Exposing people with dementia to biodynamic light: The impact of biodynamic lighting on neuropsychiatric symptoms

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E. van Lieshout-van Dal, L. Snaphaan, N. Arkink, I. Bongers. Exposing people with dementia to biodynamic light: The impact of biodynamic lighting on neuropsychiatric symptoms. Gerontechnology 2019;18(4):206-214; https://doi.org/10.4017/gt.2019.18.4.002.00 **Background** The increase of neuropsychiatric symptoms in people with dementia count for 46% of the transit to more controlled environments. Medication to repress these symptoms is widely used, but the side effects are significant, and the effect at the start is not predictable. Research that aims at non-pharmacological interventions is important. One of the promising non-pharmacological interventions is lighting. In this study, the effectiveness of dynamic lighting, lighting with variable intensity and correlated color temperature, on neuropsychiatric symptoms in older people with dementia is studied. **Question** It was hypothesized that the exposure to dynamic lighting would decrease the amount and/or the severity of the neuropsychiatric symptoms. **Methods** A dynamic lighting innovation designed to stimulate a regular and healthy circadian rhythm was installed in the common area of a clinical setting. Two conditions of 21 days with and 21 days without exposure to dynamic lighting were monitored. After each condition, measures of presence, the severity of symptoms and emotional impact were collected using the Neuro Psychiatric Inventory-Questionnaire (NPI-Q). **Results** Eighteen participants were included in the research and completed a condition with and without exposure to dynamic lighting. Per the respondent, the total index of severity of neuropsychiatric symptoms was lower after exposure. Also on a group level, a tendency (p=.187) was found for decreasing the total index of severity of the neuropsychiatric symptoms in the condition that received dynamic lighting. Significance was only found in the severity scores on the symptom disinhibited behavior (p=.01). **Conclusion** A dynamic lighting intervention can be used to decrease the severity of neuropsychiatric symptoms, more specific disinhibited behavior. This is important because disinhibited behavior is related to a disturbed circadian rhythm, is distressing for caregivers and can accelerate the process leading to institutionalization. The findings in this study implicate the importance of future research on the possibilities of dynamic lighting in dementia.

Keywords: dynamic lighting, dementia, neuropsychiatric symptoms, non-pharmacological

Background

Dementia is a common mental disorder diagnosed in (mostly) older individuals. It causes deficits in cognitive, behavioral and social functioning (Ramkisoensing & Meijer, 2015). The number of people living with dementia worldwide is currently estimated at 35.6 million. This number will be doubled by 2030. Dementia is the leading psychiatric condition for people over 60 (WHO, 2017). It is of great importance that older people with dementia stay as healthy and vital as possible so that their quality of life remains high. The costs of dementia care are high. In 2018, the Alzheimer's Association estimates the lifetime cost of Alzheimer's and dementia care at 341,840 US dollars per person. Admittance in a nursing home has a lot of impact on older people and their informal caregivers. Several studies find that neuropsychiatric symptoms are the main determinant of informal caregiver

strain and reported quality of life (Hongisto & Hallikainen, 2018) and hereby an important reason for a transition of people with dementia to a more controlled environment. The reasons for institutionalization are the need for more skilled care (65%), informal caregiver strain (49%) and neuropsychiatric symptoms (46%) (Buhr, Kuchibhatla, Clipp, 2006). Dementia can disturb the circadian rhythm even more than in normal ageing and it is aggravated by a lack of exposure to daylight. Due to a disturbed circadian rhythm, some neuropsychiatric symptoms intensify in the evening and night. Just then when the informal caregiver needs rest, leading to high distress on their part (Molony, 2017).

