

unconscious influences

Nikki de Zeeuw

**“Beauty has no obvious use; nor is there any clear cultural necessity for it.
Yet civilization could not do without it.”**

Sigmund Freud (1930)

Table of contents

Prologue
7

Introduction
9

Research on the Five Senses
13

The Three Case Studies
20

Design and the Senses
24

Conclusion
34

Epilogue
38

(Annotated) Bibliography and Illustrations
40

How design choices affect
the healing process
of patients in care facilities.

History Thesis

Nikki de Zeeuw
4431499
TU Delft

Prologue

Architecture has always been very interesting to me; ever since I was a little girl, I wanted to become an architect. But to me something seemed to be lacking when I started my education at the Delft University of Technology; I missed the extra step into human interaction with(in) the spaces that were created.

This topic is something that I have been researching more and more throughout my studies in Delft; if people interact with spaces, then that must also mean the spaces interact with people to some degree. And while these spaces are predefined and immovable, there must be at least a modicum of influence that they have on people moving or staying within the spaces.

When looking at myself; I know that I am happier in a space that is lighter and has a connection with nature, but is this something that is universally so? This was my main interest when starting my research for this thesis. To me, there is no better place to research the effect of something on (mental) health than a hospital or care facility.

This history thesis will therefore address the effect that architectural design decisions have on the five senses, and - per extension - the healing process of patients. The research will be done by looking into three recently built care facilities in the Netherlands.

Nikki de Zeeuw
Delft, April 2021

Introduction

In this day and age, a large amount of time is spent indoors, with some estimations as high as 90% (CIB Task Group 42, 2004). Seeing as these estimations are dating from before the COVID-19 pandemic, the time currently spent indoors will probably turn out to be even higher. Spending this much time indoors has such a large potential for impact on health, both mental and physical, even though research on this topic has almost exclusively been done on the direct physical effects of spaces. Direct physical effects on spaces might include, but are not limited to: temperature, acoustics, air quality, and lighting.

Seeing as these physical attributes in a building have an effect on physical health, would it then not also make sense for them to have an effect on mental health? Acoustics, for example, can lead to headaches, which is an obvious physical issue that - in this case - comes from prolonged exposure to bad acoustics within the building. Research done by Seddigh, Berntson, Jönsson, Danielson, and Westerlund (2015, p. 37) even shows that an improvement in acoustics was always met with 'lower perceived disturbances and cognitive stress'.

This thesis aims to provide insight into the effects physical attributes in the built environment have on the five senses, and - per extension - physical and mental health. Since health is an especially important factor to take into account within health care facilities, this thesis will reflect upon the design choices made within recently built health care facilities. Only recently built health care facilities were chosen for this seeing as both psychology and architecture are ever-evolving, and these facilities will hopefully provide more insight into the current state of affairs within both of these fields of study. The research question that will be used to gain insight into these effects is: *How do the design choices in recently built care facilities affect the healing processes of their patients?*

The research will be done by dividing the thesis into four chapters, which will be explained below. After these chapters an epilogue will follow, reflecting upon the research done, and a section that holds the bibliography and illustrations.

The first chapter is this one; it provides a short introduction on the subject, establishes the main question and explains how the rest of the research will be done.

The second chapter goes into the research that currently exists about the influence of design choices on the five senses. The question this chapter aims to answer is: *What does current literature say about the influence of design on the senses, and - per extension - the healing process?* To provide a clear overview of the effects certain choices have on the five senses this chapter will be organized into five paragraphs, each covering one of the five senses.

The third chapter is an introduction into three recently built care facilities within the Netherlands: Meander Medical Center in Amersfoort, Erasmus MC in Rotterdam, and het Diaconessenhuis in Utrecht.

The fourth chapter will aim to answer another subquestion, namely: *How do the case studies influence the senses, and - per extension - the healing process?* This will be done by analysing the spaces that patients interact the most with: the waiting areas, hallways, and any outside spaces that patients can use. These analyses will also be done by dividing the chapter into five paragraphs, again focussing on the five senses, after which a short comparison of the projects will follow.

The fifth, and final, chapter is a concluding chapter, and will answer the main question.

Research on the Five Senses

The main question for this chapter is: *What does current literature say about the influence of design on the senses, and - per extension - the healing process?*

To be able to answer this question it's important to first focus on what these senses are, before going into the effect design has on them. So, to structure this chapter, the chapter will be divided into paragraphs with each paragraph focussing on one of the five senses, these five senses being: sight, touch, hearing, smell, taste. These individual paragraphs will start with a short introduction on the sense, after which a summary of the research that has been done on the specific sense in relation to the surroundings and the healing process will be given. The chapter will finish off by a short introduction on the way patients in health care facilities perceive their surroundings through sensory cues, identifying the points of sensory strength and weakness.

The concept of five senses was, as far as we know, first introduced by Aristotle, who not only introduced the five senses that are spoken of in the Western world in this day and age; but also gave all of the senses their own sense objects to be able to identify what these senses were able to do. This has to be taken with a degree of careful consideration as described by Sorabji (1971, p. 60): 'Concentrating on the case of sight, I shall consider three objections to this kind of definition. The first objection is that there is such a large variety of objects that can be perceived by sight. Consequently, it would be laborious to define sight by reference to its objects.'

These sense objects do, however, help in quantifying the research. As such, the sense objects of the individual senses will be described in further detail in their respective paragraphs.

