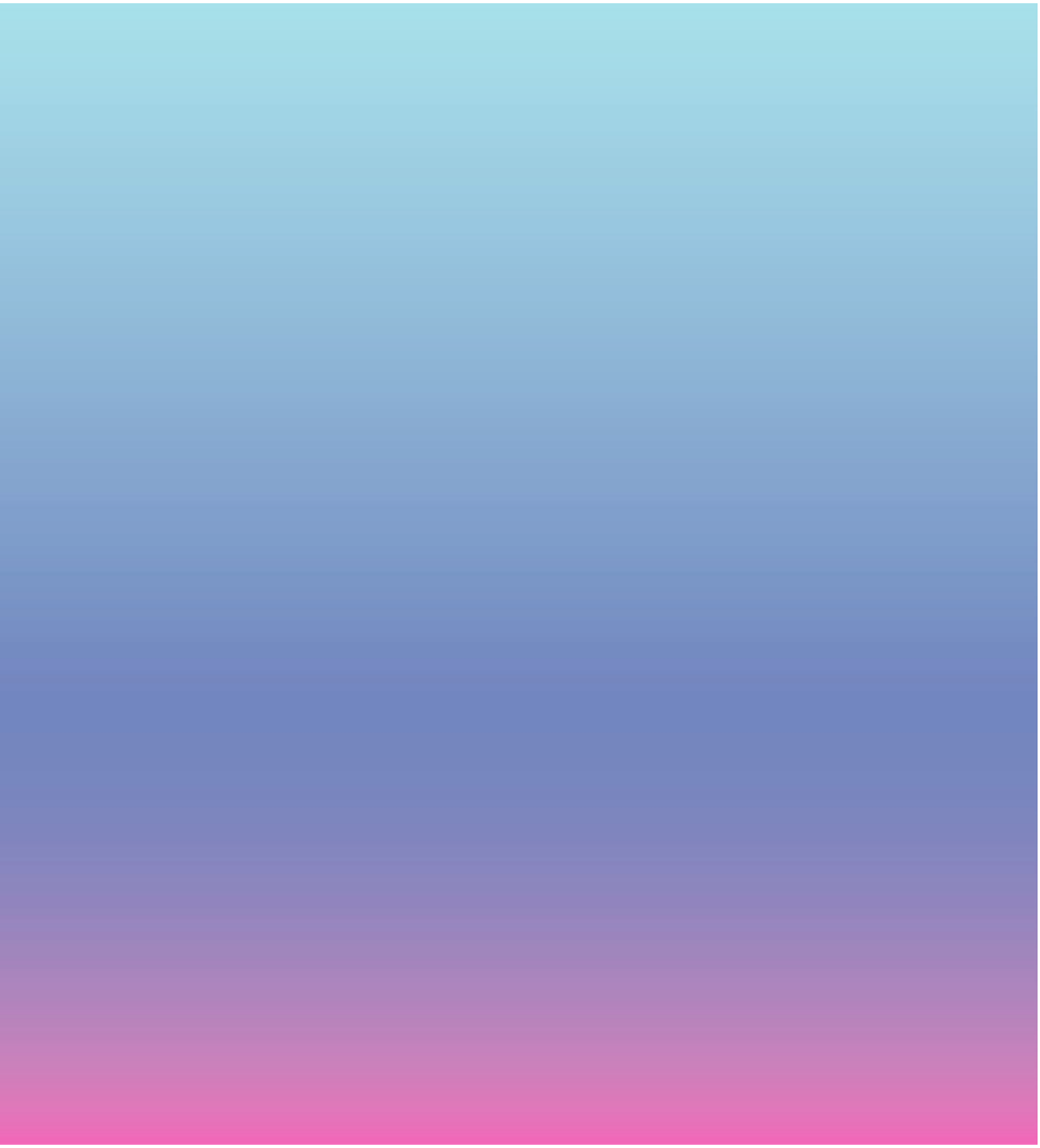

"Togetherness and the emotional effects of light are hence a central part of the staging of domestic spaces [...] that is, as a way of personalizing a (professionalized) space and make people relax."

- Bille 2013, p.59

The research project was run in collaboration with:

YOKE

demensX

Højstruphave

Aalborg University Copenhagen
Spring 2018

Program: MSc Lighting Design
Semester No.: LiD 10
Semester theme: Master Thesis

Title: Experiencing Light: Light as a Relief

Student: Paolo Rota

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INDEX

ACKNOWLEDGEMENTS

This big chapter of my life would not have been possible without the support of my mum and dad. Even if I am not close to home you have never stopped making me part of your life and listening to my constant complaints. Approving my choices, even the ones you did not really agree with.

To Alice, Michele, and Alessandro who visit me and make my life a happy mess.

To the friends who are just a message away, my personal nurse, and the sushi friend who puts up with me even if I am vegetarian now.

To my future wife to handle all my love and psychological dramas. I miss you every day and I have no clue on how I would have gone through everything that happened without you.

To Sonia, because, no matter what, you are there.

To all my new friends, for the crazy nights and also for the cosy ones.

To Davide, you drive me crazy but I also do the same to you.

To Davide for all the valuable music knowledge. I needed it.

To my roommates, Enrico and Serhiy, who handle me too stressed to answer politely but still being there with nice talks, food, and drinks.

Last but not least at all, to my grandma, you always understood me even when I decided to move. I miss you more every day.

RINGRAZIAMENTI

Questo grande capitolo della mia vita non sarebbe stato possibile senza il supporto di mamma e papà. Anche se non sono vicino a casa, non avete mai smesso ti rendermi partecipe della vostra vita, ascoltando le mie costanti lamentele ed approvando le mie decisioni anche quando non eravate veramente d'accordo.

Ad Alice, Michele ed Alessandro che quando venite a trovarmi rendete la mia vita un piacevole casino.

Agli amici che sono solo alla distanza di un messaggio, la mia infermiera personale e la mia socia di sushi che mi vuole ancora vedere anche se sono vegetariano.

Alla mia futura moglie perché sa come gestire i miei drama, sia in amore che mentali. Mi manchi ogni giorno e non ho idea di come avrei fatto ad affrontare tutto quello che è successo senza di te.

A Sonia, perché, nonostante tutto, sei sempre presente.

A tutti i miei nuovi amici, per le notti pazze e anche per quelle tranquille.

A Davide, mi fai diventare pazzo, ma lo faccio anche io con te.

A Davide per tutta la conoscenza musicale che mi hai trasmesso. Ne avevo bisogno.

Ai miei coinquilini, Enrico e Serhiy, che gestivano le mie risposte e atteggiamenti pessime perché stressato con delle belle chiacchierate, cibo e drink.

Per ultima ma non per importanza, a mia nonna, mi hai sempre capito anche quando ho deciso di trasferirmi. Mi manchi di più ogni giorno che passa.

INTRODUCTION

Attending the master of Lighting Design at Aalborg University in Copenhagen has changed my vision for light. I have understood how significantly light can influence somebody's life and experiences.
Depending on the environment and the atmosphere that should be set with the design. The designer should take relevant choices about technology, interactivity, and dynamism.

This thesis focuses on the relaxation effect that light can have on people affected with dementia. And it has been developed in collaboration with YOKE, an interactive digital design studio, demensX, a group of different professionals who want to improve the lives of people affected with dementia, and Højstruphave, a care home for elderly people diagnosed with dementia.

The research has been carried out to find out which lighting design would be best for implementing a relaxation area in a care home which hosts elderly people diagnosed with dementia.
The lighting researchers spread throughout the world are looking into the benefits that light can have on people. Therefore, the research has started with an analysis of the literature in order to define the best technology, set up, and the concept of relaxation, on a general basis, and more specifically for the users in consideration.

Relaxation can be induced with light, sound, and generally giving subtle inputs to all the senses. But as a practical limitation of this thesis and its positioning within the field of lighting design, it has been chosen to take into consideration just light as a stimulus.

The thesis follows the structure of the Aalborg University's Problem Based Learning (PBL) method (pbl.aau.dk). And, it is as follow:

Analysis
This chapter is the base for all the whole research. It introduces the readers to the topic and it also goes into detail on the

different aspects which have to be taken into consideration.

Idea Generation
In this chapter the vision, and the research question are built upon the requirements of the research and following the guidelines of the project.

Design Concept
Here, the different parameters, on which the research is based, are presented. Furthermore, design decisions are taken and explained.

Testing
This chapter shows the procedures and the results of the two tests which have been run during the research. Moreover, every test has its own evaluation, and a final and general evaluation is written about both tests.

Conclusion
This chapter sums up the findings, as a normal conclusion chapter, but it also discuss and re-evaluates the needs of the users. It also illustrates future works, possible new ideas, and opens up the discussion for new perspectives.

Hence, the thesis first goes through an analysis of what relaxation is, the disease, the space, and the light situation. All this is important in order to frame the research environment and put the readers' mindset into it. Afterwards, the design criteria are defined, with which it is possible to set up an initial design and a test.

Moreover, a test is run to assess the theory enlisted. Unexpected but still very interesting results have been shown. Thus, the conclusion argues if the needs described by the client correspondes with the needs of the users. And, it re-evaluates the needs and shows possible alternative solutions.

In conclusion, I would like to give a very warm thanks to everybody who helped and sustained me in the process. Especially my supervisors Nanet and Stine for always being very supportive and inspiring. André for giving me new points of view and being interested in my work, Anne Sofie who proposed this topic to me in the first place, and everybody at YOKE where I have felt at ease from day one.

MOTIVATION

Højstruphave is a care home where more than thirty people permanently live. Moreover, there are around ten people who spend their days at the day centre but still live in their own homes.

The client hired YOKE within demensX to create a light installation where the elderly could spend their time relaxing during the day. The final delivery should be easy to use and provide relaxation to the inhabitants.

The main objective of this thesis is to investigate a possible solution for helping elderly people suffering from dementia relax. This research based project should bring a design that would not just fit Højstruphave's facility but that could be iterated in other centres.

The main motivation is the well-being of the users. Dementia is a fast spreading disease, and every day it is easier to experience cases personally. Since there is still no cure, it is important to try to find alternative ways, when appropriate, to ameliorate the lives of ill people.

