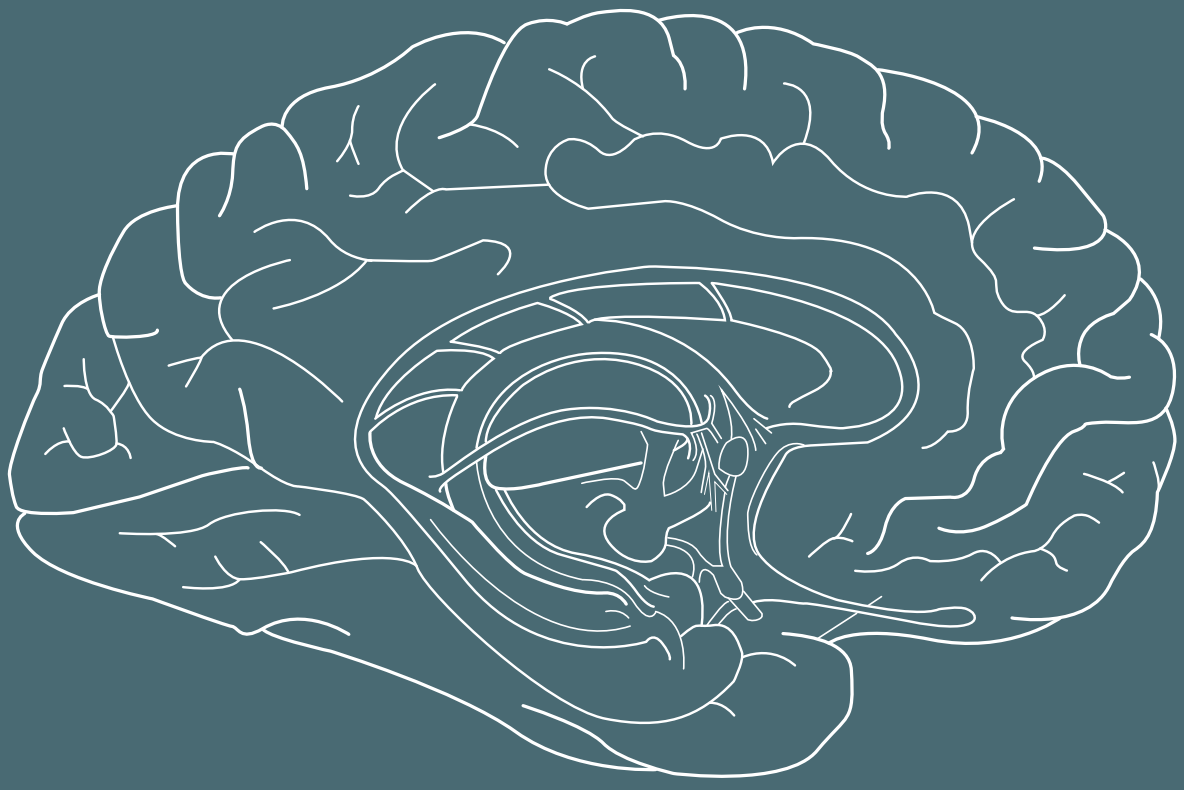

PTSD, architecture and the brain

- The design of a sustainable asylumcentre.

The Master thesis of

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Abstract

The project revolves around the design of an asylum centre. The process behind the final architectural design is subdivided into two phases, firstly; an assessment of architectures correlation with the health and well-being. Inquiry on this correlation was performed through assessments on the neurological- and psychological underpinnings of architectural preference and a corresponding examination of the state of the art review of the literature and empirical findings on architectures correlation with preference and emotional modulation. The first phase also included an assessment of the health and well-being of asylum-seekers applying for refugee status in the European nation. This inquiry displayed post-traumatic stress disorder as a wide spread mental issues among the designated user group of the architectural project. The assessment of the neurological- and psychological underpinnings of architectural preference and the findings on the topic, were correlated with neurological- and psychological abnormalities of post-traumatic stress disorder to extract user specific design guidelines for the implementation in the design of the asylum center. The second phase includes the design of a site specific asylum centre, positioned in 'Hammer bakker'. The design process and inquiry for the project includes considerations on trinity of sustainability. These considerations were included in combination with the extract design guidelines from the first phase; resulting in an energy efficient architectural design with low environmental impact. The spatial configuration of the asylum center were designed according to the findings of phase one, therefore, theoretically, improving the treatment efficiency of post-traumatic stress disorder and generally improves the health and well-being of the center occupants through architectural interventions.