SIGHT

The first of the five senses in this chapter is sight; when talking about architecture and design this sense might also be the most obvious one, seeing as people's first impression of a building tends to be through looking at or seeing the building. When looking at Aristotle's definition of sight, as described by Sorabji (1971, p. 60), he specifies sight's sense objects being 'color and the brightness of things that can be seen in the dark'.

When looking at color as a sense object the issue of over- versus understimulation arises (looking at complexity or unity of color patterns), as well as how specific colors are perceived by individuals. Research by Mahnke (1996) goes into both of these topics, explaining that when looking at selecting colors the functions within the area become most important.

For example cooler hues have been found to work better when concentration within the space is needed, as is the case in schools or operating rooms, while warmer hues like red and orange might actually affect a person's impression of the temperature in the room; and, as such, make the room feel warmer.

In regards to lighting as a sense object, the difference between artificial lighting and natural lighting is one that immediately springs to mind. Studies done by Ulrich (1991; et al. 2004) show that heart surgery patients experienced less stress and needed less analgesia when their rooms looked out onto natural, outside space. Whenever natural lighting is hard to obtain artificial lights emulating the full spectrum of sunlight are preferred to stimulate humans' natural circadian rhythm (Rea et al., 2002). The Hescong Mahone Group (1999) even found evidence that students that had more daylight progressed faster within their studies.

TOUCH

The second sense is touch; this sense might make a little less sense when speaking about architecture, since not many people (except for maybe architects) go around touching building, but it is still an important factor nonetheless. Aristotle defines touch as the physicality of objects, Sorabji (1971, p. 68) writes this about touch as a sense as defined by Aristotle: 'It would be unsatisfactory to rely heavily on the objects of touch in defining the sense. For one thing, the objects of touch are extremely varied. Not only would it be laborious to define touch by reference to its many objects, but also knowledge of what these objects are would give no indication of what unites the varieties of touch, nor why some kinds of sense perception are excluded.'

Seeing as the concept of touch is quite hard to grasp, this needs to be strictly defined before looking at this in relation to buildings; seeing as these are already complex enough within themselves.

In buildings touch might translate to the physical form they take on. While Sorabji deems this unsatisfactory, it might just be the approach that makes the most sense when looking at the complexity in lay-out of building. Especially ones to the size of the health care facilities that have been selected as case studies.

Taking the building's physical form into account, one of the most important parts patients deal with during their visits are the lay-outs of the different patient rooms. Pathways should be clearly marked to improve the usage of spaces, and help keep people orientated (Alexander, 1977). Use of color to improve way-finding proves especially important to younger children (Engelbrecht, 2003).

When looking at situations with many people Rivlin and Wolfe (1972) found that both destruction and aggressive behaviour increased.

HEARING

The third of the five senses in this chapter is hearing; another sense that's quite prominent when speaking of spaces within buildings. Next to sight, it's one of the more obvious ways of interpreting a space when first entering; whether a space is loud or quiet, this is something that is often noticed first when entering a room or a building. 'Similarly, the perception of sound is to be counted as hearing...', Sorabji (1971, p. 58) writes in regards to Aristotle's sense objects. This is something that is still true in this day and age, as can be seen by everyday references when speaking of acoustics; it's almost always about sound, and almost never about hearing.

When looking at sound, as mentioned above, acoustics also often spring to mind; especially when speaking about architecture. It's also one of the first technical principles most architecture students learn to design with: insulation for a stable temperature comes first, followed by acoustic insulation (often one and the same).

Research done by Evans and Lepore (1993) shows that 'a statistically significant decline in performance' occurs when asking children to perform standardized tests, under different noise conditions; with the worst performances happening where noise levels were highest.

These noise conditions seem to not only affect short term recall in children, but also long term, as was shown in research done by Hygge (2003).

To make acoustics a clearer concept towards comparing the case studies, a look at the acoustic elements within the spaces will be very important. To be able to do this, a comparison will be made between for example the amount of plants, carpets and curtains - elements that have shown to dampen sounds within buildings and spaces.

SMELL

The fourth sense is smell, and this is where the senses' relation to architecture becomes more difficult; how do architects make choices that influence the smell of a building? First it's important to note that Aristotle defines smell's sense object to be 'the perception of odor', as described by Sorabji (1971, p. 58). When speaking of odor, two things come to mind: the freshness of the air that you are breathing, and any smells that might accompany it.

A study done by Coley and Greeves (2004) looked into how low ventilation rates affect cognitive functions in primary school children. Their computerized test showed that the children's attentional processes were significantly slower when carbondioxide levels in the room were increased. Another study done by Fisk (2000) even found that carbondioxide levels and absence levels in school have a significant association; this is thought to be due to low ventilation rates leading to an increase in respiratory illnesses.

People are able to define smells by whether they find them to be generally pleasant or generally unpleasant. Research done by Quercia, Aiello and Schifanella (2016) shows that people generally find flowers and nature in general to smell more pleasant, as opposed to chemical scents and body odours, which most people find unpleasant.

TASTE

The fifth and final sense is taste, the sense to which Aristotle describes flavour to be the sense object, as written by Sorabji (1971, p. 58). Not much can be said about flavour or taste in respect to architecture, other than there being a relation between smell and taste. As such, the taste in your mouth might influence the smell in your nose and vice versa.

SENSES AND THE HEALING PROCESS

Now that the five senses have been discussed, how do these influence the healing process itself? Research done by Ugolini, Rossato and Bacarani (2014) explains: 'In sum, the patient is not able to make a professional appraisal of the clinical quality of the service, therefore relies on sensory cues, which are both physical and psychosocial. What the patient sees, hears, smells, touches and tastes confirms or runs counter to the quality judgement made. The hospital structure and service should remain in tune not only with the health needs of patients or quantitative output targets but also with the interaction needs of the patients, because the satisfaction of these needs affects clinical outcomes. Patients need to be reassured to lessen the anxiety felt.'