ANALYSIS

"Science tells us that light initiated life on earth; plants and animals could not exist without it. […] light is intrinsic to our physical and spiritual selves. It gives us the power of vision so that looking and consequent 'seeing' is possible"

(Herbert 1998)

Human beings, and most of the animals and plants have a deep connection to light.
Most often, natural light with its full spectrum and intensity gives us more benefits than electrical light could ever do.
The connection to natural light is highly described in the circadian rhythm theory where it is possible to see the benefits that people have from a regular sunlight exposure. (Illuminating Engineering Society of North America 2000, p.190)
The connection to natural light derives from the fact that it changes during the day. From dawn, humans are exposed to different colour temperatures which depend on the time of the day, and the geographical position.

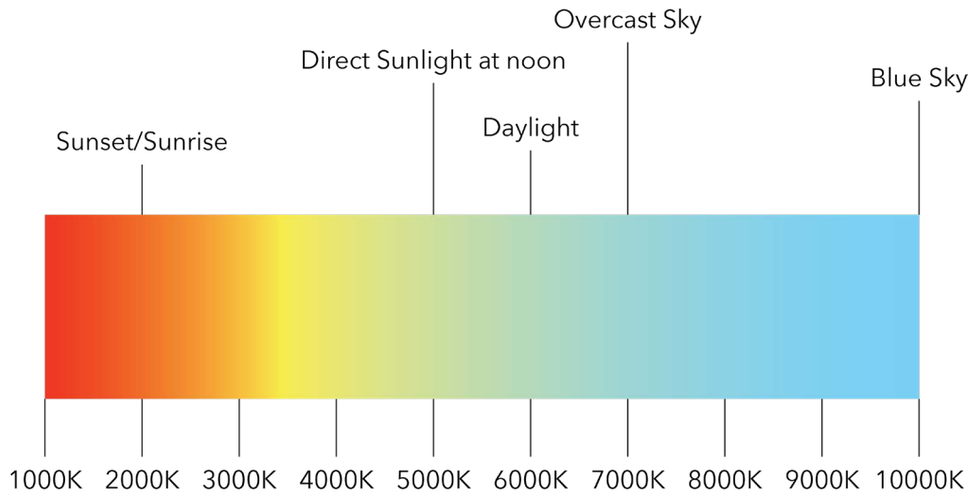


Fig. 2

Nature is also full of colours, and people establish a connection with them. The blue sky is often considered relaxing and peaceful because it is considered infinite and uncontrollable, something that humans cannot change.
Artists and philosophers like Kandinsky and Goethe wrote colours theories where they connect specific colours with emotions, sensations, and situations. These are going to be taken into consideration later. Furthermore, scientific papers related to chromo therapy or to the effects that coloured light has on people, can help in understanding how people feel when exposed to colours and coloured light.

When talking about colours it is fundamental to keep in mind the context where the research is held.
First, it is important to know what is meant for context. In fact, not just the placing of the design is important, which is a care home for elderly people affected with dementia, but also the geographical location is essential. Vallensbæk a town in the outskirt of Copenhagen, Denmark is where this reasearch took place. For these reasons, it is significant to have an overview of what is considered relaxing and cosy lighting in Denmark.
In "Lighting up Cosy Atmospheres in Denmark", Bille (2013) runs an analysis on what is needed to create a cosy atmosphere in terms of lighting. For Danish people, warm light sources such as candles or electrical light fixtures with a colour temperature variating between 2700K and 3000K, are needed.
The people interviewed by Bille find a connection with light and the activities going on around them, especially during the winters when exposure to daylight is very limited.

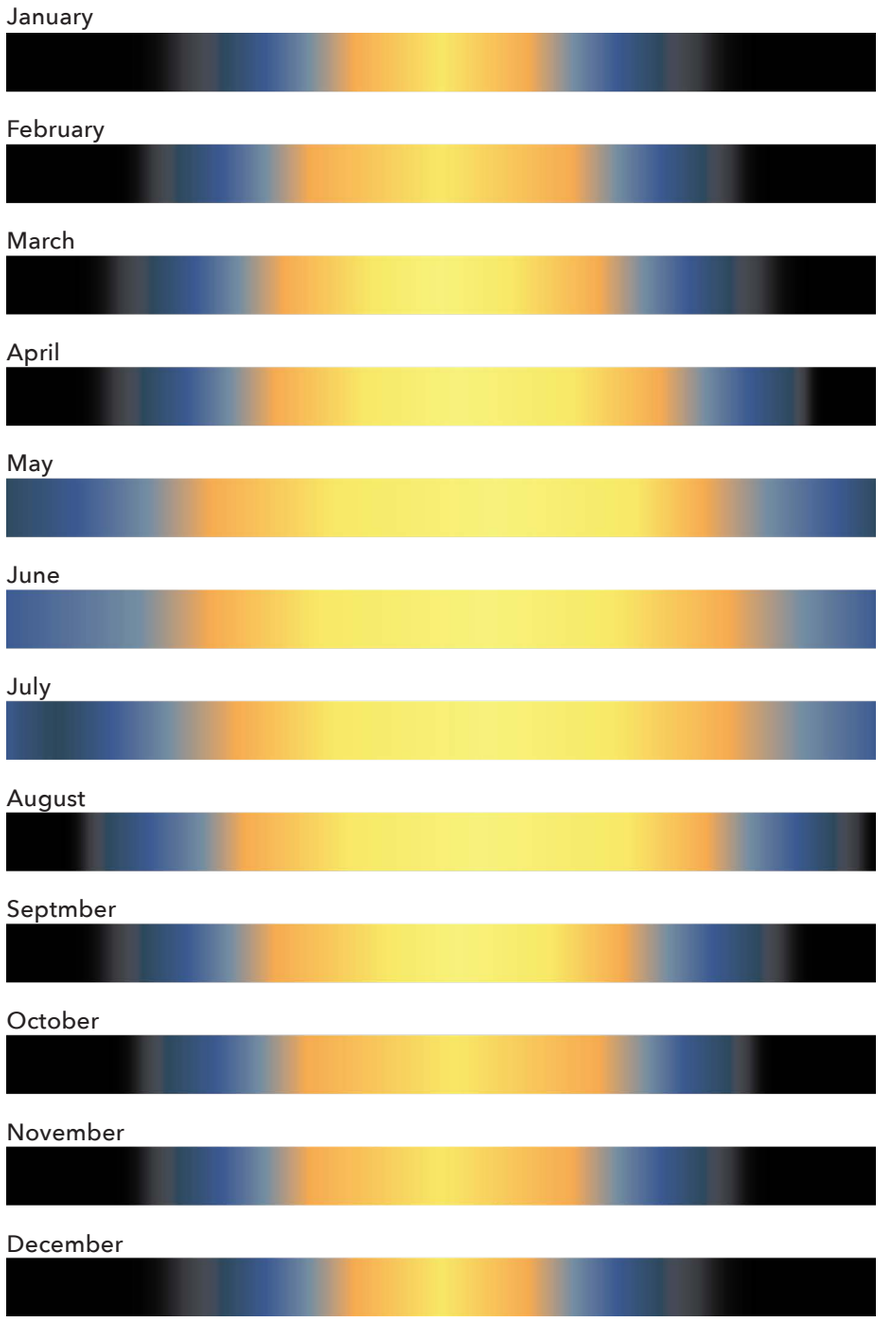


Fig. 3

It is possible to relate Bille's research with Bachelard's "The Flame of a Candle" where the relationship between human beings and candle light is shown. He explains how human bodies are attracted to candle light because:

"The flame, compared to other objects that make us dream, is one of the greatest image operators. It forces us to imagine. In front of it, since you dream, what is perceived is nothing compared to what is imagined."

(Bachelard 1961, p.11)

Still thinking about the context, but this time relating it to the people who are the users and their backgrounds, it is essential to remember that they are diagnosed with dementia and that research (D. Forbes et al. 2014) shows that light therapy can be used as a treatment. Even if this is not the case, treatments would include sessions with flashing white light in order to stimulate the brain, make it more active, and having a positive impact on their brain cells and consecutively their future.

The chapter is further developed analysing some case studies, the concept of relaxation, the space, and the light. This is being done in order to analises in a complete way the context of the project and give a general understanding of the different parameters that are necessary to be considered.

Fig. 4

LIGHT AND HEALTH

This chapter presents some case studies about how light is being implemented as a support to the daily care of people, both in care homes and in hospitals.
Light is becoming a growing field when talking about health. In fact, many projects with different objectives are spreading in the medical field sector. The aims that are trying to be achieved are mainly: synchronisation of the circadian rhythm; relaxation; stimulation; and better lighting for operations.

Chromaviso (chromaviso.com), researches on general lighting systems which allow the users to set up a precise lighting situations based on the activity they are doing. Moreover, during the day the tunable white fixtures shift to the best colour temperature in order to help synchronise people's circadian rhythm.

In addition, Chromaviso also explored which colours work best during surgical operations.

Another company which handles light project in the health sector is Wavecare (wavecare.com).
Their main objective is to create tailored solutions to relax patients in different scenarios.

First of all, in delivery rooms where Wavecare installed a *"large dynamic light source"* to help women relax and have a smooth procedure because *"stress can impede labor and delivery"*. The concept, uses *"specific combinations of Wavecare audiovisual stimulation [which] have a documented calming effect for people in hospitals by distracting from the artificial and alienating environment."*

(wavecare.com)

A second case study from Wavecare is the Sensory Rooms where adjustable LED light and a projector are installed to help set a relaxing, stimulating, or sleeping mood to the users. This happens also by the use of soundtracks synchcronised with the visuals shown.

(wavecare.com)

A third, and last project from Wavecare is the one installed at Pilekrogen where panels from Philips have been installed and used as a tool to make the inhabitants of the care home staying more into the common areas. Meanwhile, the light stimulates or relaxes people based on their needs.

(welfaretech.dk)

One of the last introductions into the field are Snoezelen rooms, or Controlled Multisensory Environments (CME), which are used as therapy tool for people with autism, development disabilities, dementia, or brain injuries.
In these rooms, users can get diverse stimuli to all of their senses with lighting effects, colours, sounds, music, fragrances, et al.

(snoezelen-professional.com)

All these solutions use light as a treatment or tool.
From the different sources, it appears that the research in this field is expanding every day. This means that a continuous update about what works better and what does not is in constant change.
Finally, different types of diseases, disabilities, or situations need different setups and have different outcomes.
For this project, it is considered more relevant the research with sensory rooms has the main topic.