The cardinal symptoms of neuropsychiatric domains are delusions, hallucinations, agitation/aggression, depression/dysphoria, anxiety, elation/euphoria, apathy/indifference, disinhibition, irritability/lability, motor disturbance, nighttime behavior, appetite/eating. (Cummings, 1994). In The Netherlands, 80% of the people with dementia have one or more neuropsychiatric symptoms (Zuidema, Derksen, Verhey, & Koopmans, 2007). The treatment of these symptoms (Neuropsychiatric symptoms in this article are classified as cardinal symptoms of neuropsychiatric domains) exists of pharmacological and/or psychosocial interventions. The use of medication increases morbidity and mortality in people with dementia and the treatment effect on the symptoms is not always that clear and predictable (Derks, 2014). Therefore, researchers became interested in the possibilities of non-pharmacological interventions such as light.

In a systematic review by Forbes and colleagues (2014) the positive effects of light therapy on cognition, daily functioning, sleep, agitation, and neuropsychiatric symptoms in people with dementia are described. The systematic review by Forbes has also been criticized by Aarts et al. (2016) and Van Hoof et al. (2010). The methodological quality of the reviewed studies is poor. An adequate description of the used light therapy method is not described. Figueiro et al. (2014) studied a small sample but also found positive effects of light on circadian rhythm, agitation, and depression in dementia. Research performed by Figueiro et al. (2015), Figueiro et al. (2014) and Figueiro, Plitnick & Rea (2016) showed that the circadian rhythm, the sleeping pattern and nightly activity improved by the employment of a light intensity level of 400-1000 lux and short-wavelength (bluish) light. These researchers all used a constant light intensity (lux) and Correlated Color Temperature (CCT). Dynamic lighting offers an adjustable range of light intensity and correlated color temperature (Light Technology Nederland, 2017). Dynamic lighting resembles a normal daylight curve and is intended to stimulate circadian rhythm. Due to age-related changes to the eye and a more disturbed circadian rhythm, people with dementia need more light but are more sensitive to light intensity, indirect light, and the CCT. Research has shown that people with dementia in a nursing home only spend 1,6 minutes a day outside (Someren, 2000a; Someren, 2017) and that the indoor light conditions in a nursing home are not sufficient for the visual and the non-visual aspects of light (Figueiro et al., 2015). Also, neuropsychiatric symptoms tend to intensify in the evening and night. This nighttime behavior is one of the symptoms, which causes a reason for the transition to a more controlled environment because of the impact on the primary caregiver (Figueiro et al., 2014). Thus, people with dementia, especially those living in a nursing home, could benefit highly from dynamic light input (Figueiro et al., 2015; Forbes et al., 2014). In this study, we will focus on the impact of dynamic lighting on the neuropsychiatric symptoms in people with dementia.

It has hardly been investigated whether dynamic lighting with its characteristic variation in light intensity and color temperature can have a positive effect on neuropsychiatric symptoms in people with dementia. A very recent study that did use dynamic lighting showed a significant decrease in agitated behavior in people with dementia in a nursing home (Wahnschaffe, Nowozin, Haedel, Rath, Appelhof, Munch & Kunz, 2017). In the present study, the impact of dynamic lighting on neuropsychiatric symptoms in people with dementia is investigated in a clinical setting. The methodology of the used lighting equipment is described. It was hypothesized that the exposure to dynamic light would decrease the amount and/or the severity of the neuropsychiatric symptoms.

Materials and methods

Participants and setting

The participants were recruited from a treatment facility for older people with neurocognitive disorders in psychiatric hospital Geestelijke Gezondheidszorg Eindhoven (GGzE) in Eindhoven. In a period of one year, lasting until January 2017 every newly admitted patient was approached to participate. The inclusion criteria for the study were a primary diagnosis of dementia diagnosed by a geriatrician or psychiatrist, based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria and the participants had to be identified with neuropsychiatric symptoms. The exclusion criteria were any other neurological disorder, including narcolepsy, sleep apnoea or restless legs syndrome or a serious eye disease incompatible with light therapy, such as retinitis pigmentosa. People

Figure 1. VitaalLicht Lamp

were also excluded if there is severe comorbidity of psychiatric disorders, like a manic episode, addiction or severe aggression in a psychotic episode, or if they were physically disabled and cannot leave their bed by themselves. No restrictions were made for medication use. In the absence of a legal obligation for medical ethics review, independent judgement was provided on the protection of patients' rights by conformity to the letter and rationale of the applicable laws and research practice. All study materials and procedures were approved by the Scientific Board of Mental Health Care Institution, GGzE, Eindhoven, The Netherlands. Informed consent was obtained from participant family members after a full explanation of the procedures, in accordance with the Declaration of Helsinki (World Medical Association, 2017).