One of the methods used to define this is the 5 Senses Ward Model, as shown in figure 1. This shows how the senses become receptors through which the entirety of the hospital is perceived, and judged. It also shows that patients play a role in their own healing process through this perception as well.

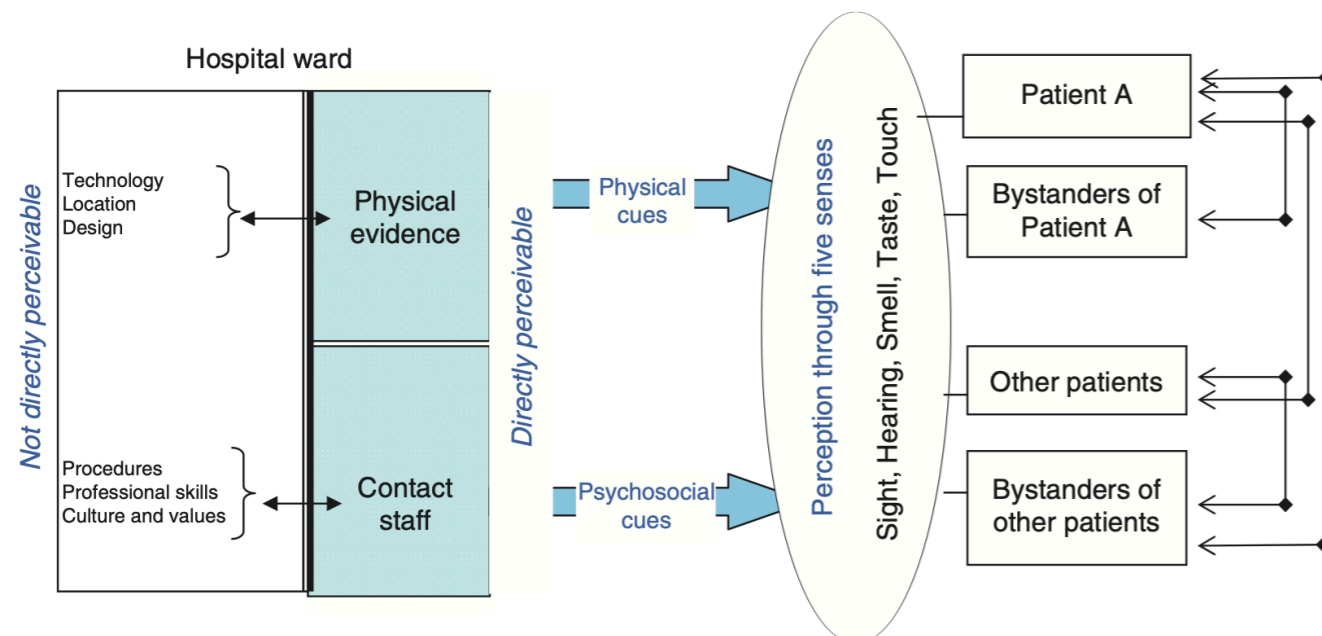


Figure 1: The 5 Senses Ward Model by Ugolini, Rossato and Bacarani (2014)

The Three Case Studies

This chapter will give a short introduction about each of the three case studies chosen to help in the understanding of choices made in the design process. The three case studies that will be discussed in this research are: Meander Medical Center in Amersfoort, Erasmus MC in Rotterdam, and het Diaconessenhuis in Utrecht.

To be able to do this research, and because the care facilities are immense, the choice was made to only look into the waiting areas / patient rooms, hallways, and any outside spaces that patients can use, since these are the spaces that patients will be in contact with the most.

MEANDER MEDICAL CENTER

Located on the outer perimeter of the city of Amersfoort, this is one of six locations where Meander Medical Center operates. The center in Amersfoort prides itself on being designed and built following the principles of healing environments through the incorporation of for example: single person rooms, privacy, lots of daylight, and looking out on a green environment from every direction (Meander Medisch Centrum, n.d.).

The location in Amersfoort was designed by atelier PRO and finished in 2013. After delivery of the project, it was awarded with multiple prizes in regards to the architect's focus on patients and visitors. Due to the size of the building, the choice was made to divide the different functions into different blocks, and have them be connected through the usage of a large corridor named 'de LAAN'. A few extra functions - such as 'de ORANJERIE', 'de FOYER' and 'de BRINK' - were added to 'de LAAN' to promote them as informal waiting rooms, all with their own specific functions. There are separate, specific routes for employees to take when there's an emergency, or the need to move

between the operating rooms and patient rooms, or even to supply all of the individual functions present in the building. One of the prime examples of the groundbreaking manner in which Meander Medical Center was organized is the location of the hotfloors - acute and intensive care - which are not connected to any of the public spaces, and can only be reached by going through the orangerie.

ERASMUS MC

In contrast to the Meander Medical Center mentioned before, the Erasmus MC is located in the center of Rotterdam, right beside the Museumpark. The renovation and building process of Erasmus MC took about eight years and ended up being a joint effort by EGM architecten, Claus en Kaan Architecten and OD 205 Architectuur, with EGM architecten taking on the lion's share.