THE CONCEPT OF RELAXATION

relaxation /riːlakˈseɪʃ(ə)n/ n. [mass noun]

1. The state of being free from tension and anxiety.
'I guided my patient into a state of hypnotic relaxation'

2. Recreation or rest, especially after a period of work.
'his favourite form of relaxation was reading detective novels'

2.1. The loss of tension in a part of the body, especially in a muscle when it ceases to contract.

3. The action of making a rule or restriction less strict.
'relaxation of censorship rules'

3.1. In physics: the restoration of equilibrium following disturbance.

(oxforddictionaries.com)

relaxation [ree-laks-ay-shŏn] n.

(in physiology) the diminution of tension in a muscle, which occurs when it ceases to contract. r. therapy treatment by teaching patients to decrease their anxiety by reducing the tone in their muscles.

(Martin, McFerran 2014)

Oxford dictionaries give a detailed explanation of what relaxation means.
From the Latin "relaxare", the term relaxation already meant to let something go releasing psychological and physiological tension. Tension can be interpretated as stress. There are many cases when people can be stressed and it is also very common to see it in daily life. Adults are mainly the stressed ones because of the busy and fast paced daily life. In the modern world, people always live in a rush.

It is important to take some moments where it is possible to switch the brains off and try relaxing. This, can be done in different ways depending on the person who has to achieve it. For example, nowadays people join gyms, do yoga, and start meditating to try release the stress accumulated from the day. Releasing the stress and achieving relaxation can be related to freedom. Getting out of the office and just starting to think about the inner self. The possibility to be free in this world can be associated to situations like being home, being in nature, or on vacation. In all of these settings, it is possible to connect with the surroundings in a deeper way, by switching off the mind. People can feel more comfortable because of the connection that they have with different spaces. Home is always a safe spot, the place that welcomes every person at the end of the day. In nature, as previously said, people have a connection with the plants, the animals, and the wildness with which everything grows and keeps living freely. During vacations, the stress mentioned before should be out of the picture because all the preoccupations are not an issue during that moments.

Moreover, it is easy to connect relaxation to cosiness. All the situations previously described, about nature, and vacations are usually associated to cosiness. Also, a dinner with friends or spending time with family are often defined as cosy.
An example can be found in Bille:

"Light, particularly the flickering flame, becomes a way of visually separating and carving out spaces that are not physically separated by, say, walls. These separations of lighter and darker spaces may simultaneously connect people affectively as well as shaping a sense of secureness and community. Togetherness and the emotional effects of light are hence a central part of the staging of domestic spaces"

and again:

"[...] that is, as a way of

personalizing a (professionalized) space and make people relax."

(Bille 2013, p.59)

Therefore, the connection between cosiness and relaxation can be drawn and the lighting setup has a central role in it. Cosy lighting which recalls candlelight can help people relax but also "personalising" a space can be effective.

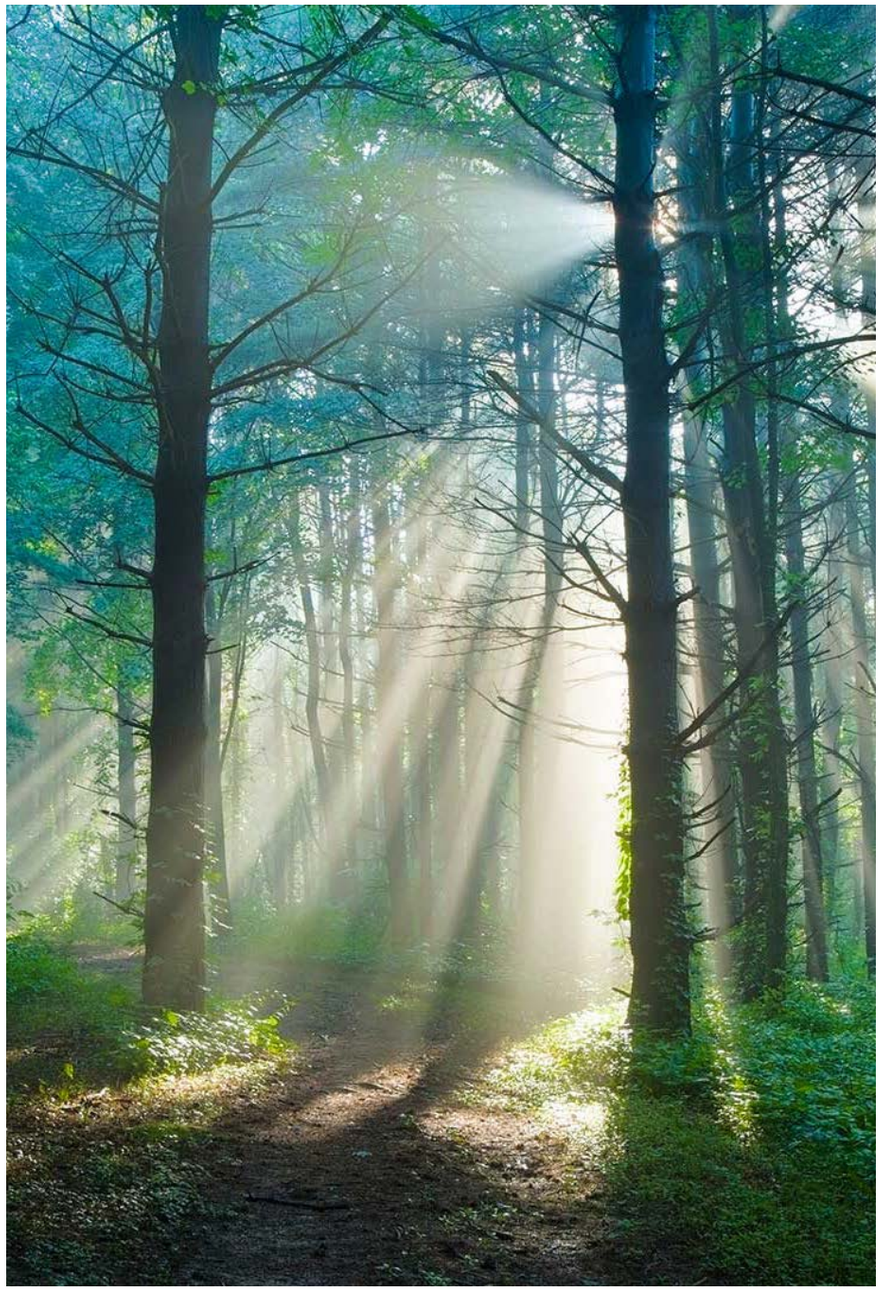


Fig. 5

THE SPACE

Højstruphave is a care home situated in Vallensbæk, Copenhagen, Denmark.
The research was be held in a multi-activity room on the ground floor of the building.
The activities run in the room are varied and are for both inhabitants and caretakers.
A first analysis of the space makes noticeable to the observer: the kitchen positioned along one side; two windows, one big with also a door and a smaller one; another very visible characteristic is the high and tilted ceiling. It is connected through a sliding door to the room which is mainly used for the daily visitors. There, they eat, sing, talk, and play together.
The windows face south, hence they are exposed to direct sunlight both during summer (Fig. 9) and winter (Fig. 10).

To be able to make the experience more engaging, the room should be divided to shade the light coming from the windows and to create a more private environment.
There cannot be any kind of built obstrucion because the room must be flexible in a way that is still possible to run all the activities, and events that may requiew using the whole room.
Putting up a curtain in order to still be flexible but also be able to effectively divide the space into two has been proposed.

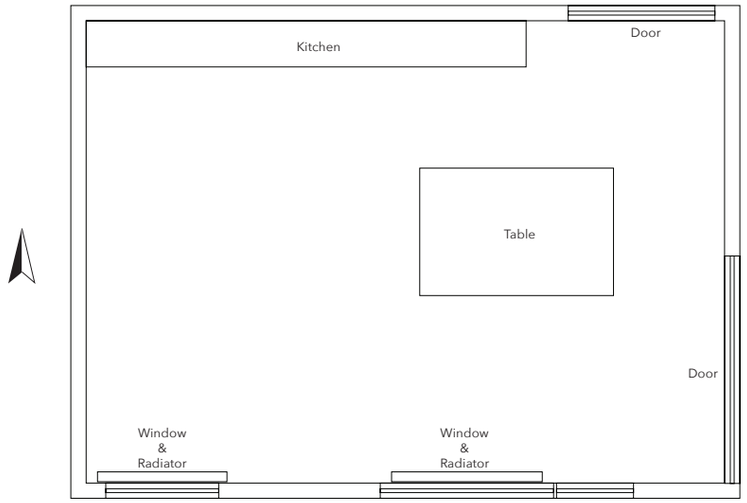


Fig. 6

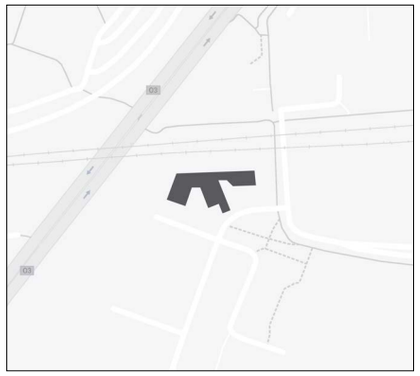


Fig. 7

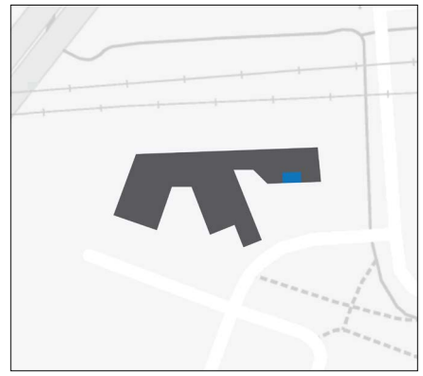


Fig. 8

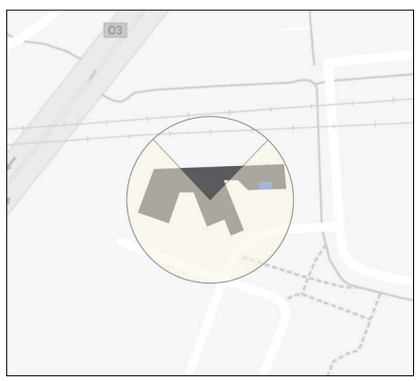


Fig. 9

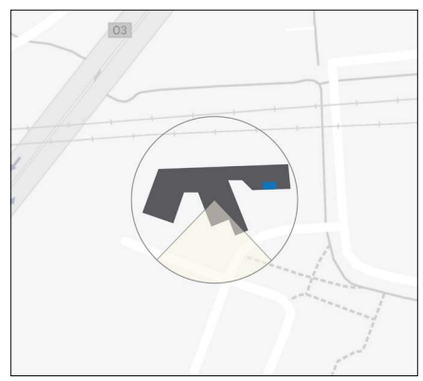


Fig. 10

THE LIGHT

In this chapter, how light should influence the space and create a pleasant atmosphere, and briefly how the actual lighting is, is going to be analysed.