Design and intervention

The study was performed using a quantitative prospective quasi-experimental crossover design. After 21 days of exposure (condition A), the dynamic lighting lamps were removed from the common area and the group receives the regular lighting condition (condition B) during the next 21 days. Dependent on the date of admittance subjects started their condition with or without exposure. The first two weeks of the condition were marked as a washout period to minimize carry-over effects (Bouter et al., 2010). The parcel lamp, type Bright Brenda (Sparckel, 2018) is used in this study as lighting armature. Three lamps were placed in the common room of the ward. Participants spend most of their time in this common area. In this room they eat all their meals, play games, read, watch television, listen to music and receive visitors. In this dynamic lighting, the illuminance level and the correlated colour temperature are combined in the right proportion and varied throughout the whole day from 7:30 am to 10:30 pm resembling a daylight curve. All these aspects are accounted for in the designation of the Sparckel lamp, type Bright Brenda. This lamp has been developed after extensive research in a co-production with lighting specialists and users. A fixed day curve programme was installed and used in our study. *Figure 1* illustrates the situation in a clinical ward of GGzE and *Figure 2* shows the floorplan of the used common room with the location of the three biodynamic lighting armatures.

One lamp can produce to 7500 lumens, five times more than usual in respectively an office or living room. It also produces a CCT of 2700-6500 Kelvin (indirect-direct) and the spectrum of the biodynamic lighting simulates a regular daylight curve by following this curve in light colour and intensity. There is no risk of blue light hazard and no exposure to UV-radiance. Other important measurement data like the Colour Rendering Index and the Melanopic Effect Factor are shown in *Table 1*.

A close-up from the topside and screen of the lamp is shown in *Figure 3*. The topside of the lamp produces indirect light and contains 12 high power LEDs producing a maximum of 3 W per piece. It consists of 4 lights producing 6500K, 4 lights producing 2700K and 4 lights producing 1800K. The bottom side produces direct light and contains 196 medium power LEDs producing a maximum of 0.3 W per piece. It consists of 98 lights producing 6500K, 49 lights producing 2700K and 49 lights producing 1800K.

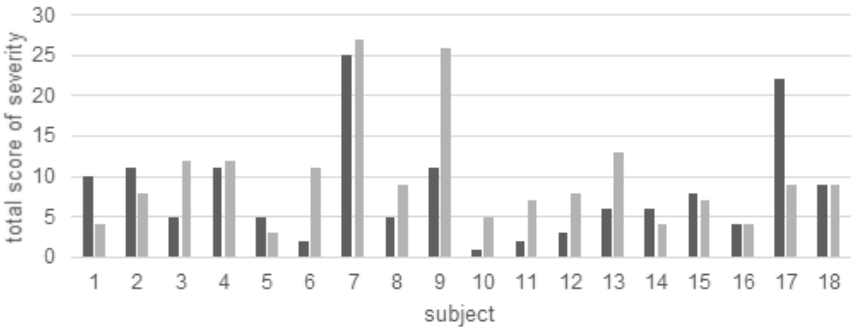


Figure 2. Total score of severity of symptoms per participant in condition A (black) and B (grey).