Table of content

Img: 1 - (Ponomarven, 2016)

Project introduction

Various religious- and political conflicts across the world, have resulted in the displacement of 68,5 million people across the world. 6,1 million of whom is either under refugee status or have obtained asylum-seeker status within the European nations (UNHCR, 2018). The so-called 'refugee crisis', has resulted in international conventions aimed at cultivating the conduction of national legislation aimed at resolving the refugee crisis through various strategies; including accommodation a significant minority within European countries, as asylum-seekers (Phillimore, 2017). Approximately half of the national legislation, in the democratic European nations, is supporting the international policies conducted to resolve the refugee crisis (Huddleston et al., 2011). National legislation, in democratic nations, is heavily influenced by the political discourse, especially the question regarding how well immigrants integrate into host societies, plays a critical role in the public debate. In Denmark, immigration policies are under constant and substantial debate, resulting in a vast difference in political stance between the government, opposition, and the corresponding public standpoint (DR, 2018). The tremendous political attention towards immigration politics and, the resulting differences in ideology and the perception of threat to cultural values, have fostered a political breeding ground for new political parties fighting solely against immigration. As of 21. of February 2019, the Danish parliament changed immigration legislation from a political strategy of integration into an approach purely focused on repatriation. A paradigm shift highly criticised by various humanitarian organisations (Ritzau, 2019). This project, will follow the Danish legislation pre 21/2/2019, international political set goals and follow the recommendation by humanitarian organisations and construct inquiry upon how architecture can support the integration process.

Ager and Strang (2008) isolated positive- and negative factors contributing to foreigner's ability to integrate into new culture and society. One of the hinders of integration was the sensation of perceived fear and insecurity, factors which closely reassembles the mental disorder post-traumatic stress disorder (PTSD); a mental disorder associated with the exposure to armed- and political conflicts. The aim of the project is, therefore, to understand how architecture could interfere with the perception of safety and how mental disorders of the population group affect the usergroup preference of architecture. The purpose of this inquiry is facilitating evidence-based design principles for the design of an asylum-centre specially designed to accommodate and threat asylum seekers with reduced mental health. Improving the physical environment, housing this highly exposed user group,