"The atmosphere is the space of mindful physical presence into which one enters or finds oneself, owing to the type of experience involved. This experience is mindful physical sensation"

(Böhme 2013, p.27)

Light should follow the main theme of relaxation and should manifest its presence by filling the space and making it possible for the users to experience their own presence within the space.

"Gernot Böhme is a German contemporary philosopher whose research interests cover classical philosophy, philosophy of science, theory of time, natural philosophy, philosophy of technical civilization, philosophical anthropology, ethics and aesthetics. He emphasizes the concrete human bodily experience in a special environment and gives priority to the original coexistent relationship between human and nature. With this theory, Böhme attempts to underline the idea that humans are a part of nature."

(Böhme in Wang 2014)

In other words, humans and nature are connected. They coexist and they interact with each other. In particular, humans see light and use it to their advantage even when they are not completely aware of it. Because daylight always accompanies people and during the dark hours electric light can simulate either a cosy and warm sensation, as at sunset, or a colder and more functional one with which it is possible to work, focus, and be more productive.

As we can read from Böhme in "Seeing Light":

"The word light tempts us to regard the phenomenon we are talking about as a something, an entity"

(Böhme 2017, p.197)

It is also possible to draw a connection to the concept of luminance which is what actually allows people to see. In other words, light is in contrast of dark but what actually make people see in darkness is the brightness of a light source. The previous statement makes it also possible to relate to light as a phenomenon and not as an object. Light has no fixed shape, it is possible to see it just when it hits an object and from that refractions or reflections are visible to human eye. *"Light creates space"* (Böhme 2017, p.208), moreover, it makes it possible for people to experience the presence of themselves in the space. Because, as it has been cited before, light waves hit objects, and people are made to feel part of the space. These create shadows, as light and motion plays with their shapes and the materials they are made of.

The actual lighting installed in the room consists of nine florescent lamps from Philips TL5 HE (28W 3000K 2625lm) hung from the ceiling. The system does not allow any kind of dimming nor division in sections to switch off some of the lights. Daylight influences the space very much because of the two southern facing windows which do not have proper sun blocking curtains.

THE DISEASE

The users that are involved in the research are the residents or daily guests of the elderly care home for dementia called Højstruphave based in Vallensbæk situated in Copenhagen's outskirt.

Dementia is not a specific disease (www.alz.org/what-is-dementia.asp). It is a wide term that includes different symptoms, one of the most common being memory loss. It is usually an initial stage for other diseases, in fact dementia can be divided into types:

- **Most common:**
  - Alzheimer's Disease
  - Vascular or Multi-Infarct Dementia
  - Dementia with Lewy Bodies
  - Frontotemporal Dementia
- **Less common:**
  - Parkinson's Disease Dementia
  - Huntington's Disease
  - Creutzfeldt-Jakob disease and other prion diseases
  - Dementia in HIV/AIDS
  - Traumatic Brain Injury
  - Wernicke-Korsakoff syndrome (includes dementia from alcohol abuse)
  - Leukodystrophy

In Denmark, sunhed.dk, divides dementia into three phases:

1. Mild:
memory problems, problems remembering names of objects and people

2. Moderate:
bigger speaking problems, coordination problems

3. Severe:
physic and motoric weakening, urinary incontinence

The Ageing Eye

The users considered for this research are in a late stage of their lives, therefore, lighting requirements should follow the needs for older people.

The main ones are:

- There is a reduction of both contrast and illuminance of the image projected onto the retina. Disability glare is, therefore, more pronounced.
- There is an increased prevalence of retinal dysfunction, especially in people over the age of 70.
- Dark-to-light and light-to-dark adaptation times are increased.

It is important to pay attention about the space characteristics:

- To avoid glare, light sources should be indirect or with a low luminance level and positioned away from the users' directions of sight. Moreover, windows should have means of excluding low-elevation sunlight.
- Uniformity is important within a certain limit. There should not be any dark areas. Too high uniformity levels are not good anyway though, it could hinder orientation and make recognition of particular spaces harder.
- Specular reflections in shiny materials can cause both disability and discomfort glare.

(Tregenza 2006, p.82)

VISION

Finding a lighting solution which can help elderly people affected by dementia to relax. So that their daily lives are impacted positively.

RESEARCH QUESTION

How can a **light experience** fulfil a space and have a **relaxing effect** on elderly people affected by **dementia**?

IDEA GENERATION

DESIGN CONCEPT

The analysis highlighted that human beings are connected with nature and the need to relax has also been described as when people are immerged into nature, as if they are in a forest. The immersion into a space happens when people feel part of the atmosphere and feeling their bodily presence in the space.
To achieve all of the previous listed characteristics, after what the analysis has shown the design has to include, colours and dynamics. The objective is to fill the room with light, making it reflect on every object and person present in the room. For these purposes, a possible solution would be to use wall washers or to change the general lighting with RGBW fixtures. These solutions would make the room change drastically by having a more flexible lighting, especially with the change of the general lighting.

Moreover, the final design should have a relaxing soundtrack which would recall, or be, natural sounds. Hence the users would not have to focus just on the light, and they will have a background and not just silence or external sounds.

THE COLOURS

Different strategies could be followed when it comes to the choice of colours.

A cultural strategy following the cultural traditions could be the right way. Using warm colour temperatures, between 2700K and 3000K, which resemble candle light. This would give a very private feeling to the space and to the experience (Bille 2003) and it would stimulate the body to release melatonin which means that the users should be more relaxed and fall asleep easier. Though, it is important to keep in mind that the therapy sessions are not going to take place during the evening when melatonin should be produced. But, during the afternoon when there should be the highest level of activation. This would not be in agreement with the circadian rhythm theory which shows that people should be exposed to white bright light with a colour temperature of 5000K during that time of the day.

Another strategy, could be of using RGBW fixtures and find a range of colours which have been already tested once during scientific tests. Especially, with blue or orange colours like in "Lighting to Make You Feel Better: Improving the Mood of Elderly People with Affective Ambiences" written by Kuijsters A., et al. (2015) and many other studies where the blue and orange light is compared. Because, blue light speeds up the recovering period after being stressed but also excite the brain making it more active. More generally, there are studies that test how effective light therapy is. (See the references number: 3, 9, 11, 12, 13, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29)
A different path is to follow colours theories written by artists or philosophers. They do not talk about colours in the terms of physics, but about how the colours in paintings and nature make people feel. Kandinsky in "Concerning the Spiritual in Art" (1912), relates colours to characteristics and timbres. He states that blue is peaceful, supernatural, deep, *"typical heavenly color"* (Kandisky 1912, p.116). The lighter it is, the more calming it is. When in the end it becomes white, it reaches absolute calmness. Moreover, colours theories relate colours to emotions.

When talking about blue and orange it is not like talking about a 6000K and a 2700K light sources. It is fundamental to remember that coloured light is not described with colour temperatures but within the RGB scale, where everyone of the three parameters has a range from 0 to 255.

The colours chosen are going to be from magenta to light blue, passing through blue. In the RGB scale these colours are:

- Magenta: 255, 0, 255
- Blue: 0, 0, 255
- Light blue: 0, 255, 255

This choice can be justified from Goethe's "Colours' Theory" (1840) where he says about blue:

"As yellow is always accompanied with light, so it may be said that blue still brings a principle of darkness with it. As a hue it is powerful, but it is on the negative side, and in its highest purity is, as it were, a stimulating negation. Its appearance, then, is a kind of contradiction between excitement and repose. As the upper sky and distant mountains appear blue, so a blue surface seems to reitre from us. But as we follow an agreeable object that flies from us, so we love to contemplate blue, not because it advances us, but because it draws us after it. Blue gives us an impression of cold, and thus, again, reminds us of a shade. We have before spoken with its affinity with black. Rooms which are hung with pure blue, appear in some degree larger, but at the same time empty and cold. The appearance of objects seen through a blue glass is gloomy and melancholy".

(Goethe 1840, p.310-311)

Moreover, more than one study prove that blue colour has relaxing characteristics and helps to feel relaxed way faster than other colours:

"Blue and yellow put the participants into a more positive state. […] Furthermore, heart rate was significantly affected by hue; it increased in the red and yellow conditions and decreased in the blue condition".

(AL-Ayash, et al. 2016, p.205)

Starting from blue, it has been chosen to use the colours which are right next to it in the RGB scale. Since, blue should be the main colour of the design and the colours next to it are magenta and light blue which should assimilate more with blue itself as seen previously in this chapter with the RGB values.

Fig. 11

Fig. 12

Fig. 13

THE DYNAMISM

Because of the choice of having different colours and having a more interesting environment, what the design should be and low dynamic it should be have been looked into.

The research have been run to explore relaxation through the use of light. Therefore, the wrong rhythm could make the design stimulating instead of relaxing. For this reason, and also because of what Laganier and Van der Pool say:

"[…] subtle changes of light that have a calming effect on people. These dynamics are close to natural light".

(Laganier 2011, p.20)

The design is intended to be subtle. But, what is really subtle and what is not?
It is very easy to imagine a very dynamic lighting design, for example it is possible to think about disco lighting or concert lighting. But, when people think about subtle lighting designs, it is easier to think about static lights and chromo therapy rooms where the lights create a fulfilling experience in the space. These last experiences are the ones that should be taken in consideration for this research. But, they should be integrated with some movements because the colours have to shift between each other and there are not going to be any other objects involved during the experience.

Hence, the rhythm will be designed following the subjective opinion of the author on thinking how subtle changes are.

TESTING

The test is divided into two phases: Alpha Test and Beta Test. This was chosen because the care home is accessible by appointment only, and the test needs to be checked if: the set-up is functioning; and the procedure is easy to understand. Moreover, it is significant for the tester to see how healthy people react to it and be able to compare to the elderly people.
The first one is going to be run in a controlled environment with random participants who do not know anything about the project or the final outcome. The second one will be run in the care home itself.