A very important principle in the design of Erasmus MC was the usage of evidence-based design (EGM architecten, n.d.); by using scientific research, patient and employee welfare was put first. Because the design's main focus was to combine old and new, and make the entire ensemble less chaotic, a large passage was added. This passage's focus is to not make it feel too much like a hospital and for this reason restaurants and shops were added, all to be used by patients, employees, visitors, and even students from nearby schools and universities.

The design of Erasmus MC is also very much patient oriented. All patient rooms are made to house one person at a time, which contributes to the healing process by improving privacy, rest, and hygiene. Patients are also able to open their own windows, and visit one of the green roofs on their own whenever possible. These green roofs are available to patients on the lower parts of the hospital, and provide some much needed green space within the city.

To make the entire ensemble of the Erasmus MC as navigable as possible, the nursing wards and outpatient clinics were made to be as similar as possible. This approach was carried through to the entire design of the hospital.

DIAKONESSENHUIS

The third, and final, case study is located in Utrecht, in the neighbourhood Oost. Het Diaconessenhuis is in the process of renovating the older buildings, as well as building new facilities. The part of the building that will be discussed, will mainly be the new entrance hall, since that's the first part that has been finished since starting the renovations. This new entrance hall has been designed by INBO, and focussed on the use of natural materials in its design.

Within the design the contact between medical personnel, patients and visitors was made into the most prominent theme (INBO, n.d.). This was mainly done by combining waiting rooms and making information counters and consultation rooms easy to spot. To make this even more clear any extra functions, such as the shops and a restaurant, were pushed to the side, to create even more clarity in the general layout of the area.

Combining the waiting rooms also serves a more practical purpose, as this makes it easier to regulate the flow of patients and visitors whenever there's spikes in the amount of people present in the building.

Design and the Senses

In this chapter the question '*How do the case studies influence the senses, and - per extension - the healing process?*' will be answered. To be able to do this, the research done in the second chapter will be applied to spaces within the three case studies that were described in the previous chapter. The spaces chosen for this are: the waiting areas, hallways, and any outside spaces that patients can use.

This chapter will have a paragraph discussing each sense and its accompanying forementioned research. Due to the limited influence architectural design choices have on the sense of taste or flavour, this sense will be omitted from the rest of this chapter. As such, the senses discussed will only be sight, touch, hearing, and smell.

The individual paragraphs will then be divided to discuss the different case studies - and their chosen spaces as mentioned before - and link them to the research that is currently available.

SIGHT

As mentioned in the second chapter the most important properties whenever looking into the sense of sight are color and brightness. These will therefore also be the factors that will be looked into in regards to the three case studies and their individual spaces.

Meander Medical Center

Seeing as the Meander Medical Center prides itself on the incorporation of patients and visitors, and their comfort into the design, it should come as no surprise that the architects at atelier PRO obviously used existing research about comfort while they were busy designing the building. When looking at figures 2 through 5 an obvious sense of brightness becomes clear, as well as the use of natural materials, which will be



Figure 2: Waiting area Meander Medical Center, Teunissen & van Beek (2020)



Figure 3: Hallway Meander Medical Center, Teunissen & van Beek (2020)



Figure 4: Outside terrace Meander Medical Center, Teunissen & van Beek (2020)



Figure 5: Outside space Meander Medical Center, Teunissen & van Beek (2020)

discussed one location in the building at a time.

The waiting rooms in the Meander Medical Center are all very bright and open, as can be seen in figure 2. In terms of the brightness mandated through research, there are very many windows surrounding the waiting areas, providing more than enough natural lighting in the spaces. As for the use of color within the space; the architects at atelier PRO chose to use different shades and tones of natural materials. The only colors that do not fall into this palet of natural tones are the seats that are scattered around the area to offer some extra seating, but even then these are all yellow; which doesn't seem to have too many negative connotations either.

When looking at the hallways in the Meander Medical Center in figure 3, the same thing springs to mind as when looking at the waiting areas; probably because, due to the layout, these types of rooms seem largely connected to each other. The main hallway in Meander Medical Center is 'de LAAN' which connects all of the other seperate functions, and provides a connection not only to these other, seperate functions but also to the outside; providing a lot of natural lighting as well. Looking into the colors used for the hallways is simple, seeing as these are quite similar to the colors used in the waiting area. The same natural tones are used for the stonework and woodwork, with again the exception of one defining element: the information desk. To make this stand out more, the architect chose to use a bright green color; this hue leans more towards the cooler side, thus promoting focus and concentration.

While the outside spaces in figures 4 and 5 do not seem to be designed to fit a certain target group, there are quite a lot of them; the unsurity remains whether or not these spaces are to be visited by patients as well, but one must only believe that they are, seeing as there are ramps leading up to every single one of them. In regards to color there doesn't seem to be much difference when looking at the rest of the building; the natural hues continue in the outside furniture, together

with some pops of color to provide more of a contrast with the aforementioned natural tones.

Erasmus MC

The approach that was used for the design of the Erasmus MC is obviously very different from the approach that was used in the design of Meander Medical Center, because it was also renovated for a large part. This becomes quite clear in the photos in figures 6 to 9 as well; there are a lot more smaller spaces and divisions in the design, something that's especially noticable when looking at the aerial view in figure 9.

Looking into the waiting areas at the Erasmus MC an obvious discord happens; the waiting areas in the older, renovated parts of the building are a lot smaller and more closed off, while the waiting areas in the newly built parts of the building are a lot more bright and open. When looking at research related to sight, the newer waiting areas tend to work better for patients, as opposed to the older waiting areas; seeing as these newer parts get a lot more natural light. In regards to colors the older waiting rooms, as shown in figure 6, tend to have a more cool color palet, while the newer waiting ares tend to lean more towards warmer colors. This might also have something to do with the older waiting rooms being closer to the individual specialists' areas, and thus having the need to promote a more focused and concentrated environment, as opposed to the newer waiting areas, which are further away from the specialists' areas.