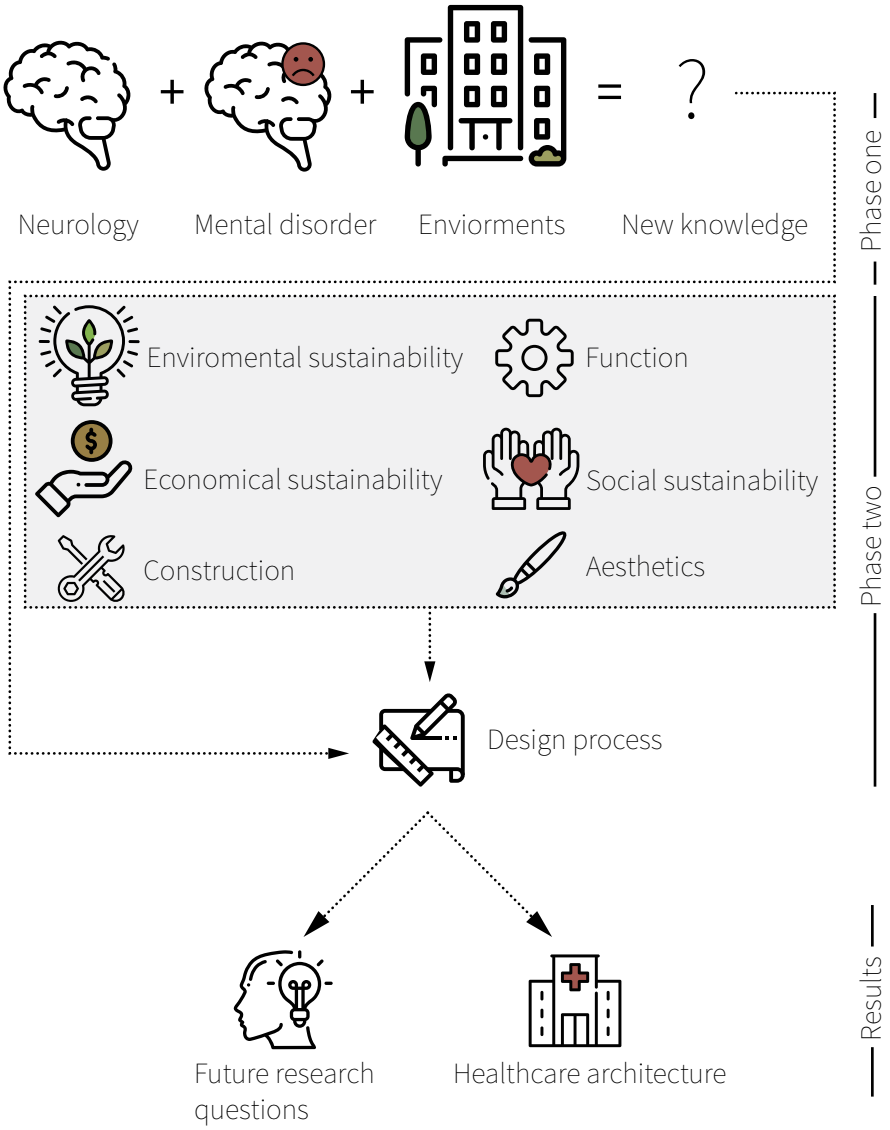
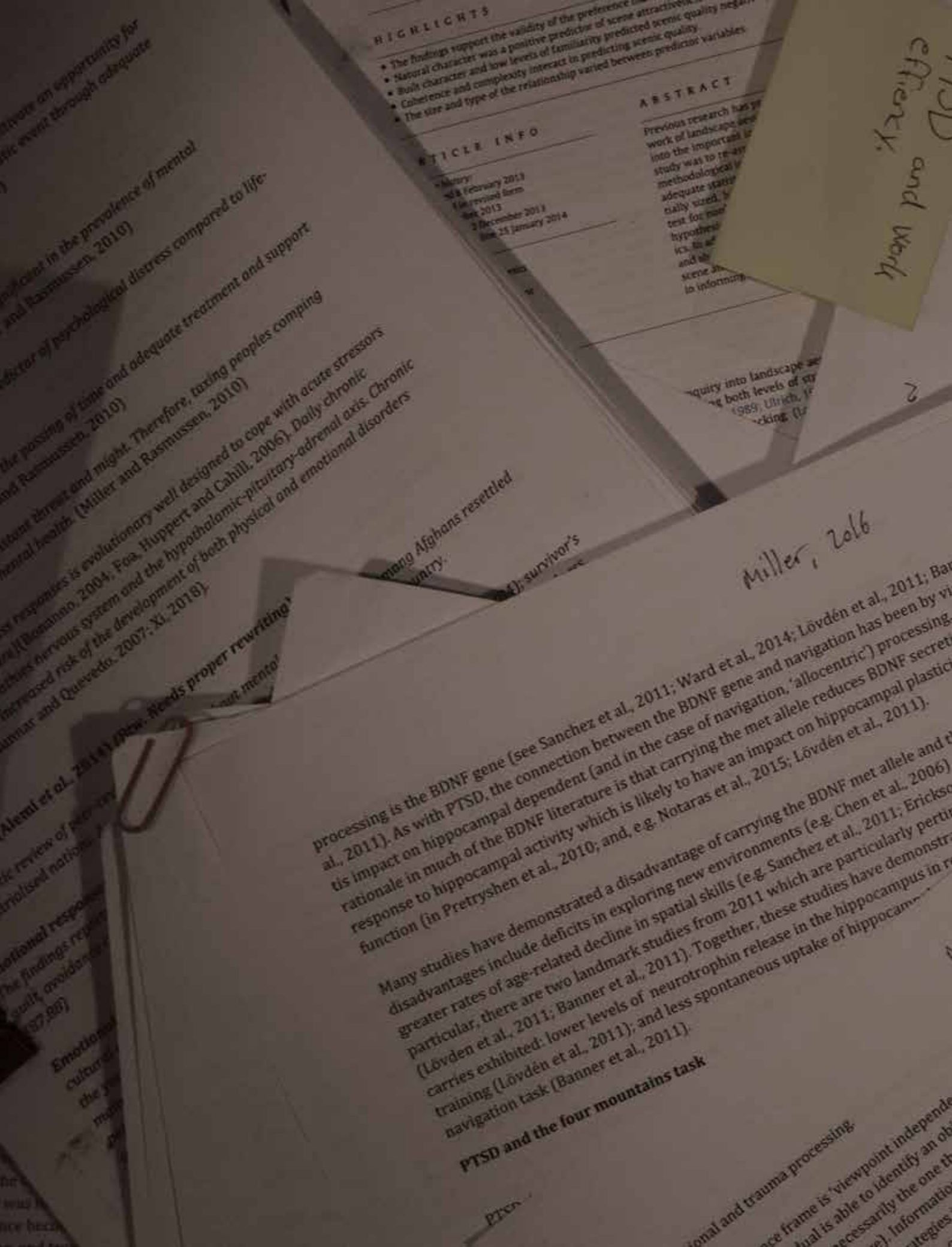


Fig: 1 - Project structure

might positively affect the health and well-being, thus enhancing their general life quality, therefore potentially counteract the sensation of fear and insecurity; improving the chances of these individuals ability to become functioning members of their host society – supporting the integration process.