Table 1. Measurement data of one Sparckel lamp, type Bright Brenda

Parameter	Lamp measurement	Remark
Colour temperature	4847 K	Direct light
	4750 K	Indirect light
Light intensity	1984.2 cd	0,1 m distance
Colour Rendering Index	87	CRI_Ra
S/P ratio	2.0	1m distance
Melanopic Effect Factor	0.682	According to standard DIN SPEC 5031-100:2015-08
Light spectrum	465-480 Nm	(equivalent) Melanopic lux
Luminous Flux	6818 lm	1 m distance
Blue light hazard risk group	0	No risk

Note: Adapted with permission from Olino Measurement Report Vitaal Licht. Retrieved from Olino website www.olino.org/private/129719/fb18f324120d03e4952d5dba8182fad0/2017

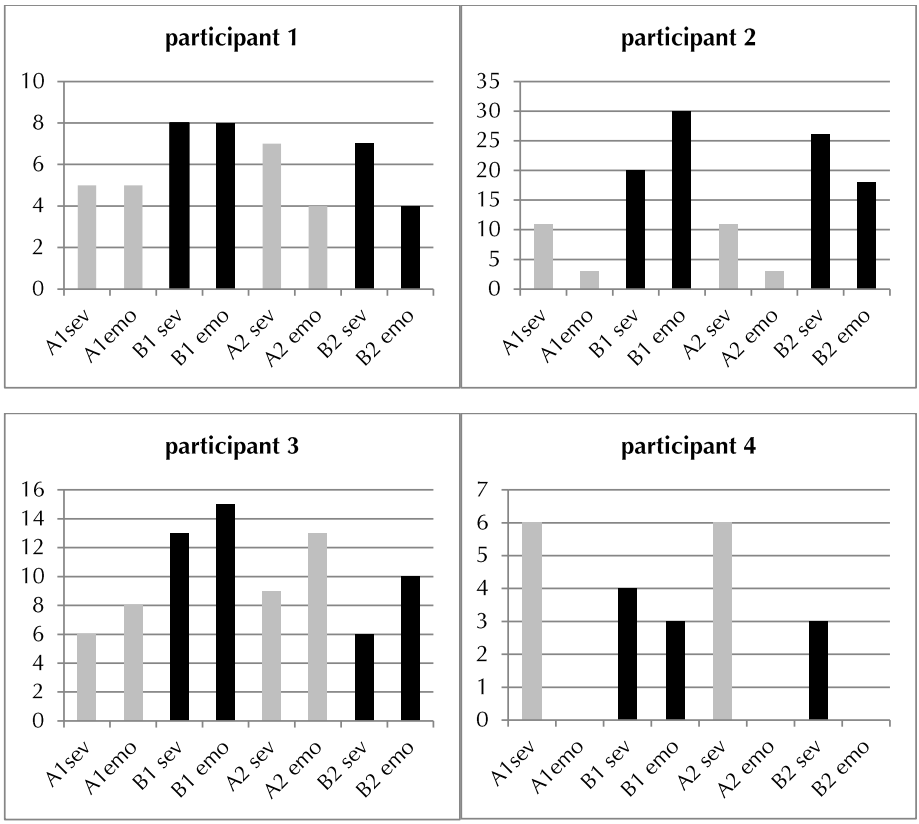
Because of the sensitivity of the aging eye, we dimmed the exposure to 75%, to increase the comfort of the older people. During the day the participants received gradually a light intensity from 600 lux at 8 am, 1100 lux from 10 am until 2 pm and 600 lux at 5 pm. During the day the CCT is around 6500 Kelvin, bluish light. During the evening, the CCT is warm, around 1800 Kelvin.

Figure 4 shows the power spectrum, the sensitivity curves and resulting night and day spectra at 1 m distance.

In order to have objective measurements of the received amount of lighting by the participants, lighting measures were collected. In each condition, the amount of lux was measured manually at least three times a week at three fixed locations in the common room at three fixed moments a day (9:00 AM, 1:00 PM and 5:00 PM). Vertical measurements were obtained at eye level because they approach the real-life situation of light collected by the ganglion cells in the eye the most. The lighting measurements were collected with a Voltcraft MS-200LED-lux meter. Most people were exposed to dynamic lighting from 10 am to 1 pm and from 3 pm to 6 pm.

Measurements

When a condition of 21 days with or without exposure to dynamic lighting was finalized, the



Note: sev = severity of symptoms, emo = emotional impact on caregiver

Figure 3. Results of four participants that completed an ABAB-condition.