The test consists of participating in a pre-programmed light session. After the research is done, it is possible to produce a video with After Effects. This is made taking into consideration the knowledge earned from Goethe, Kandinsky and Laganier about colours and dynamics. After the video is produced, it can be read with MadMapper and transmit the data through an Enttec DMX interface to the fixtures. MadMapper is able to read the values of the colours' hues and translate them to numbers that fit into the RGB scale. Moreover, another value which is handled by MadMapper is the intensity. All these values are then translated to the fixtures with a DMX interface which can address the different values to the correct channels.
The light experience lasts for ten minutes. During the experience, the participants are free to talk with the tester or among themselves. The tester is always present during the whole test to be able to take notes about comments and observations. After the ten minutes have passed the participants are invited to fill out a questionnaire.

The light is shifting between the three chosen colours (blue, light blue, and magenta). There are moments when the light is monochrome but changing the intensity, and other moments when the it consists of a combination of the three colours together.

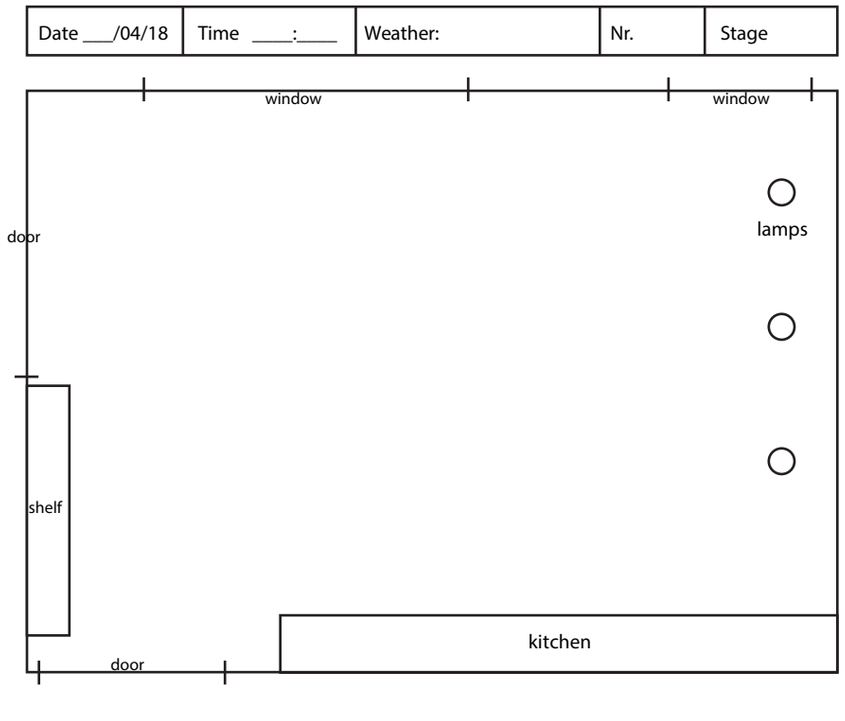
The purpose of the test is to research about the colours set during the analysis, and to see if the participants relax during the experience. It is fundamental to keep in mind that the set-up and light sequence of the test is not a final design test, but an in-progress test to set the parameters.

Qualitative: Observation of the reactions

As initially said in the previous chapter, this part of the test consists of recording all the expressions, reactions, and comments of the participants. It is held as a diary and the original notes can be found in the appendix. The diary is maintained for both tests. But for the Beta test an additional movements' tracking is held. Getting more into detail, the observation is run mapping the movements of the participants on the plan of the room, how they are moving, entering, and leaving the space, and with which pace. For the Alpha Test instead, the diary is redacted just for the comments of the participants. In fact, during the session the participants are invited to express their impressions and sensations about what is happening. Also, the participants' mood and the changes of it have been tracked in order to know which parts of the session are more appreciated. In addition, the duration of the experience is tracked, based on when the people enter the room until when they leave.

Quantitative: Questionnaire to the participants

The questionnaire is made thinking about who is going to fill it out. Therefore, for the elderly people who are affected with dementia, and as explained in the Analysis chapter it is a disease which affects the cognitive functions of the brain. It has to be easy to understand and fill out. It is made following the VAS (Visual Analogue Scale). This is a psychometric response scale and it is an instrument



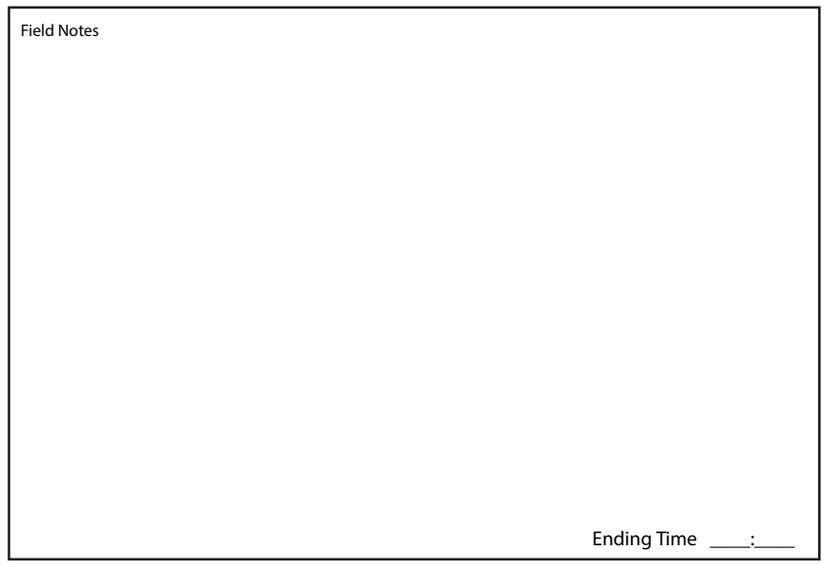


Fig. 14

for measuring subjective characteristics or attitudes that cannot be directly measured. (en.wikipedia.org/wiki/Visual_analogue_scale)

The scale is graphical and it is composed by smiley with different facial expressions related to one colour each There are four smileys:

1. very sad: red
2. sad: orange
3. happy: light green
4. very happy: green

This is chosen to not make the people deal with numbers which would be confusing and possibly stressing. There are just four answers to keep it simple, have clearer results, and eliminate neutral answers which would give inconclusive results. The test is composed by six closed questions and one open question. The open question is kept at the end and it can be answered freely from one word to a sentence.

Fig. 15

Brugerundersøgelse - Nr.

Sæt kryds over den smiley, der bedst beskriver din oplevelse
Put a cross on the smiley which best represents your experience

1. Det ville have været dejligt hvis lysoplevelsen varede længere tid
It would have been nice if it lasted longer

2. Jeg følte mig tryg
I felt safe

3. Jeg følte mig stimuleret
I felt stimulated

4. Jeg følte mig afslappet
I felt relaxed

5. Jeg kunne godt lide farverne
I liked the colours

6. Jeg kunne bedst lide
I preferred

7. I løbet af lysoplevelsen følte jeg .....
During the light experience I felt

Fig. 16

ALPHA TEST

This test is run in the Light Lab of Aalborg University in Copenhagen, where the environment gives the opportunity to have a dark room with no distractions around.
The set up consists of three PAR lamps, Stairville LED Par 36 COB RGBW 12W. They are placed on a straight line at 1m distance from a white wall and pointing towards it, with a distance of 1,2m between each other. Moreover, four chairs are placed at 2,5m from the wall and participants could sit wherever they want.

The participants are invited to the room where the general lighting is on. Once they sit on one of the chairs, the tester switches off the general lighting and introduces the test.
The test is presented as a “light experience”, it is said that the participants can talk to each other, or to the tester and that they can leave before the session ends if they do not feel like staying until the end.
At the end of the test a questionnaire is handed to the participants.

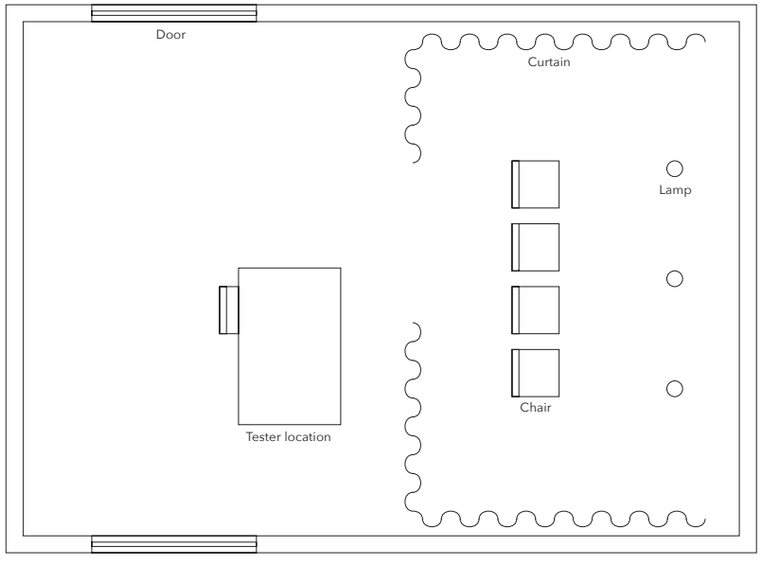


Fig. 17

Fig. 18

Results

The Alpha Test had thirteen participants, among them there were students and researchers from Aalborg University and students from other universities. Most of the time the participants were silent during the experience if they were not alone and giving comments at the end of the test while filling out the questionnaire. Instead, if alone, the participants felt freer talking to the tester.

In the graph (Fig. 19) it is possible to see the single questions and how the participants answered them. Even if, the questionnaire was limited to four different answers which did not include a neutral one, the participants wanted to have the neutral option, and some of them put the cross in the middle of two answers. These answers were considered as half point to one answer and half point to the other one. There were some comments about the first question. The results were not completely clear, some participants left a comment about the timing being not too short nor too long.
It is possible to say that, even if the environment was pretty dark, everybody felt safe. Moreover, the participants felt more relaxed than stimulated. Finally, the colours were found enjoyable and likeable.