The project is comprised of two integrated parts; a theoretical part and a "practical" architectural project. The purpose of the preliminary theoretical inquiry is to establish a theoretical and empirical foundation; accessing the mental health of the refugee population and correlating this with architectures influence upon health and well-being. The findings from the preliminary work will be conceptualized in the architectural project together with other aspects of the architectural profession (e.g., sustainability; indoor climate; aesthetics; function). Combination of the scientific approach and the creative ingenuity of an architect/engineer will hopefully cultivate both improved design strategies for health and well-being architecture and disover new lines of inquiry within the field of environmental psychology.


HIGHLIGHTS
ABSTRACT
ARTICLE INFO
Miller, 2016
processing is the BDNF gene (see Sanchez et al., 2011; Ward et al., 2014; Lövdén et al., 2011; Ba
al., 2011). As with PTSD, the connection between the BDNF gene and navigation has been by vi
tis impact on hippocampal dependent (and in the case of navigation, 'allocentric') processing,
rationale in much of the BDNF literature is that carrying the met allele reduces BDNF secret
response to hippocampal activity which is likely to have an impact on hippocampal plastici
function (in Pretryshen et al., 2010; and, e.g. Notaras et al., 2015; Lövdén et al., 2011).
Many studies have demonstrated a disadvantage of carrying the BDNF met allele and r
disadvantages include deficits in exploring new environments (e.g. Chen et al., 2006)
greater rates of age-related decline in spatial skills (e.g. Sanchez et al., 2011; Erickso
particular, there are two landmark studies from 2011 which are particularly pertin
(Lövden et al., 2011; Banner et al., 2011). Together, these studies have demonstra
carries exhibited: lower levels of neurotrophin release in the hippocampus in r
training (Lövdén et al., 2011); and less spontaneous uptake of hippocam
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PTSD and the four mountains task

01

PTSD, architecture and the brain

Introduction

Studies conducted on the correlation between the physical condition of housing for asylum seekers and health and well-being has displayed findings that it has a strong correlation between the quality of the accommodation and corresponding physical- and mental health of the occupants. The studies have primarily focused on factors, such as; indoor climate; overcrowding and housing security (Ziersch and Due, 2018). The aim of this first phase is to investigate the correlation between housing and health, but from a different angle, compared to Ziersch and Due (2018). The project will investigate the underpinning mechanisms governing the correlation between architecture and the emotional system. The existence of this correlation has previously been proven by Brorson (2013), who displayed a direct correlation between the spatial configuration of an environment and activation of the human neuroendocrine system. Through inquiry of the connection between architecture, emotions and the mental issues prevailing in the population group; design strategies will be derived, with the aim at improving the health and well-being of the population group through architectural interventions; thereby supporting the integration process through architectural design.

Architecture; a biological definition

Architecture in its briefest description is the design of spaces; environments primarily constructed for the occupancy of humans. According to biology; environments are defined as the sum of all thinkable factors affecting its occupants. Physical dimensions, location, social value, the purpose of the occupants and indoor climate are examples of commonly considered parameters in the architectural profession but as evident by the Brorson, (2013) and Jiang, Chang and Sullivan (2014) these external factors interfere with the internal environment of the occupants of the environment through modulation of the neuroendocrine system; constructing a correlation between the external variables and the internal environment of the agent in the given environment; affecting and determining the consequence of all action the agent performs in said environment (Kirsh, 2000) and influencing the health and well-being of the occupants (Sternberg, 2000). Implementation of this biological notion of environments broadens the perspective of architectural considerations, by inclusion of all perceivable factors into the account; especially the evident correlation between the common variables of the architectural profession and the internal reaction in the agents is of substantial interest, as the interaction between the environment variables and the resulting neurological composition of its occupants is a reflection of the "true" value of architecture, this can both be stated for the subjective- and collective architectural experience. The aim of the following chapter is, therefore, to expand and upon this biological definition of environments and construct a theoretical framework for upon the underpinnings of the interaction in question, and extract the essential lines of inquiry within the infinite pool of variables proposed by the preliminary biological definition of environments/architecture.