Table 2. Description of study population, n=18

Age	76,4 (11.7)	
Sex		
Male	9 (50%)	
Female	9 (50%)	
Dementia type		
Alzheimer's Disease	6 (33%)	
Frontotemporal dementia	1 (5.5%)	
Dementia due to substance abuse	1 (5.5%)	
Dementia NOS	10 (55%)	
Medication	**Start**	**End**
Typical antipsychotics	14 (67%)	8 (44%)
Atypical antipsychotics	3 (16.5%)	6 (33%)
Sedatives/ Benzodiazepines	9 (50%)	9 (50%)
Pain medication	7 (38.5%)	6 (33%)
Antidepressants	4 (22%)	5 (27.5%)
Other medication (e.g. vitamin D)	13 (71.5%)	13 (71.5%)

SD or percentages are shown in brackets

neuropsychiatric symptoms of each participant were measured with a standardized questionnaire, the Neuro Psychiatric Inventory Questionnaire (NPI-Q) by the primary formal personal caregiver of each participant (Kaufer & Cummings, 2000). The Neuro Psychiatric Inventory-Questionnaire is a standardized 12-item tool designed to rate the presence of symptoms (present or absent), the severity of the present symptoms (3-point scale) and the caregiver distress of these symptoms (5-point scale) by the primary formal caregiver. A higher score on the NPI-Q is associated with greater severity of symptoms and a greater impact of the symptom manifestation on caregivers (Kat., 2009). The NPI-Q is recently used in a 3-year longitudinal study of 514 patients to confirm the association between dementia severity and neuropsychiatric symptoms (Brodaty et al., 2015). NPI-Q was completed for all participants in both conditions. Medication dosage and use were monitored during the study by checking the pharmacotherapy data in the electronic patient files by the start and end of the participation in the study.

Analyses

Prior to the study, a power analysis was performed. Under the assumption of a within the subject correlation of r =0.50, 34 participants would be needed to be included, at a 2-sided a level of less than .05, a power of 0.80 to detect a moderate effect size of 0.5. A post hoc power analysis, taking into account the smaller sample size than anticipated, yielded a power of this study of 0.52 with an effect size of 0.5 (Ai-therapy Statistics). Data were analysed using SPSS, version 19 (Baarda, Van Dijkum, & De Goede, 2014). The sum scores in conditions A and B were compared at the symptom level, group level, and participant level.

Results

From January 2016 to January 2017 sixty-one older people with dementia were admitted to psychiatric hospital GGzE in Eindhoven, The Netherlands. Two people did not sign the informed consent, nineteen people could not be included because of severe comorbidity of psychiatric disorders (i.e. manic episode, psychotic episode, aggression caused by detox of substance abuse) and/or physical complications (i.e. wheelchair dependence, kidney dialysis) and twenty-two people did not complete two conditions (i.e. transition, discharge, death). Eighteen participants were included in this study (nine men, nine females; mean age was 76.4 ± 11.7 years) and completed two conditions. Four participants completed four conditions in an ABAB-design. All participants used medication at the start (i.e. antipsychotic medication, antidepressant medication, melatonin, vitamin D, pain medication). In four participants, medication was changed during the study. Two participants received no antipsychotic medication during the condition