The comments were also reflecting the answers to the previous questions. The participants felt relaxed, and calm. Some of them state:

"I felt stimulated in the sense that the lights were 'mysterious' like hiding something and 'calling you' to discover it"

"I felt a sense of calmness that you experience by looking at the sea"

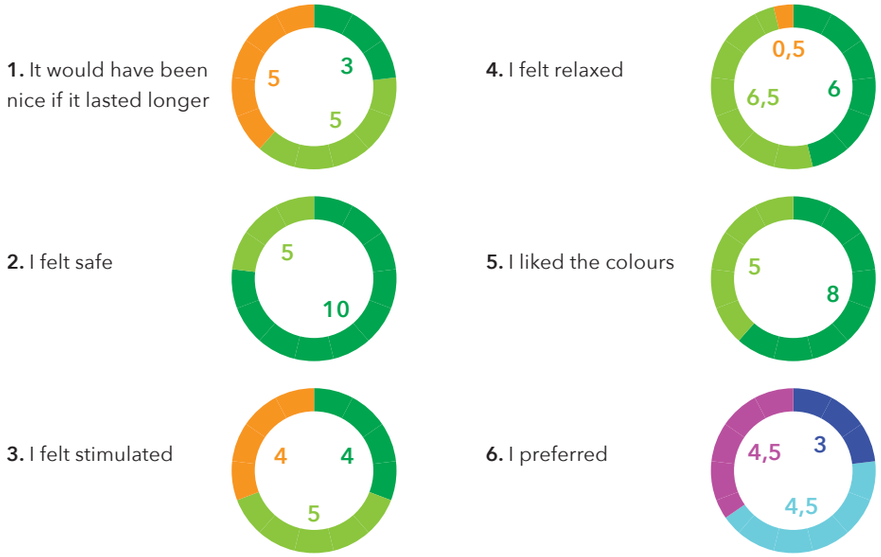


Fig. 19

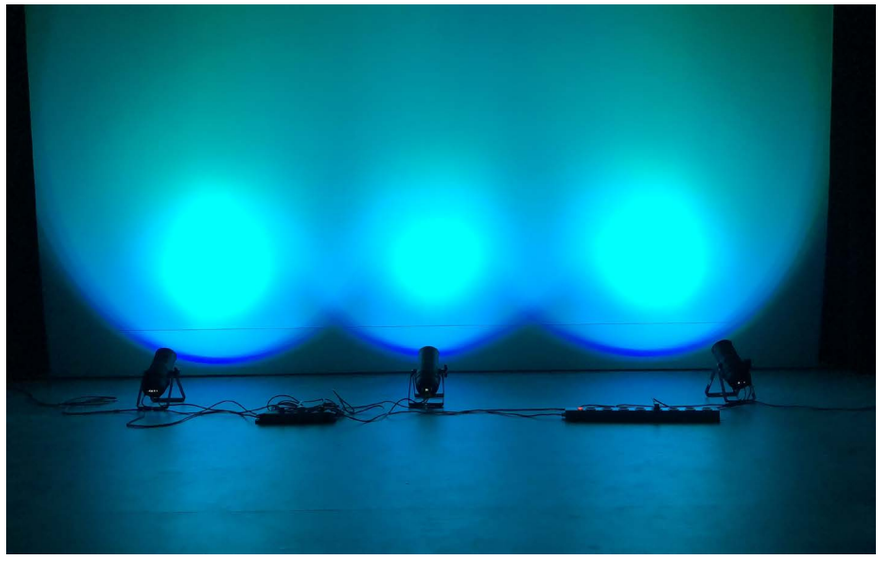


Fig. 20

Evaluation

The test had some problems. First of all, MadMapper crashed sometimes. This meant that there were some interruptions during some of the sessions. After restarting the program and taking it from the point where it stopped, it all ran smoothly until the end. No matter what, the participants did not seem to mind.

The participants joined the experience as a break during their working day or at the end of it. Twelve out of the thirteen people found the experience relaxing and with a positive impact in their mood. Surely, being in the Light Lab where there are no windows and the room is free from distractions without any objects other than the light fixtures, the chairs, and black curtains all around. Hence, it looks like a stage.

The questionnaires give a starting a point for discussion, the answers are fulfilling the main purpose of the design: relaxing the participants.

The oral and written comments stated that the participants were relaxed, calm, and sleepy after the experience. Moreover, they felt like they were submerged in deep water because of the colours but also because of how the lights was looking on the wall.

"It looks like the light has depth, thanks to the overlaying".

Some comments also mention that there should be sound. How it is stated before, sound has been taken into consideration before the design but, since the research is based on the effect of the light, it was decided to discard an extra level of analysis.
One of the comments states:

"I felt more relaxed when the light was monochrome and more 'active' when the light was combined by the three colours".

This is very valuable because it makes it possible to understand how dynamic the experience can be. Nobody had comments about the variation of the intensities or about the variation of the colours but if more than one colour was present it was considered more activating than relaxing. This might have happened, because of the speed of the variation, or the quantity of colours all together, or again because of what happens while the colours shift between each other.

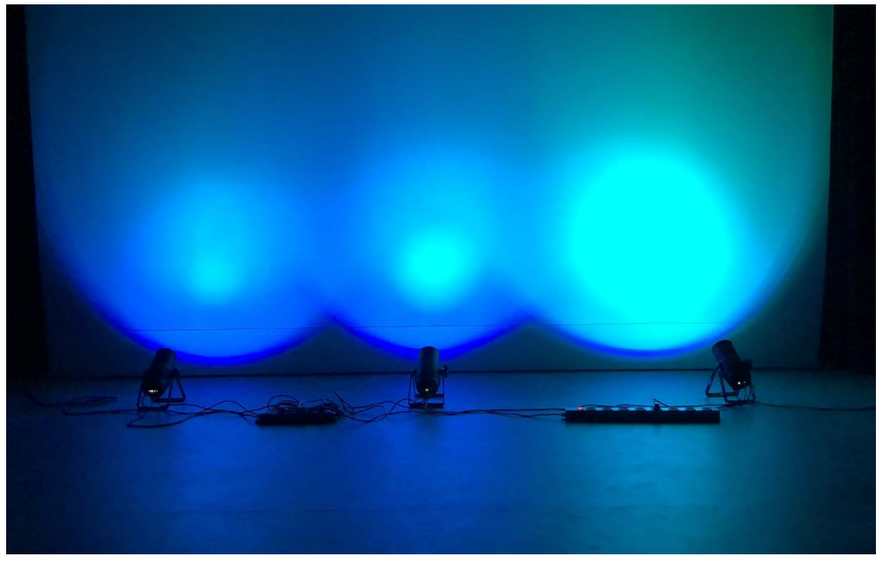


Fig. 21

BETA TEST

This test was run in the multi-activity room in Højstruphave in Vallensbæk. The room was prepared adequately, in order to run the test smoothly. The windows were shaded with black molten. The sunlight could partly get in, but the room got quite dark, no lux level was measured. The objects standing near the wall, where the light was going to be cast, were moved and the wall was free without any painting nor table. Moreover, four chairs were put facing the wall. Here, the participants sat while taking part in the experience.

The set up consists, as the previous test, in three PAR lamps, Stairville LED Par 36 COB RGBW 12W. They are placed on a straight line at 1m distance from a white wall and pointing towards it, with a distance of 1,2m between each other. The four chairs are placed at 2,5m from the wall and participants could sit wherever they wanted.

The participants are part of the day care and inhabitants of the care home. The non-inhabitants are the ones who come every day from their houses. They should be more independent and in the earlier stages of the disease compared to the ones who live in the care home. Another part of the participants are the caretakers. They also took part of the experiment since they also have the opportunity to use it during their breaks.
The elderly people are not an easy test group, especially because of the dementia which they are diagnosed with. Because of the disease, they easily lose connection with the real world. Sometime, they cannot or they do not want to communicate with other people. It is also difficult to understand what they are feeling.
The participants were welcome in the room where the general lighting was switched off, but the three PAR lamps were on in a static mode casting magenta light. After they took a seat, the test was introduced letting them know that they could talk or do any activity they preferred. They were also informed that they could leave the room whenever they would like to.

Fig. 22

The participants

The users are both males and females, between them there are literate ones and some that have never had a proper education. Moreover, the disease stage is different from case to case. Anyway, all of them are effected with dementia and they either have permanent residency in the care home (medium and advanced stages) or they daily visit it to participate in activities and spend some quality time (early stage).

In order to simplify the categorization of the inhabitants it has been decided to establish an ad-hoc Dementia Scale with three stages:

- Stage 1: light mental and physical problems

- Stage 2: mental and, maybe, physical problems

- Stage 3: strong mental and, maybe, physical problems

Daily visitors to the centre can be categorized in Stage 1. This group of people live not far away from the care home, and they can still run their own life independently. They visit daily in order to not spend the whole day alone and to do some activities.

The permanent Højstruphave's inhabitants belong to the other two stages. The categorasing is evaluated by observation and/or by asking to the caretakers.

Another group of people that pass their time with both inhabitants and visitors are the caretakers. These are not effected by dementia but they know the habits and the lives of the users of the care home. Therefore, also the caretakers are taken into consideration as users, because they spend most of their time in the care home, they have a stressful job which can benefit from a relaxing break, and they would be with the elderly people during the experience since they are not independent enough to take the initiative or, in some cases, to be able to reach the space alone.

Living in a care home can be tough. It is common for the subjects not to be calm, and for some of them to have violent attacks towards people and objects around them.
The inhabitants participate in different activities which can be creative such as art classes, singing classes, and more to be stimulated with.
It is fundamental that the inhabitants also have a time for relaxing which should not just be with spending time by themselves in a flat environment. Relaxation can also be active in the sense that people can do activities to achieve it. For example, practising meditation is one of the activities used as to achieve relaxation in an active way.