In evolutionary biologically, the term optimality principle describes the condition in which a creature efficiently allocate its time and energy to perform a diverse range of tasks with the intention to maximise the overall return from these actions (Lewontin, 1978). The optimality principle is deeply rooted in the mechanics of evolutionary development, as creatures whom more efficiently allocate resources to ensure the organism biological goals would thrive over competitors. A well-adapted creature would therefore through evolution, learning and intelligence, strive towards a condition that provided the superior allocation of its available internal- and external resources to assure its biological goals, in other words; the motivational drives of the human psychology (Lewontin, 1978;Maslow, 1943). As all adaptive behaviours accrue in the physical world; the efficiency of these actions must, therefore, be affected by the context in which these actions occur. Environmental properties, therefore, cause potential alteration of yield from actions, thus effecting behavioural strategies applied by its occupant to fulfil the biological premise of the optimality principle; accruing the highest return from available resources through ideal allocation. The environments influence upon the possible return of resources constructs the superoptimality principle; a creature, whom already allocate its time and resources optimally among its various tasks, is left with a single possible solution to increase the return of its action; changing the environment in which these actions are taking place. As suggested by David Kirsh (2000); a well-adapted creature therefore only have three possible

options in improving its current condition; adapt to the environment; migrate to new surroundings or adapt the environment itself. The correlation between environment and return illustrates a correlation between human behaviour (mental state) and architecture, therefore also a correlation between architecture and preference, as environments supporting the efficiency in the achievement of biological goals, would be as preferable within the premise of the optimality principle. This notion follows that of the 'by-product' hypothesis in which preference valance is thought to be the result of an evaluation of sensory information in correlation with the motivation governing facilitation of adaptive behaviour (Hekkert, 2006). Following the theory of Abraham Maslow (1943); motivation can be divided into five hierarchically ordered categories, respectively; physiological needs, safety needs, belongingness and love needs; esteem needs and self-actualization. The structure of the hierarchy reflects their ordered value; where preliminary concerns are required satisfaction partly, before needs of higher-order emerges, e.g., the need for safety is required to be addressed prior considerations upon romantic involvement emerges. The environments affordance of fulfilling these needs must, therefore, be correlated with preference in accordance with the superoptimality principle (David Kirsh, 2000) and the by-product hypothesis (Hekkert, 2006) . As proposed by Heidegger (1950;1955), safety is the essential property of an environment; reflection the similar importance of the need for safety in the hierarchy structure by Abraham Maslow (1943). The environment affordance of providing a sensation of safety must, therefore, be highly influential on the alteration of the occupant's neurochemical composition and in correlation with the theory of Abraham Maslow (1943) and enable the individual to pursuit needs of higher-order. The hierarchy of motivation as proposed by Abraham Maslow (1943) might, therefore, also be an indication of the value assigned to variables of architecture, and construct a similar hierarchical structure. This notion also highlights an interesting consideration regarding preference for architecture; where hierarchical progression towards needs of higher-order might be reflected in the preference of environments: If environmental features can be correlated with the fulfilment of physiological needs and safety, a shift in motivation will occur, resulting in an alteration in requirement for the environment to be continuously regarded as preferable. This postulation indicates a motivational progression in architectural preference, and underlines the importance of fulfilment of the basic needs, before architectural interventions designed to address the needs of higher order, such as self-actualization, is beneficial as preference resulting from by these design decisions might not result in mental modulation in the occupants as a the design failed to fulfill preliminary motivational goals.

Returning to the 'by-product' hypothesis; valence for the environment is a result of information evaluation (Hekkert, 2006), this notion requires the sensory information to be evaluated in correlation with the occupants pre-existing understanding of the world, in order to evaluate if the ambient environment is supporting the fulfilment of occupants biological goals. The schemas applied for evaluation of sensory information can be derived by multiple accounts; either hardwired evolutionary programming of mental- and bodily functions; or subjectively constructed, as a result of social-, moral- and cultural- programming - the result of the individual exploration of the unknown (Peterson, 1999). The adaptive response will presumably be facilitated by a combined interpretation conducted with the inclusion of multiple schemas, of various

origination and associated somatic- and biological value. The same environmental setting could, therefore, be subject of variation in preference valence based on the environments features correlation with the beholder's personal- motivation and schemes applied to interpret the somatic- and corresponding biological value of the environment spatial; facilitating a corresponding adaptive response. The degree of variation will be influenced by the magnitude of the biological- and somatic value associated with environments individual properties and the degree of involvement of subjective schemas and the variation between subjective schemas, applied for interpretation. Redrawing parallels to Heidegger (1950;1955) notions on safety as an essential quality of environments; the concern for safety is a primal need, therefore, a motivation associated with the primal state and early development of the human mind a reflection of the motivation composition and cognitive functions of other animals, of whom motivational needs of higher order are non-exisiting. The schemas evolutionary developed to interpret environments affordance of safety, might, therefore, be less subject of variation, as these schemas might be hardwired neurologically through evolution; therefore universal in the human species, and another organism alike. Needs of higher order and corresponding applied schemas for interpretation might be more subjectiv to variation than the concern for safety, as higher tier needs are less represented, if even present, in other species, therefore, less likely to hardwired as a result of evolutionary development, but based on subjective intelligence and desire to construct meaningful knowledge of the world, applicable for conduction of efficient adaptive behaviour – autobiographical knowledge (Maslow, 1943; Peterson, 1999). The interpretation of spatial information accrues both consciously and unconsciously, responses based on information from the given environment; how easily this information is interpreted by the mind is cognitive congeniality – how efficient a cognitive task can be conducted (Kirsh, 2000). The communicational efficiency of the environments information is both related to the properties of the environment and the internal function of the human brain; how well sensory information is translated into adaptive behaviour and how well the information present in the environment correspond with the individual's preexisting knowledge and neurological function. If the mind fails to construct precise and correct decision, based on memory, the organism would be put into potential harm. Difficulty in the facilitation of proper contextual response could, therefore, be negatively associated with preference, in correlation with superoptimality principle (Kirsh, 2000), as the agents would have difficulty in achieving the highest possible yield, due inefficient information interpretation.