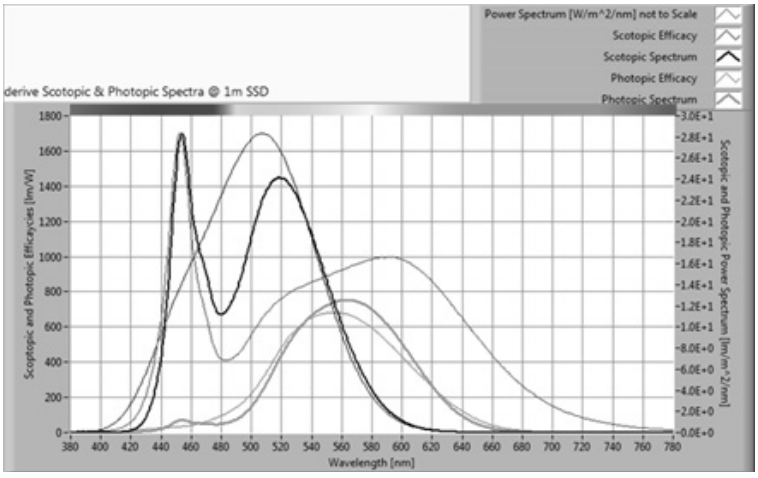


Figure 4. Power spectrum, sensitivity curves and resulting night and day spectra (1 m distance)

Table 3. Scores on the severity of symptoms in condition A (exposure) and condition B (no exposure)

Neuropsychiatric symptoms	Condition A n=18 mean (sd)	Condition B n=18 mean (sd)	sign. (*p*)
1. Delusions	1,00 (1,00)	1,44 (1,29)	0,11
2. Hallucinations	0,56 (1,04)	0,67 (1,19)	0,49
3. Agitation/aggression	1,11 (1,08)	1,33 (0,98)	0,36
4. Depression/dysphoria	1,17 (0,92)	0,78 (0,81)	0,24
5. Anxiety	1,11 (1,23)	0,72 (1,23)	0,25
6. Euphoria/elation	0,28 (0,75)	0,39 (0,70)	0,48
7. Apathy/indifference	0,50 (0,79)	0,50 (0,92)	1,00
8. Disinhibited behavior	0,33 (0,77)	1,22 (1,26)	**0,01***
9. Irritability/lability	0,83 (1,10)	1,22 (1,17)	0,23
10. Aberrant motor	0,39 (0,85)	0,11 (0,32)	0,16
11. Nighttime behavior	0,72 (1,13)	1,17 (0,99)	0,21
12. Appetite/eating	0,17 (0,51)	0,17 (0,71)	1,00

* indicates a significant difference at the severity of symptoms between condition A (exposure to dynamic light) and condition B (no exposure)

with exposure and did in the condition without exposure. One participant received no sedating medication in the condition with exposure and did in the condition without exposure. One participant received no antidepressant medication in the exposure condition and did in the condition without exposure. For a description of the included study population see *Table 2*. Ten participants started with exposure to dynamic lighting (condition A) and eight participants started with the normal daylight condition (condition B).

The mean amount of lux in the 'dynamic lighting' condition was 1150 lx ± 560 lx with a minimum of 390 lx and a maximum of 1900 lx. The mean amount of lux in the 'normal lighting' condition was 390 lx ± 280 lx with a minimum of 60 lx and a maximum of 900 lx. A two-tailed paired t-test did show a significant difference between the amount of lux in both conditions (p<0.001).

Severity of neuropsychiatric symptoms

As shown in *Table 3*, a significant difference was found for only one neuropsychiatric symptom. For the symptom disinhibited behavior a significant decrease was revealed between exposure and no exposure to dynamic lighting (P=.01). The data were not normally equated. Therefore, the Wilcoxon signed-rank test is used to compare the data.

The mean total score in the exposure condition is 8.1 (SD=6.4) and in no exposure condition 9.6 (SD=6.0) (P=.289). Visual inspection of the variables shows that none of the scores was normally equated. The non-parametric Wilcoxon signed-rank test was used to analyze the data.

At a group level, a comparison is made in total score with and without exposure to dynamic lighting.

The total scores of the severity of symptoms at an individual level in both conditions are shown in *Figure 2*. The first eight participants started in condition B (no exposure). In five participants the total score of severity decreased in condition A (exposure) and in three participants the score increased in condition A. Ten participants started in condition A (exposure) and in five participants the total score of severity of symptoms increased in condition B (no exposure), decreased in three participants and stayed equal in two participants.