The main hallway within the design of the Erasmus MC was added as one of the newly built parts of the building and forms a connection between all of the individual pieces of the hospital. This main hallway - shown in figure 8 - is very bright, as it was built as an atrium, and forms a more public area that's freely accesible to the public; the atrium itself is about twenty meters wide, and 300 meters long. Due to it being an atrium, the area gets a lot of natural light, which works really well for patients and visitors entering



Figure 6: Waiting area Erasmus MC, EGM architecten (n.d.)



Figure 7: Waiting area Erasmus MC, EGM architecten (n.d.)



Figure 8: Hallway Erasmus MC, EGM architecten (n.d.)



Figure 9: Outside spaces roofscape Erasmus MC, EGM architecten (n.d.)



Figure 10: Waiting area Diakonessenhuis, INBO (n.d.)



Figure 11: Waiting area Diakonessenhuis, INBO (n.d.)



Figure 12: Waiting area / hallway Diakonessenhuis, INBO (n.d.)



Figure 13: Outside space Diakonessenhuis, INBO (n.d.)

the building. When looking at the colors used it seems to be a similar color palet to the one used in the Meander Medical Center, with maybe a few more greyish tones due to an increased use of metals. EGM architecten even chose a similar color for the information desk in the main hall, which promotes focus and concentration due to its cooler hue.

The main outside spaces for patients to use at Erasmus MC are the green roofs on top of certain parts of the renovated buildings, as shown in figure 9. While these spaces are very green by themselves, they all look out unto roads and more of the city, which could've been better, but is to be expected when building a facility in the center of Rotterdam.

Diakonessenhuis

The lay-out of the Diakonessenhuis in Utrecht is even more different as the ones from Meander Medical Center and Erasmus MC, seeing as there's still a lot of renovating going on. The newest part of the building is the part designed by INBO, pictured in figures 10-13. This part also functions as the entrance hall and hallway, as well as waiting area for patients while the renovations in the rest of the building are going on. As such, this part of the building will be discussed as a whole in relation to the research instead of seperating the different functions.

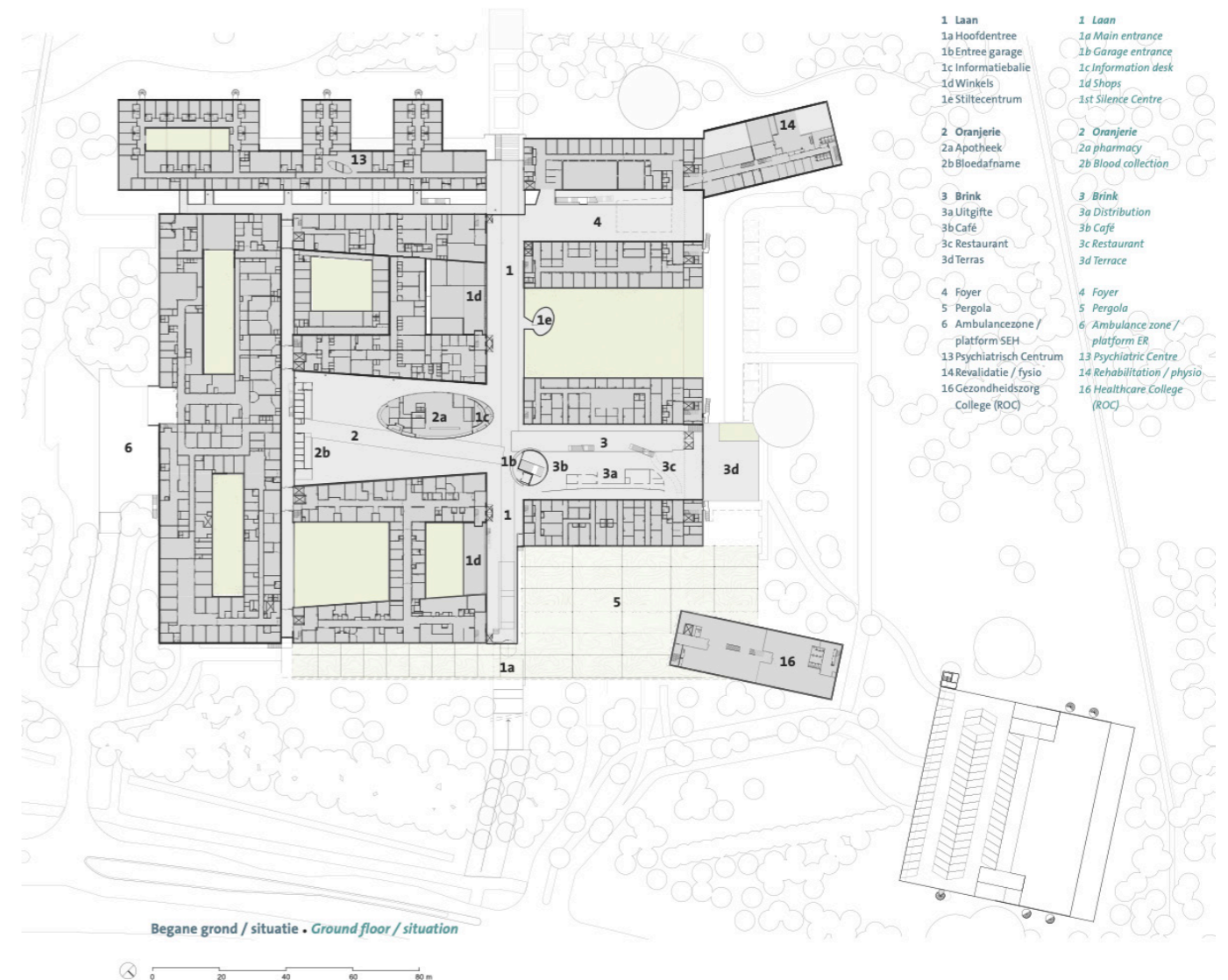
When speaking about the brightness and natural light within the Diakonessenhuis, there is a lot of natural light due to the usage of glass in the outside facade as well as through incorporating skylights in the roof. The division of color in the design is very intriguing though. A lot of natural colors were used, similar to the Erasmus MC and Meander Medical Center, but the furniture in the space were given different colors. The general waiting areas as pictured in figures 10 and 11 tend to have more warm tones, while the waiting area in front of the information desk has cooler tones in its design. This decision can be explained similarly to the other case studies in that cooler hues promote more focus, while warmer tones make the room actually feel more warm.