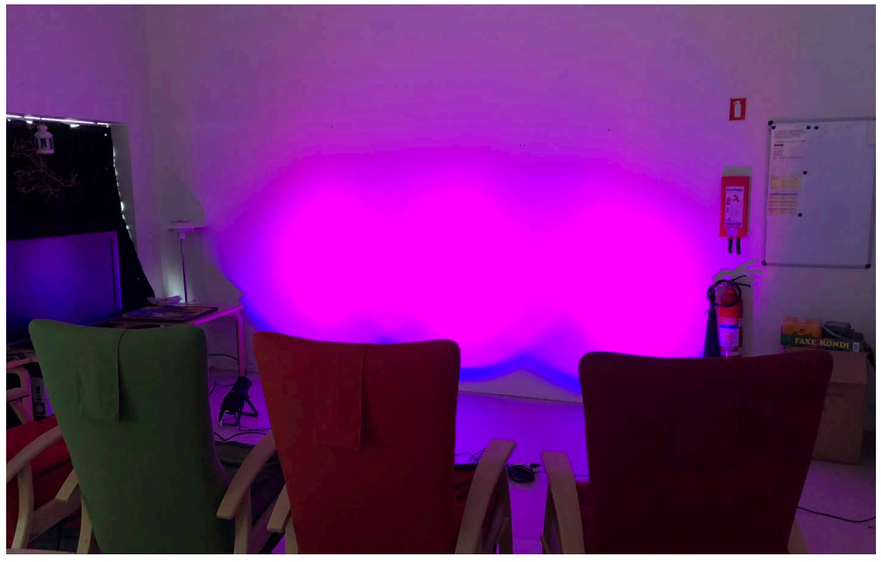


Fig. 23

Results

The Beta Test was run in two different days and had seventeen participants. Fourteen of them were elderly people and three were caretakers. One of the elderly was not able to fill out the questionnaire and not really responding to any stimulus. Another, arrived in the room already half asleep and then fell asleep completely during the experiment. A third one left the room without filling out the questionnaire. And, a last one, left before the ending but still filled out the questionnaire.
The experiment was run for four sessions, and the questionnaire was filled out fourteen times.
The participants are divided into:

- 3 caretakers (Fig. 24)
- 7 in stage 1 (Fig. 25)
- 2 in stage 2 (Fig. 25)
- 2 in stage 3 (Fig. 25)

Having a diversed group of participants is an advantage of running the test in the field, this would not happen in a lab.
The results will be divided between caretakers and elderly. But, the elderly will be considered as a whole group since there were not enough participants to analise the different stages singularly.
As in the Alpha Test, the participants put some crosses between two answers, and, again, these crosses were considered half for the first answer and half for the second one. Moreover, there were two cases, among the elderly questionnaires, where no answers were given.
Generally, the questionnaires were revealing the same results as the ones of the Alpha Test.
The participants felt relaxed, calm, safe, and they enjoyed the colours.
The written comments show that the participants felt relaxed and safe. But, they were also expecting something more.
Many of them were missing a soundtrack. Also, they were missing something to concentrate on.
The more active participants were talking to each other during the test.

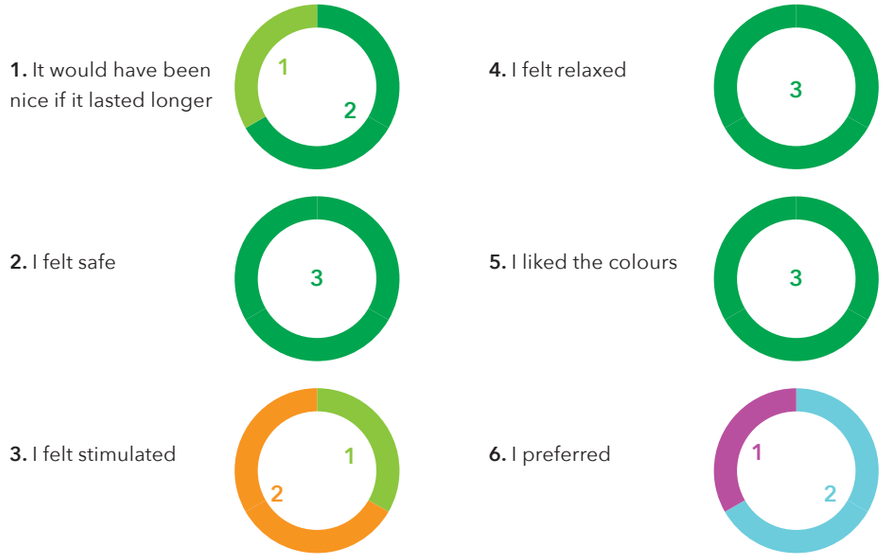


Fig. 24

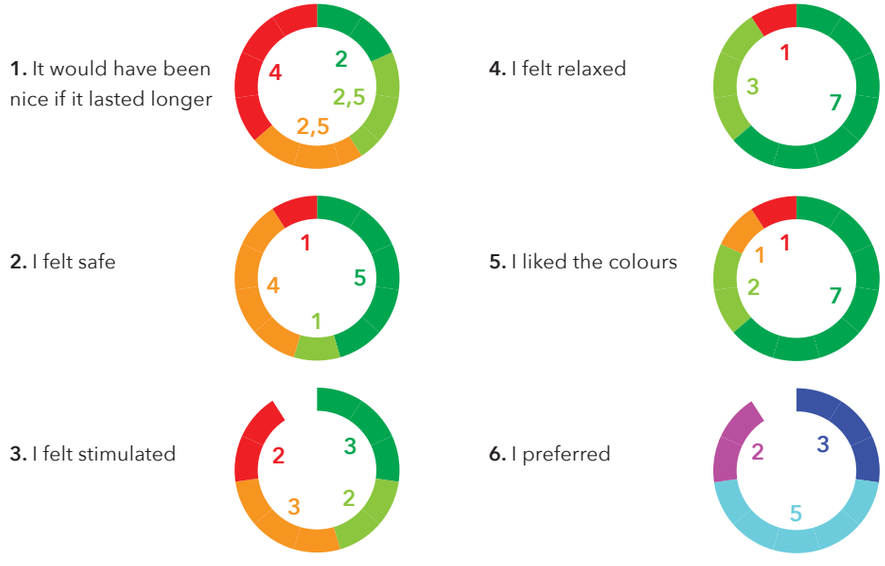


Fig. 25

Evaluation

The very first question that came to the mind of the author and tester right after the test is: "Do they really need this experience?" The participants seemed to like it and have a relaxing experience. But, some of them were expecting something more such, as sound or pictures. Others were completely fine with just enjoying the light but they also liked it for less time.

During the Beta Test, the tester took notes about movements, oral comments, and about the general surroundings of the environment. The recording of the movements did not work properly as expected. The participants were taken to the chairs by the caretakers who were taking the fastest way to seat them. Moreover, when they left, they were also taking the same way out. No changes were visible to the way they moved. The oral comments were more useful in order to understand what they were thinking about it.

Some of them were:

"Kønne farver – ikke noget at bruge dem til"
– "Beautilful colours – nothing to use them for"

"Gud, hvor er det interessant"
– "God, this is interesting"

"Hvad skal vi se?"
– "What are we watching?"

Therefore, the colours were much appreciated and also the experience. But, some of them wanted more to happen. In relation to this, it could be considered whether there should be different experiences based on the target. Because the people affected with dementia are very different between them, depending also on what provoked the disease. The notes about the surroundings mainly describe the light and the sound in the space. Since, the windows did not have proper curtains to shade the sunlight coming in the room was not completely dark. Also, because the weather was fluctuating, between cloudy and sunny, in those hours the room looked different while the experiment was running.
The space, even if it was possible to move some furniture, still looked messy and with many items around. Moreover, there were noises coming from next door. In one instance, there was music coming from the other room but since it was not directly related to the experience, the comments were still pointing out that a soundtrack was missing.

One of the written comments is really interesting and a good starting point for a discussion:

"Lige ved af falde i søvn, vil ikke prøve igen"
– "Almost falling asleep, I don't want to try it again"

That is a step forward in regards to reconsidering the needs of the target group in discussion. "Do they really have the need of relaxing during the day?" Dementia can make the diagnosed people very stressed, because of the effort they often have to make remembering details of their lives. But, the test results show that they might not need to relax during the day, maybe it would be better to get a relaxation session in the evening before sleeping. Again, elderly people have also difficulties staying awake, while dementia can also cause sleeping disorders.
From the comments, it is possible to notice how the person does not want to fall asleep, this participant was also one of the more active and mentally present one. Maybe, the design should be more flexible for this target group.

General Evaluation

The two tests ran smoothly and got constructive comments and observations.

The Alpha Test was more effective for the participants. The users were taking a break from their daily routine. Most of them were students or researchers at Aalborg University. Initially just one person joined but then she spread the word to her colleagues. Hence, more people joined the experiment because of being in need of a break. It did not matter at what time of the day they participated. Some people came before their day started, others in the middle of it, and others again at the end. This shows that busy people with a work or student lives can benefit from light sessions like the one used in the test. It could be good to develop a relaxing area in the working or in the student environment where people could take a break from their busy lives and recharge themselves.
It is important to remember that the Alpha Test has not particular impact on the field of dementia. Since the participants were healthy people.

The Beta Test was quite more difficult to run in comparison to the Alpha test. The participants were brought to the room by the caretakers. This was done, because the tester was not allowed to go around freely in the care home and look for participants.
Moreover, the participants were not always responsive and making comments during or after the sessions. In many cases, the caretakers or the tester had to help them fill out the questionnaires, since they were not all able to do it by themselves.