The total score of (formal) caregiver distress was also compared. There was a decrease in scores on the emotional impact on caregivers reported by caregivers in 11 participants in condition A. In one participant the emotional impact scores reported by the caregiver were equal in both conditions. In 6 participants the caregivers reported higher emotional impact scores in condition A compared to condition B.

In condition A the mean total score of caregiver distress is 8.89 (SD=7.9) and in condition B 11.00 (SD=6.18). A Wilcoxon signed-rank test is performed and no significance was found (p=.087). Four participants completed two A and two B conditions in an ABAB-design. Visual analysis of all participants in *Figure 3* shows that dynamic lighting has a positive impact.

In all participants, there is a positive effect of scores on the severity and emotional impact of the formal caregiver compared to the previous condition. This suggests that dynamic lighting can have a positive effect on the severity of symptoms and emotional impact on caregivers when exposed to this lighting for a prolonged period. The effect is reversible which indicates the positive effect is caused by the exposure to dynamic lighting. In participants 1 and 4 the effect, however, is not that strong. Both participants were psychically deteriorating and suffering from alcohol-induced dementia. They were both not able to return to their homes and were admitted to a nursing home.

Discussion

The present study set out to investigate the effects of a dynamic lighting intervention on neu-

ropsychiatric symptoms in people with dementia admitted to a psychiatric hospital during January 2016-January 2017. It was hypothesized that exposure to dynamic lighting during the whole day and evening (7:00-23:00) with an average of 3-6 hours of exposure time a day would have a more positive impact on the measures of severity of neuropsychiatric symptoms at clients and scores of emotional impact on formal caregivers than the normal lighting conditions in the common room of the hospital. Eighteen participants primarily diagnosed with dementia with a mean age of 76 years were included in this study. The effect of exposure to dynamic lighting has been measured on different levels (symptom, individual and group). Information and selection bias was minimalized by questioning mostly the same formal caregiver per participant by one and the same investigator. The internal validity was ensured by collecting all data of the NPI-Q and the data of the electronic patient files and registered in SPSS.19. Co-researchers independently controlled all the data and analyses. By placing three Sparckel lamps in the common area of the ward the internal validity was also ensured as people are exposed to dynamic lighting at any place in the common area.

The present results showed that a 21-day exposure to dynamic lighting decreased the total score of severity in seven (delusions, hallucinations, agitation/aggression, euphory/elation, disinhibited behavior, irritability/lability, and nighttime behavior) of the 12 symptoms. Only at the symptom of disinhibited behavior, a significant difference was revealed (P=.01). This finding is consistent with recent research by Wahnschaffe et al. (2017) who found that dynamic lighting in a nursing home significantly reduced scores on the Cohen Mansfield Agitation Index (CMAI). The CMAI includes several symptoms of disinhibited behavior. Another study of Brodaty et al (2015) which followed the prevalence and course of neuropsychiatric symptoms on the NPI-Q in dementia over 3 years, found that overall levels of neuropsychiatric symptoms increased over 3 years, in particular delusions, hallucinations, agitation, anxiety, apathy, disinhibition, irritability, and aberrant motor behavior significantly increased. Actually, several of these symptoms (delusions, hallucinations, agitation, disinhibited behavior, and irritability) even decreased a very important finding in our study. The medication was monitored and there was no medication prescribed influencing this behavior. Lighting can stimulate the circadian rhythm and hereby might have a positive impact on disinhibited behavior because people sleep better, are less tired and can regulate their behavior better.

In three participants who started in the exposure condition, the total score of severity of symptoms increased compared with the no exposure condition. This is the opposite result of our hypothesis. Possible reasons for these findings could be that according to Zuidema (2007) neuropsychiatric symptoms increase because of the progressive state of dementia. On the other hand, we found also participants who ended in the exposure condition the total score of severity of symptoms decreased. It could be that because of the exposure to Sparckel lighting, people become more active and notice their limitations in daily life more. This assumption could also be seen in our results because of the largest difference was found in symptoms of delusions, disinhibited behavior, and nighttime behavior. Another possible explanation for the increase of severity of symptoms during the exposure condition at the start of the study could be the emotional impact and consequences of admittance in a hospital.