The only space in the design of the Diakonessenhuis that feels unfinished is the outside area at the front entrance as pictured in figure 13. This is, coincidentally, also the main area that patients can use to go outside. While they are still busy renovating and there are plans for the area in front of the facility, one must hope that there are also plans to make more outside spaces available to patients.

TOUCH

In the second chapter of this report, the most important factor of touch was defined to be the lay-out, and usage thereof. To define this more clearly, the choice was made to look into the clarity of routes present, and the amount of people within the space. This will be done similarly to the first paragraph about sight.

Figure 14: Ground Floor layout Meander Medical Center, Teunissen & van Beek (2020)



Meander Medical Center

Looking into the layout of the Meander Medical Center as pictured in figure 14, it's quite a clear layout due in part to 'de LAAN' that was added in the design. 'De LAAN' offers a clear route throughout the building, which can also be seen in figure 3. The clarity of this route makes it easier for patients and visitors to find their way in the building, and all of the areas connected to this hallway are also clearly defined as waiting areas. Thanks to the separation of waiting areas and walking routes, the amount of people in the spaces is also limited, thus providing a more relaxing experience for people when visiting the hospital.

Erasmus MC

While the design of Erasmus MC might seem more chaotic in its layout in the aerial view, as shown in figure 9, the addition of the main hallway that connects the different buildings and functions helps a great deal in wayfinding for visitors and patients. Even though this improves the clarity in layout a great deal, the overall ensemble still proves to be quite chaotic due to the many different buildings. It does help a lot that a similar decision was made as with the Meander Medical Center in regards to waiting areas. As shown in figure 6 and 7 these waiting rooms are separated from the main hallway, which also lessens the amount of people present in the area at once.

Diakonessenhuis

As seen in figures 10-13 the new addition to the Diakonessenhuis designed by INBO, while multifunctional, misses a clear definition in routes and areas, which might prove difficult to understand for patients and visitors. Since these spaces are not as clearly defined, they will also become crowded more easily, which increases the amount of stress experienced by everyone in the space.

HEARING

To be able to analyze sound in the chosen case studies a comparison will be made between amounts of elements that have shown to dampen sounds within buildings and spaces, such as plants, carpets and curtains, seeing as visiting the actual sites is impossible due to current COVID-19 measures.

Meander Medical Center

While the waiting rooms and outside spaces of the Meander Medical Center seem to be adequately equipped to deal with echos, due to the usage of for example plants, as shown in figures 2, 4 and 5, 'de LAAN' might prove difficult when talking about echos in the building. Since it's shaped as a long hallway surrounded by orthogonally placed walls, sounds will probably cause an echo, as opposed to being diffused. The addition of certain smaller elements, such as the information desk and bridges on the higher floors, that break up the straight lines most definitely help with lessening echos though.

Erasmus MC

The Erasmus MC, with all its little nooks and crannies, might not necessarily work that well when looking at clarity in the routing of the building, but does work wonders when trying to reduce echos. To reduce these echos even more, EGM architecten used acoustical fins hanging from the ceiling in the main hallway, as shown in figure 8. Besides taking these measures, a lot of greenery and extra elements in the space were also used to reduce noise within the atrium. The other spaces within Erasmus MC are comprised of much smaller areas in which echos become much less of a problem.

Diakonessenhuis

Something similar becomes clear when looking at the Diakonessenhuis as when looking at Erasmus MC on the topic of acoustics. Where both of these care facilities might 'score' less well on account of being less clear in routing and layout, these factors score better when looking at acoustics. Due to the different elements used in the area, the echos also

become less and less. So while the way in which the waiting areas are arranged might be less clear in wayfinding, these individual elements prove to be more successful when taking acoustics into account.

SMELL

As defined in chapter two, the most important factors when taking smell into account are ventilation rates and generally pleasant or unpleasant smells. Both of these topics are very difficult to discuss without having been to the locations, and making assumptions also becomes near impossible from just looking at photos. For that reason the decision was made to not go into detail any further into this topic, but to further urge architects designing care facilities to take these factors into account; the chemical smells of cleaning agents obviously do not help in a patient's healing process.

