is more frequent. Here, too, the significant drop could be seen in the midwinter period when returning from the intervention situation to the basic variant (Fig. 3). The second lighting situation did not have the anticipated positive effect, at least on verbal communication, but could only stabilise the situation here; a slight increase in non-verbal communication was, however, brought about. Here, seasonal effects may have played a role but also the fact that during the second intervention situation, significant changes occurred through several incidences of new occupancy on three wards within a four-week period. On the ward least affected, a significant increase in communication could be recorded (Fig. 4).

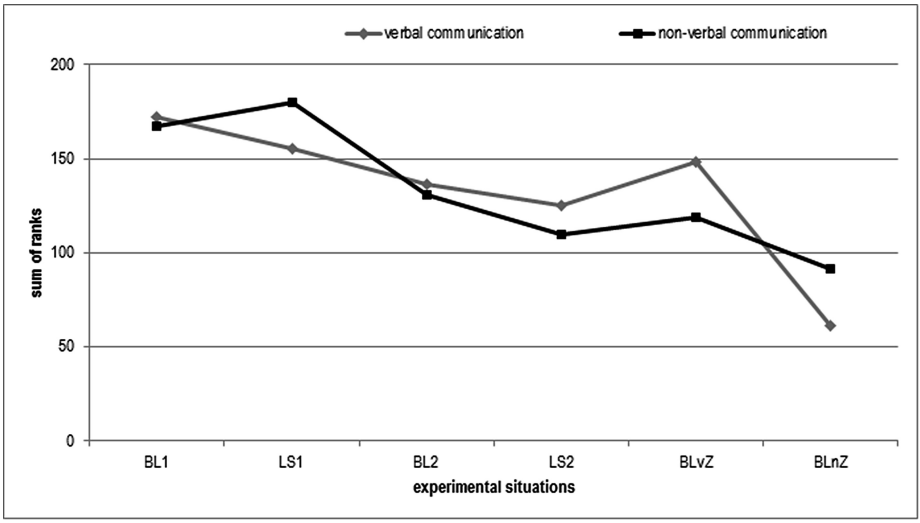

Fig. 3. Results of the frequency of verbal and non-verbal communication for residents participating over the entire period (B: Basic lighting situation, LS: Intervention situation; vZ/nZ: before/after time change).

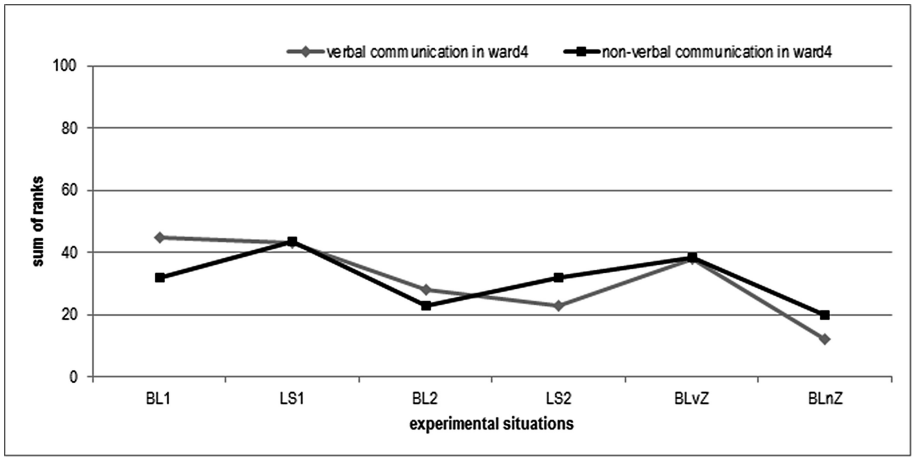

Fig. 4. Results of the frequency of verbal and non-verbal communication for residents participating over the entire period in ward 4 (B: Basic lighting situation, LS: Intervention situation; vZ/nZ: before/after time change).

4 Conclusion and Outlook

Based on the data analysed so far, it is not yet possible to unambiguously determine whether the improvement that occurred was due to the increased illumination or the dynamics of the lighting situation or the higher color temperature or the combination of

these three factors. The results from the previous exploratory studies - albeit with significantly fewer subjects - suggest, however, that an increase in illuminance alone does not appear to be sufficient to achieve an improvement in the welfare of the residents. In view of the not yet fully evaluated data, it is currently still pure speculation whether it is not just the dynamics that evoke a stabilisation in the desired direction with the residents. Here, there is definitely a need for further research.

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