Four participants completed two full conditions as in an ABAB-phase design. In all conditions, there was a positive effect on scores of the severity of symptoms and emotional impact on caregivers compared to the previous condition. This effect was reversible in three of the four participants. In the exposure condition, the neuropsychiatric symptoms and the emotional impact on the formal caregivers decreased, then it increases during the no exposure condition, it decreases again in the exposure condition. This suggests a positive impact of dynamic lighting when participants are exposed for a prolonged period. The participant that shows no reversible effect was suffering from increasing somatic complaints and was admitted to a nursing home.

The present study also has some limitations. The exposure to dynamic lighting reduces neuropsychiatric symptoms indicating short-term effects from higher daily light exposure. The found effect, however, might not be strictly due to the dynamism of the used lighting armatures. The found higher lighting levels, the color temperature or a combination thereof can also obtain results. This study should be replicated using a larger sample size to increase the power of the study and using a longer treatment duration to determine if long-term exposure could significantly reduce neuropsychiatric symptoms in people with dementia, and therefore reduce formal caregiver distress. Further investigation is also needed before results can be extrapolated to at-home situations. People with mild dementia would possibly benefit more from light treatment as their Supra Chiasmatic Nuclei (SCN) is likely to be less degenerated. Participants in this study had severe dementia. Furthermore, formal caregivers may have known the purpose of the intervention and answered accordingly, however, this is unlikely because they were unfamiliar

with the questionnaire and their responses did not always favor the intervention condition. The choice of using proxy-data instead of self-report data stemmed from the fact that all participants were diagnosed with dementia.

Another limitation is that there was no baseline measurement. Several variables could have influenced the symptoms during the treatment duration. To minimize these influences, the conditions should be repeated several times within the subjects to be able to make conclusions about implications (Bouter et al., 2010).

The positive effect of light is also found in previous research. A recent systematic review of Mitolo et al. (2018) on the effects of light treatment describe some studies that show some effect of bright light therapy on the reduction of agitation in people with dementia (Burns et al., 2009; Lovell et al., 1995; Mishima et al., 1994). Figueiro et al have shown the positive effect of light exposure in several studies (2014, 2015 & 2016). They found an increase in sleep duration and a decrease in symptoms of depression and agitation with exposure to dynamic lighting interventions. Shirani and Louis (2009) concluded positive effects in a study on sleep, depression, and dementia with exposure to 5000 lux one hour per day for several weeks. Onega et al. (2016) showed that bright light exposure was associated with significant improvement in depression and agitation in people with dementia. To improve the methodological quality of future light studies Aarts et al. (2016) and Van Hoof et al. (2010) suggest a multidisciplinary approach and a combination of the efforts of a medical/biological researcher and a light engineer.

There were three lamps in the common ward producing a maximum of 5625 lux. The correlated color temperature also varied. In the morning bright-bluish light was produced in the evening warm red light (2700-6500 Kelvin). Participants were at least 180-360 minutes a day exposed to dynamic lighting, because of their daily activities. The aim of this study was to investigate a non-pharmacological intervention that can reduce the neuropsychiatric symptoms in people with dementia. Medication use and doses of intake were monitored during the study. The present study showed that dynamic lighting exposure for three weeks in a geriatric ward of a psychiatric hospital significantly decreases disinhibited behavior. This finding is consistent with the study of Wahnschaffe et al. (2017) and implicates dynamic lighting is a promising intervention in influencing disinhibited behavior in people with dementia. According to the review study of Sink, Holden and Yaffe (2005) primary treatment of neuropsychiatric symptoms consists of non-pharmacological interventions, because the effect of medication use is not clear at the start and because of the side effects. The clinical relevance of the exposure to dynamic lighting as the non-pharmacological intervention is confirmed in this study. The Sparkle lamp might even be suitable for home use and hereby reduce the informal caregiver distress that is one of the main reasons for the transition of older people with dementia to more controlled environments.

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