Conclusion

The main question for this thesis has been: *How do the design choices in recently built care facilities affect the healing processes of their patients?*

Through texts written by Aristotle sense objects were identified for each of the five senses, after which these were related to architecture through existing research. The three case studies chose, Meander Medical Center, Erasmus MC, and Diakonessenhuis, were first described, and then the areas that patients and visitors are most in contact with - hallways, waiting rooms, and outdoor spaces - were analyzed according to the research from the second chapter.

The first conclusions that can be made are from the perspective of sight, on the sense objects of brightness and colors. When looking at the brightness, and especially natural lighting, within spaces atriums are a great option to incorporate into the design. Not using natural lighting might lead to slower healing rates and more usage of pain medication whenever this is part of the treatment.

Speaking of colors, the main ones discussed in this thesis are the warmer and cooler hues. Warmer tones like oranges and reds might make a person actually feel warmer, while cooler tints promote concentration and focus. For this reason the recommendation would be to use cooler tones in the office and desk areas, and warmer tones in patient rooms and waiting areas.

The main conclusion that can be made from the perspective of touch is that layout and clarity thereof is incredibly important when talking about patients and visitors. Research has shown that people experience more stress when paths and areas are not clearly marked or arranged. Something similar happens when looking at the amount of people in the space: the more people in a smaller

space, the more stressed these people are.

The third, and final, sense that ended up being discussed - the other two, smell and taste, were omitted due to unsubstantiality of data and an unclear relationship to architecture - has been hearing. Research showed that people are actually unable to retain information as well when the noise levels in a room became higher. Seeing as clear communications is of the utmost importance in hospitals and care facilities, it is very important as an architect to take acoustic design into account.

One of the main things that became very clear throughout the entirety of this research is that there are a lot of factors to take into account, and while one design solution might work wonders for one of the senses, it might work terribly for one of the other senses. This alone should encourage architects to do more research into the effects that their design decisions might have on the end users of the building.

Epilogue

A history thesis is not normally my cup of tea so to speak, and the fact that I got lost in research the first couple of weeks did not help at all. However, in the last few weeks I was able to find a clearer way of presenting the research found, and I ended up with a thesis of which I'm quite proud.

If I'm completely honest with myself, I should have defined my parameters more concretely from the start, but since I find this topic too interesting I was afraid to cut away too much of the research at a way too early stage.

There also isn't much research in relation to the senses and the healing process when speaking about architecture, which made it quite difficult sometimes to find out whether or not certain sources were even relevant.

As said before, I am quite proud of the end result, especially looking at everything that's going on in the world right now, and I hope to be able to start my graduation sometime next year in a similar topic.

To round off my thesis, I would like to thank Marcel Teunissen, who tutored me, for his support and understanding throughout this entire course.

(Annotated) Bibliography and Illustrations

ANNOTATED BIBLIOGRAPHY

Barrett, P., & Barrett, L. (2010). The potential of positive places: Senses, brain and spaces. *Intelligent Buildings International*, 2(3), 218–228. <https://doi.org/10.3763/inbi.2010.0042>

Missing the existence of a framework for designers to work with in regards to the holistic experience of spaces, Barrett and Barrett (2010) propose a framework that captures this essence. This paper combines the way in which humans receive information, the way in which this affects the body and psyche, and the way in which the brain perceives and processes this information. Both this source and the second one call for an integrated multi-disciplinary approach, and these can be used side by side. Both of these also propose a way in which the research can be done, which can be implemented in the research on the different case studies.

Bluyssen, P. M. (2010). Towards new methods and ways to create healthy and comfortable buildings. *Building and Environment*, 45(4), 808–818. <https://doi.org/10.1016/j.buildenv.2009.08.020>

With a call to action, Bluyssen (2010) reflects upon the practice of comparing static performance indicators with a dynamic process; mainly pointing out using a certain point in time to measure being exposed to a certain building. Seeing as health and comfort of occupants are both dynamic processes, these need to be evaluated differently to be able to get any valid outcomes. Both this source and the first one call for an integrated multi-disciplinary approach, and these can be used side by side. Both of these also propose a way in which the research can be done, which can be implemented in the research on the different case studies.

Krishna, A. (2012). An integrative review of sensory marketing: Engaging the senses to affect perception, judgment and behavior. *Journal of Consumer Psychology*, 22(3), 332–351. <https://doi.org/10.1016/j.jcps.2011.08.003>

Combining different articles into a review, Krishna (2012) offers a clear overview of research that has been done on sensory marketing. While this is not a subject that directly relates to architecture, a lot of the research can be related in the sense that it goes further into the perception of the senses. This offers a clear

summary of research that has been done on the subject, and is a great starting point for the research. This source offers a lot of different research on the subject of perception of the senses, which can be extracted and used as a comparative tool for the chosen case study projects.

Liapi, M., Linaraki, D., & Voradaki, G. (2012). Sensponsive architecture as a tool to stimulate the senses and alleviate the psychological disorders of an individual. *Cognitive Processing*, 13(S1), 233–237. <https://doi.org/10.1007/s10339-012-0454-z>

Liapi, Linaraki, and Voradaki (2012) focus on a similar topic, but more from the side of the building. An important part of the research is the ways in which the spatial qualities of the surrounding environment affect the human senses and consequently the hormonal changes and the production of the corresponding emotions and actions. Seeing as mental health is as a big factor in physical health as well as recovery, these results offer more insight into the true state of the senses in regards to health architecture.