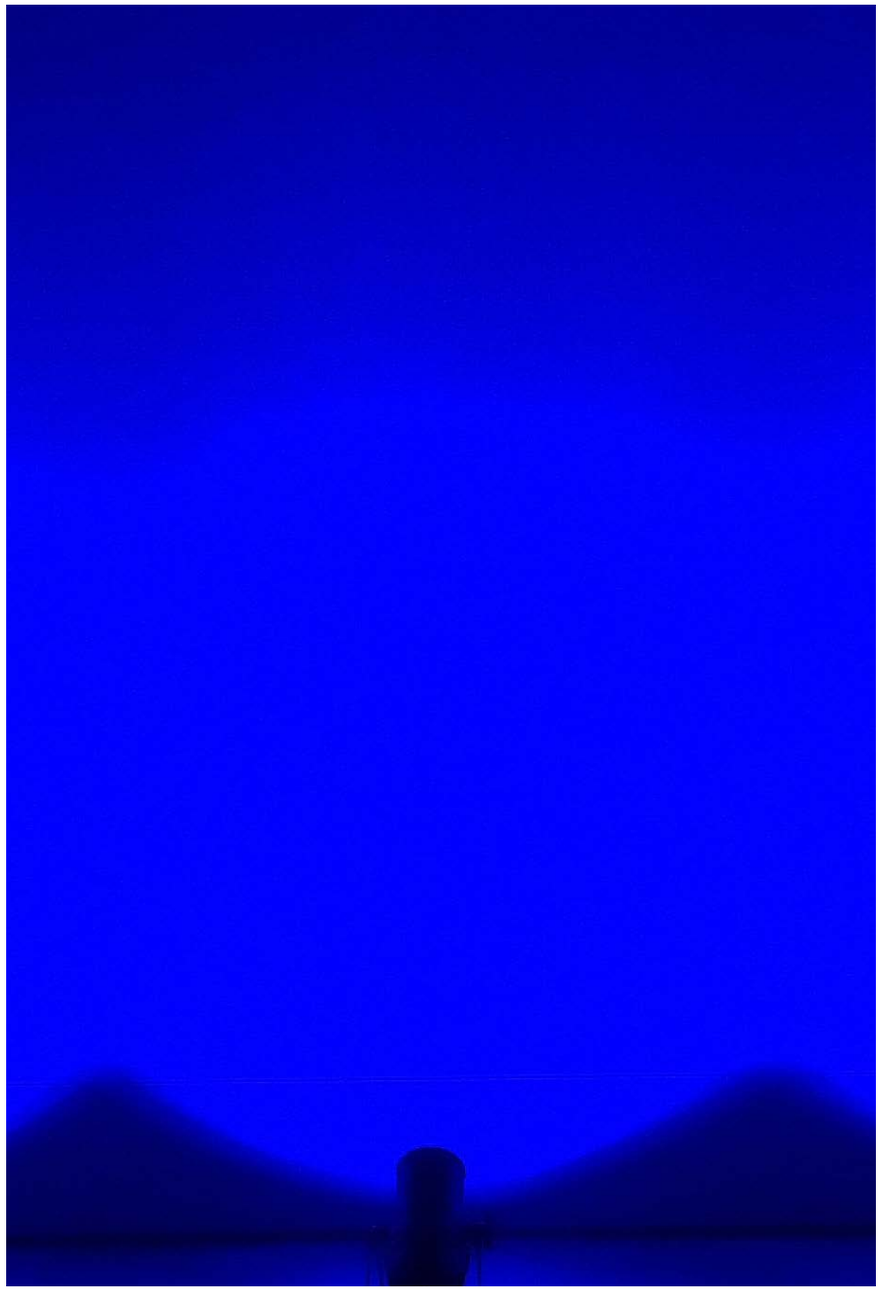


Fig. 26

CONCLUSION

To conclude the research, it is possible to state that the proposed solution did not correctly answer the purpose of the research. Rather, the solution correctly answered the purpose of the research but the users were not satisfied anyway. This made it possible to open up the discussion and go back to evaluate if the blueprint from the client was correct.
As it is common in the design process, tests show what can be changed, improved, or discarded. Usually, the designers would slightly re-design the initial idea and develop it using the test results as a starting point. In this case though, continuing on the same path would not make sense.

In fact, drawing from the analysis, and the results of the test, it is noticeable how there is a demand of re-evaluating the needs of the users.

Re-exploring the users' needs

As mentioned previously, after the results of the test, the different comments demonstrated that re-exploration of the needs of the users is needed. In this case, the users are elderly people affected with dementia who live or spend most of their time during the days in a care home. They spend most of their days talking to each other and sitting in the common room. In this room, they also have snacks, sing, play board games alone or together, and they socialise. All these activities are made in order to make them enjoy their days in the best way possible. Keeping them active and helping them interact with each other. Also, because one of the effects of dementia is to have disrupted sleeping cycles, this includes falling asleep during the day and then not being able to have a whole night's sleep. Thus, the initial analysis of the inhabitants' needs from Højstruphave's director and the of the case studies described in the "Light and Health" chapter

were challenged by the test results. The research highlighted that the inhabitants generally liked the experience but did not want to relax too much during the day because they would have fallen asleep.
On the contrary, the caretakers enjoyed it more and it would probably work as a room where they could take a break from their stressful job.

Since the project was made mainly for the inhabitants and not just for the caretakers, a reconsideration of the needs is desirable.
The inhabitants have a quite boring and monotonous life. During the day, they could probably benefit more if they had access to more diverse activities. For this last purpose, a parallel project for the activity room is being developed: an interactive and multi sensorial table.
Relaxation is needed but just in some cases, and also in other situations. For example, the less ill people, usually do not accept that they have dementia, losing the capabilities of running a complete normal life like they were used to, is difficult to accept. This section of the user could use a relaxation experience before going to bed to help them fall asleep better and having a whole night's sleep. On the other hand, the ones that are in more advanced stages could have a better input during the day when they are getting too stressed. For example, some inhabitants become violent with the people next to them, and, sometimes, it is not possible to communicate.

Regarding solutions now present on the market, as shown in the analysis, and related to care homes like Højstruphave, it is easy to find lighting solutions which make the whole building synchronised with the users' needs. A common solution is about lighting which can regulate the circadian rhythm with just changing the colour temperature during the day. These solutions are implemented using tunable white fixtures which change during the day according to the sun cycle, and provide a clear interface to let people have the possibility to choose a specific set up. This research does not want to interfere with any of these solutions, because they work on a bigger scale and with other parameters.

FUTURE WORK

As said in the previous section, the two solutions that are going to be presented are not meant to substitute the solutions now present on the market. Especially, the ones that have the purpose of regulating the circadian rhythm.
Here two solutions are going to be presented which take into consideration the analysis ran in the beginning of the thesis. For this reason, the concept of relaxation, natural feeling, and the atmosphere have to be taken into consideration.
It is essential to remember that every person is different and has diverse needs. The solutions could be developed until the possibility to create tools which can help the users, and those who take care of them, throughout the every day life without being dependent from them, but making them adaptive.

The systems which have been thought about are:

- Portable system
- Background system

Portable system

The first system is a portable device which would not be fixed in one space or room. But, it could follow the user everywhere. This would make sense because it could be brought to the living room before a daily nap, or to the bedroom before sleeping time. This device would use the colours which are presented in the analysis and would fulfil the room where it is. Moreover, the light would be coloured, because as shown in the research, it is more relaxing.

The device should have a very easy interface, since it is aimed at elderly people affected with dementia. Hence, they would either have to turn it on by themselves or the people taking care of them should, and it still has to be easy because of the time they would have to spend activating it.

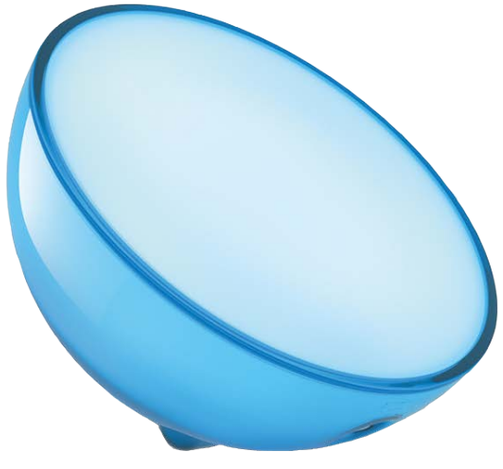


Fig. 27

Background system

Another solution would be, what has been called a “Background system”. This is meant not just as a relaxing system, but something that can follow the people every day in every activity. The system would be an add-on to the general lighting.
This solution is called “Background system” because it is not meant to be too attractive and draw too much attention. Thus, it should influence people without them realising it.
The parameters that it should work with are still the same ones: colours and dynamism.

Maybe, it could integrate also the circadian rhythm principals. This would mean that it should be synchronised with the time of day and all the activities. Thus, not just having colours but also the tunable white option. Because, the circadian rhythm theory states that the electrical lighting should change during the day as the daylight does. Therefore, as seen in the analysis, during the day, natural light has a different colour depending on the time of the day. It has a warmer colour temperature (2000K) at sunrise and sunset and it is colder during the day (between 5000K and 10000K depending on the weather conditions).

Another option could be to add to the design patterns. These are meant to be of natural elements and give a more direct and clear connection to nature which is a very important point of the analysis. To implement this idea, it would be necessary to have either GOBOs or projectors. The real problem would be to not be too obvious with the design since the whole idea is to not create a screen people should stare at. Thus, a solution which can be interesting for the users and catch their attention in a more passive way. Or, again, to influence people’s mood without them realising it.

Fig. 28

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Pictures

Fig. 1: Cover image. Gradient from magenta to light blue by Paolo Rota
Fig. 2: Colour temperature scheme, by Paolo Rota
Fig. 3: Daylight scheme, by Paolo Rota. Data from: www.torbenhermansen.dk/almanak
Fig. 4: Candle light. Link: i.ytimg.com/vi/XXMinSgKw7U/maxresdefault.jpg
Fig. 5: Canadian forest. Link: / www.cbc.ca/natureofthings/content/images/episodes/talktalk_1920.jpg
Fig. 6: Højstruphave activity room plan view, by Paolo Rota
Fig. 7: Højstruphave position, by Paolo Rota
Fig. 8: Højstruphave's activity room position, by Paolo Rota
Fig. 9: Sun path on the 21st June at Højstruphave, by Paolo Rota. Data from: suncalc.net
Fig. 10: Sun path on the 23rd December at Højstruphave, by Paolo Rota. Data from: suncalc.net
Fig. 11: Magenta, by Paolo Rota
Fig. 12: Blue, by Paolo Rota
Fig. 13: Light blue, by Paolo Rota
Fig. 14: Field notes scheme, by Paolo Rota
Fig. 15: Test questionnaires' smileys, by Paolo Rota
Fig. 16: Test questionnaire, by Paolo Rota
Fig. 17: Alpha Test plan view, photo by Paolo Rota
Fig. 18: Alpha Test set up, photo by Paolo Rota
Fig. 19: Alpha Test results by Paolo Rota
Fig. 20: Alpha Test set up, photo by Paolo Rota
Fig. 21: Alpha Test set up, photo by Paolo Rota
Fig. 22: Beta Test set up, photo by Paolo Rota
Fig. 23: Beta Test set up, photo by Paolo Rota
Fig. 24: Caretakers results by Paolo Rota
Fig. 25: Elderlies results by Paolo Rota
Fig. 26: Alpha Test set up by Paolo Rota
Fig. 27: Portable system example by Philips Hue, Philips Hue Go. Link: images.philips.com/is/image/PhilipsConsumer/7146060PH-IMS-da_DK?wid=988&hei=870&$pnglarge$
Fig. 28: Background system example "Wind-animated foliage shadows projected by the sun onto an interior surface" by Kevin Nute. Link: images.theconversation.com/files/177618/original/file-20170710-5935-1g77ui5.jpg?ixlib=rb-1.1.0&q=45&auto=format&w=1000&fit=clip

Appendix

1. Phenomenology Seminar, Focus Area Report, LiD 9 – 2017/2018, AAU CPH. Link: issuu.com/paolorota3/docs/report_paolo_rota
2. Alpha Test questionnaires. Link: issuu.com/paolorota3/docs/collected_questionnaires
3. Beta Test questionnaires. Link: issuu.com/paolorota3/docs/beta_test_questionnaires
4. Beta Test diary. Link: issuu.com/paolorota3/docs/beta_test_diary

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