The project will assume the notion that preference for enviorments/architecture is the result of an alteration of mental state,facilating corresponding adaptive behavaiour in correlation with the superoptimality principle. The alteration of mental state will be a result of the beholds motivation and schemas applied for interpretation of the enviorment. This preeliminary assumption highlights essential paths of inquiry for achieving the desired goal: Extracting design guidelines for refugee accomendation and improvement of the contemporay understanding of the correlation between architecture and the human mind.

As indicated by the theoretical framework, the enviroments influence upon the occupants mental state is the result of the shcemas applied and its corresponding efficency for

interpretation and beholds underpinning motivational needs. This postulation indicates the requirment to construct inquiry upon the neurological fondation of the arcitectural experience, to address the involvment of schemas and construct an indication of the biological value assigned to individual features of enviroments. Secondly, comparrision of the neurological involvement in the neurological modulation by environment variables and the potential neurological abnormalities in the refugee population highlights potential difficulties in interpretation of spatial information, thus rendering the architectural experience undesirable due to negative emotional modulation. Furthermore, schemas presumably involvement in the architectural experience also indicates the requirement to construct inquiry on the psychological alteration in the refugee population, in order to establish a common determinator for the user groups interpretation of spatial information. The construction of user-orientated inquiry is essential, and allows the constructs of hypotheses of how refugees might divert from healthy controls, of whom is the primary test subject in studies on interaction between architecture and the human mental state. Furthermore, the theoretical framework will be applied to contextualise the projects included empirical findings, hereby also challenge the integrity of this preliminary framework.