Yang, W., & Moon, H. J. (2019). Combined effects of acoustic, thermal, and illumination conditions on the comfort of discrete senses and overall indoor environment. *Building and Environment*, 148, 623–633. <https://doi.org/10.1016/j.buildenv.2018.11.040>

When looking at the effect of spaces on the senses, a more straightforward effect is also in place; the effect of the indoor environment on the senses. Yang and Moon (2019) did research into the effect different temperatures, illumination levels, and sound levels had on their subjects and how comfortable they were within the space. This source offers more practical research into the indoor environment within spaces, making it possible to dive deeper into the effect of temperature, lights, and acoustics within architecture, instead of only focussing on the shape and movement of the spaces themselves.

BIBLIOGRAPHY

Alexander, R. (1977). *Policy and Practice in Primary Education: Local Initiative*. London, United Kingdom: Routledge.

CIB Task Group 42 (2004). *Performance Criteria of Buildings for Health and Comfort*. Rotterdam, The Netherlands: International Council for Research and Innovation in Building and Construction (CIB), 3–70.

Coley, D.A. and Greeves, R. (2004). *The Effect of Low Ventilation Rates on the Cognitive Function of a Primary School Class, Report R102 for the DFES*. Exeter, United Kingdom: Exeter University

EGM architecten. (n.d.). Erasmus MC Ziekenhuis. Retrieved 2 April 2021, from <https://www.egm.nl/architecten/projecten/erasmus-mc-ziekenhuis/347>

Engelbrecht, K. (2003). *The Impact of Colour on Learning*. Chicago, United States of America: Perkins and Will.

Evans, G. and Lepore, S. (1993). Non-auditory effects of noise on children: a critical review. *Children's Environments*, 10(1), 43–72.

Fisk, W.J. (2000) Health productivity gains from better indoor environments and their relationship with building energy efficiency. *Annual Review of Energy and the Environment*, 25(1), 537–566.

Heschong Mahone Group (2003). *Windows and Classrooms: A Study of Student Performance and the Indoor Environment*. Fair Oaks, United States of America: Californian Energy Commission.

Hygge, S. (2003) Classroom experiments on the effects of different noise sources and sound levels on long-term recall and recognition in children. *Applied Cognitive Psychology*, 17, 895–914.

INBO. (n.d.). Diaconessenhuis, Utrecht. Retrieved 2 April 2021, from <https://www.inbo.com/nl/projecten/diaconessenhuis-utrecht>

Mahnke, F. (1996). *Color, Environment, & Human Response*. New York, United States of America: John Wiley and Sons.

Meander Medisch Centrum. (n.d.). Dit is meander. Retrieved 2 April 2021, from <https://www.meandermc.nl/patientenportaal/dit-is-meander>

Quercia, D., Aiello, L. M., & Schifanella, R. (2016). *The Emotional and Chromatic Layers of Urban Smells*. ICWSM. Retrieved from <https://ojs.aaai.org/index.php/ICWSM/article/view/14736/14585>

Rea, M., Figueiro, M. and Bullough, J. (2002). Circadian photobiology: An emerging framework for lighting practice and research. *Lighting Research and Technology*, 34(3), 177–187.

Rivlin, L. and Wolfe, M. (1972). The early history of a psychiatric hospital for children: expectations and reality. *Environment and Behaviour* 4(33), 33–73.

Sorabji, R. (1971). Aristotle on Demarcating the Five Senses. *The Philosophical Review*, 80(1), 55–79. <https://doi.org/10.2307/2184311>

Seddigh, A., Berntson, E., Jönsson, F., Danielson, C. B., & Westerlund, H. (2015). The effect of noise absorption variation in open-plan offices: A field study with a cross-over design. *Journal of Environmental Psychology*, 44, 34–44. <https://doi.org/10.1016/j.jenvp.2015.08.004>

Ugolini, M. M., Rossato, C., & Baccarani, C. (2014). A five-senses perspective to quality in hospitals. *The TQM Journal*, 26(3), 284–299. <https://doi.org/10.1108/tqm-01-2014-0010>

Ulrich, R. (1991). The effects of interior design on wellness: theory and recent scientific research. *Journal of Health Care Interior Design*, 3(1), 97–109.

Ulrich, R., Quan, X., Zimring, C., Joseph, A. and Choudhary, R. (2004). *The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity. Designing the 21st Century Hospital Project*. Concord, United States of America: The Center for Health Design.

ILLUSTRATIONS

Figure 1: Ugolini, M. M., Rossato, C., & Baccarani, C. (2014). A five-senses perspective to quality in hospitals. *The TQM Journal*, 26(3), 284–299. <https://doi.org/10.1108/tqm-01-2014-0010>

Figure 2-5: Teunissen, M., & van Beek, H. (2020). Samenspel. mens | natuur | architectuur. Retrieved from <https://brightspace.tudelft.nl/d2l/common/viewFile.d2lfile/Database/MTc4MzI2OQ/Meander-Medisch-Centrum-2020.pdf?ou=278587&display=1>

Figure 6-9: EGM architecten. (n.d.). Erasmus MC Ziekenhuis. Retrieved 2 April 2021, from <https://www.egm.nl/architecten/projecten/erasmus-mc-ziekenhuis/347>

Figure 10-13: INBO. (n.d.). Diaconessenhuis, Utrecht. Retrieved 2 April 2021, from <https://www.inbo.com/nl/projecten/diaconessenhuis-utrecht>

Figure 14: Teunissen, M., & van Beek, H. (2020). Samenspel. mens | natuur | architectuur. Retrieved from <https://brightspace.tudelft.nl/d2l/common/viewFile.d2lfile/Database/MTc4MzI2OQ/Meander-Medisch-Centrum-2020.pdf?ou=278587&display=1>

