

Public Summery

This thesis project is commissioned by Studio Kleurmerk BV. Studio Kleurmerk BV is a company that focusses on light, colour, and interior design. The assignment is to make the lighting design for a new part of a children's hospital in the Netherlands. The hospital communicated a key driver for decision making, this key driver is *reducing the stress among parents during their stay*. Hence, the main research question:

Main research question: How can lighting assist in stress reduction among parents and staff in a children's hospital?

1. What is the light demand written in the genes of humans?
2. How does this relate to the lighting an average human is exposed to?
 1. How does this relate to the lighting the parents and staff are exposed to?

The aim of the research questions before is to find what the lighting demand for the stakeholders, the parents, patients, and staff. The lighting demand is the light needed to suit a healthy circadian rhythm. A circadian rhythm is a biological process that takes 24 hours.

The circadian rhythm for human beings is under influences of hormones. The two dominant hormones are melatonin and cortisol (licht.de, 2014). Melatonin is a hormone that slows down body functions and provides a person with a good night sleep (Mazzoccoli et al., 2011). Cortisol is an activating hormone that activates organs and other body functions to prepare themselves for an active daytime (Schlangen & Price, 2021). Cortisol and melatonin have an opposite working and therefore have a strict, 24-hour, rhythm in which they determine the activeness of body functions throughout the day (licht.de, 2014). Food digestion, stress levels, happiness levels and many other body functions are under the control of the hormone levels of melatonin and cortisol. When these hormone levels are out of balance, the human is diagnosed with a disrupted circadian rhythm. This can be a serious threat to the mental and or physical health of a person (Corbalán-Tutau et al., 2014; Reddy & Sharma, 2019). Research shows that specific cells in your eyes determine when melatonin and cortisol are produced (Schlangen & Price, 2021). These cells respond to light. These responses have been in our genes for hundreds of thousands of years, even to when our eyes were in other organisms. The only light an organism received was sunlight, moonlight and maybe fire. Not office light or cell phones.

When designing a lighting plan, it is important to know to which light a person is, and should be, exposed to at which time of the day. To enhance the optimal circadian rhythm, the light of the sun must be rebooted. This means cool light in the morning, bright light in the afternoon and warm light in the evening. This means that the static office light is replaced with natural and dynamic light, called *biodynamic lighting*.

Stress is a factor that is related to cortisol, one of the circadian hormones that are influenced by lighting. When the body restores and lives a healthy circadian rhythm, cortisol levels are controlled. This is realised by implementing biodynamic lighting in the children's hospital.

Implementing biodynamic lighting in the children's hospital is optimal for people that benefit by following a normal circadian rhythm. However, in a hospital not everyone can remain this rhythm. Staff members have deviating circadian rhythms and would not benefit from the biodynamic lighting for normal circadian rhythms. Nurses need other light than the regular biodynamic luminaires provide for each hour of the day. To compensate for the conflict of interest between all the stakeholders, and most likely even assist the staff members in their current circadian rhythm, the concept of the *Bio-Boost* is generated.

The following research questions concern the Bio-Boost.

1. What are the possibilities for a short-term bio-boost light treatment to influence the circadian rhythm of a person positively?

1. How will the stakeholders be motivated to use the light treatment?

Overall, the light plan for parents, to reduce stress, and the plan for the staff, to improve sleep cycles, in a children's hospital, is achieved with a broad image. The light design consists of the optimal luminaire placement and of a way to motivate potential users to use the Bio-Boost.

The lighting design is tested to European safety norms, NEN-EN12464-1 norms, and predicted biological responses of the body to light with the usage of DiaLux evo. This is a lighting program that can stimulate and calculate important values that play a role in lighting design. As a result, there is an optimal location and luminaire choice for each light source in the room. This is provided to the user with 2D and 3D visuals. For the specific information of the luminaire placement and calculation results, a DiaLux evo file is generated.

The final design of the lighting in the parents-lounge is an environment that has biodynamic lighting for the entire day. Furthermore, there is an option to receive the bio-boost. For the staff-lounge, the lighting will not be biodynamic. The bio-boost will be the element that will help nurses in restoring their circadian rhythm after an unregular shift.

Bibliography

- Corbalán-Tutau, D., Madrid, J. A., Nicolás, F., & Garaulet, M. (2014). Daily profile in two circadian markers "melatonin and cortisol" and associations with metabolic syndrome components. *Physiology and Behavior*, 123. <https://doi.org/10.1016/j.physbeh.2012.06.005>
- licht.de. (2014). Impact of Light on Human Beings. *Licht.Wissen*, 19.
- Mazzoccoli, G., Sothorn, R. B., Francavilla, M., Pio De Petris, M., & Giuliani, F. (2011). Comparison of whole body circadian phase evaluated from melatonin and cortisol secretion profiles in healthy humans. *Biomedicine and Aging Pathology*, 1(2). <https://doi.org/10.1016/j.biomag.2011.06.006>
- Reddy, S., & Sharma, S. (2019). Physiology, Circadian Rhythm. In *StatPearls*.
- Schlangen, L. J. M., & Price, L. L. A. (2021). The Lighting Environment, Its Metrology, and Non-visual Responses. *Frontiers in Neurology*, 12. <https://doi.org/10.3389/fneur.2021.624861>