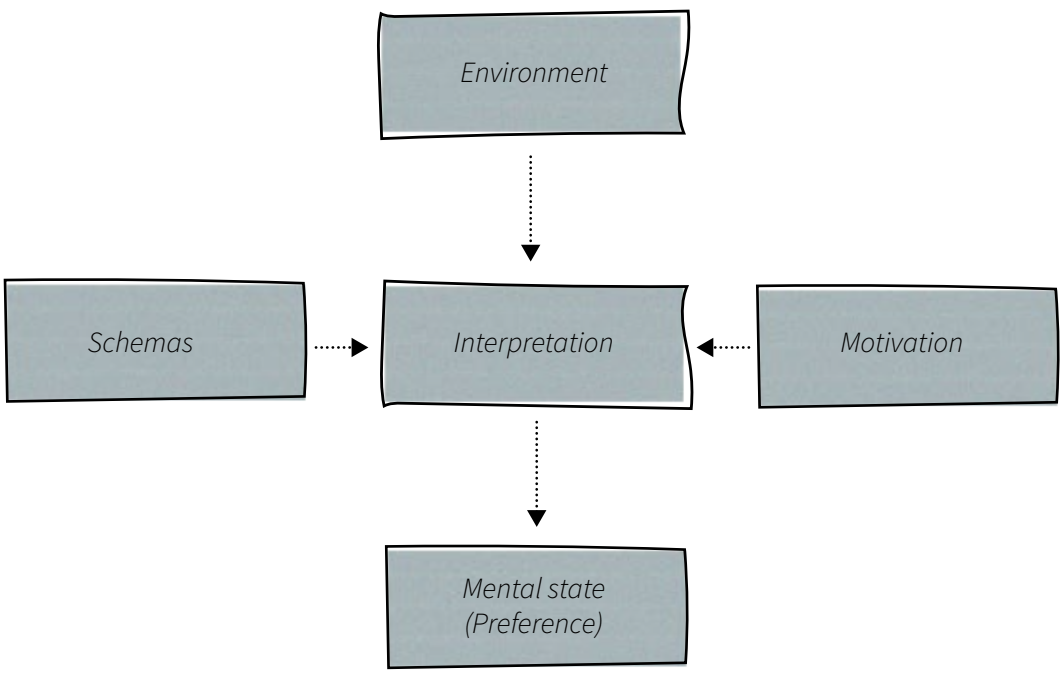


Fig: 2 - Theoretical framework

Mental health and well-being of refugees

Mental- and/or neurological disorders affect the individual's outlook upon life; altering their attitude; what excites them and what makes them grief – it alters the schemas applied for conscious- and unconscious actions . The prevalence of mental- and/or neurological abnormalities within the refugee population, therefore, constructs an unfortunately collective determinator. The prevalence of psychological- and/or neurological disorders among refugees will, therefore, be explored in the following chapter; to illustrate its severity and potentially highlight a collective determinator for the user group, hence indicating a widespread neurological-/psychological abnormality which might affect the user group neurological response from architecture, in comparison with the ordinary individual.

The vast majority of the immigrants coming into the European nation are individuals who fleed from war- and conflict-torn countries with the desire to seek protection and improve their life; exposure and emotional damage which significantly surpasses the ordinary human, thus likely to result in psychological damage. Traditionally mental impairment derived from war- and conflict exposure has been examined through the direct correlation between trauma exposure and resulting mental health. As argued by Miller and Rasmussen (2010); the complexity of the mental aftermath, in the refugee population, surpasses this traditional approach. Expansion of the traditional trauma-focused doctrine is, therefore, necessary. The diversity of factors affecting refugees mental health and resulting well-being is vastly complex, and an overemphasis on the impact of the direct trauma exposure might, therefore, not comprehend the full account of mental alterations. Miller and Rasmussen (2010) suggest supplementing the original assessment frame with a psychosocial approach; where the impact of daily stressors (direct or indirect to the trauma), is included to account for the resulting mental well-being of a refugee. The following inquiry is, therefore, restricted to account for the mental health of refugees resettled Western societies, thus, assuring the prevalence of mental health disorder corresponds to the population group in question, thereby accounting for all psychosocial variables. An exciting notion can be derived from the psychosocial approach, where the reduction of daily stressors, might positively affect the mental health and well-being, thus granting support for architectural interventions effect on health and well-being. This chapter, therefore, includes findings from three large meta-analyses, all assessing the mental health of refugees resettled in primarily western societies (Fazel, Wheeler and Danesh, 2005b; Chey et al., 2009; Alemi et al., 2014).

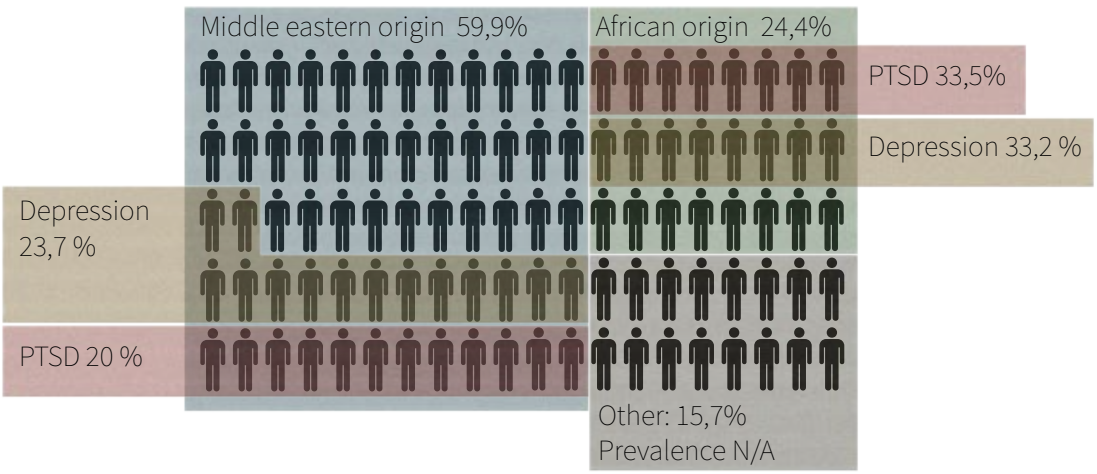
Chey et al., (2009) conducted the largest of the three studies, including a total of 161 articles surveying mental disorders within the refugee population. The articles included refugees originating from various conflicts and countries across the globe, all resettled in western societies; European- and North America countries. The majority of the included studies assessed rates of depression and PTSD and reported that these mental disorders were the most frequent, within the population group of question. 145 of the included studies reported a combined averagely weighted prevalence of PTSD at 30,6%. The included studies conducted by diagnostic interviews reported a lower

average prevalence rate of 24,6% and the self-reported surveys an average of 34,6%. Besides variance due to methodology, the degree of trauma exposure accounted for 10,8% of the variance in PTSD prevalence, exposure to political terror displayed similar variance in post-traumatic stress disorder prevalence. The time duration between conflict ceased, and the survey also influenced PTSD prevalence rates; PTSD prevalence rates after the conflict has ceased for less than a year, reported to be of 39,9%. Refugees from areas were conflicts had been ceased between 2-3 years ago reported a prevalence of 22,1%. Above six years between the end of the conflict and the survey; reported a prevalence rate of 22,3%. Comparing country of origin with PTSD prevalence rates showed the African refugees have the highest rate of PTSD (33,5%), compared with other regions such as; Kosovo/Yugoslavia 31,6%; Cambodia 30,3%; Bosnia/Yugoslavia 28,3%; the middle east 20%; Vietnam 10%. The Chey et al., (2009) study reported that gender, resettlement country and resident status was not associated with variation in PTSD prevalence. Similar results and parameters of variance were reported, in regards to the prevalence of depression; 117 studies were included, resulting in an average weighted prevalence of depression at 30,8%. Refugees exposed to torture also reported a higher prevalence of depression, and the time extent between conflict ceased, and the survey also negatively influenced the prevalence of depression. Depression rates were reduced to 19,2% after six years of ceased conflict, compared with 34,7% when the war has ceased for less than a year. Country of origin showed similar results as in regards to post-traumatic stress disorder. African natives had the highest prevalence of depression (33,2%) compared to other regions such as; Cambodia 31,4%; the middle east 23,7%; Kosovo/Yugoslavia 22,7%; Bosnia/Yugoslavia 22,0%; Vietnam 15,7%.

The second included meta-analysis is conducted by Fazel, Wheeler and Danesh (2005), reported a PTSD prevalence rate of 9%, this average was calculated based on 20 articles surveying a total for 6743 refugees resettled in seven different nations; Australia, Canda, Italy, New Zealand, Norway, The United Kingdom and The United States of America. The study conducted by Fazel, Wheeler and Danesh (2005) also included the prevalence rate for depression (5%), other psychotic illnesses (2%) and general anxiety disorder (4%), these prevalence rates are derived by numerous lines of inquiry; fourteen studies on depression, two studies on psychotic illness, and five studies on general anxiety. Comparing the findings from the study of Chey et al., (2009) and Fazel, Wheeler and Danesh (2005) a significant variation in reported prevalence of post-traumatic stress disorder and depression prevalence is displayed; 30,6% versus 9% prevalence for post-traumatic stress disorder and 30,8% versus 5% prevalence rate for depression. It is critically to note that 83% of the refugees assessed by the studies included in Fazel, Wheeler and Danesh (2005) meta-analysis originated from countries in Asia (Vietnam, Laos, Kampuchea, China and Cambodia). Comparing Fazel, Wheeler and Danesh (2005) findings with the results displayed by Chey et al., (2009) then this difference might be explained by the difference in the refugee's origin. Vietnamese refugees generally displayed a lower prevalence of both PTSD and depression, compared to other ethnicities. To account for the

differences in findings, the parameters affecting prevalence rate, highlighted by Chey et al., (2009) (time duration, amount of exposure to war and political conflict), could be used to reason the difference, or potentially highlights demands for further literature, investigating potential cultural, biological and genetic variables affecting prevalence of post-traumatic stress disorder and depression. This line of inquiry is out of the scope of this project. It should also be noted that the difference in sample size between the two studies would affect how generally their claims are. The study performed by Chey et al., (2009) included a total of 161 studies surveying a total of 81886 refugees, originating from forty different countries, hence different conflicts, in contrast, Fazel, Wheeler and Danesh (2005) study only contained 6743 refugees; primarily originated from the countries of Asia. In the study of Chey et al., (2009) no variation was displayed as a result of the place of resettlement, and the most influential factors were the degree of exposure to a traumatic experience, the experience of political violence and the time duration between survey. These factors were not accounted for in the studies of Fazel, Wheeler and Danesh (2005) and it could, therefore, be noted that their reported average weighted prevalence rates might not correspond with the refugees currently resettled in the European Union or that of future individuals seeking asylum within the European Union.

In the years of 2016 – 2017 59,9% of the asylum seekers in the European Union had a middle eastern background, mainly originating from Syria, Afghanistan and Iraq which, respectively, accounted for; 27%, 14% and 11% of the asylum seekers in the European nations. 24,4% of the Asylum seekers were from Africa, primarily from Nigeria and Eritrea, accounting, respectively, for; 5% and 4% of the asylum seekers within the European Union. Only 5,8% of the asylum seekers originated from Asia. Primarily from Bangladesh (34%) (Statistical Office of the European Communities, 2018). The findings from Chey et al., (2009), therefore, appear to correspond superior with the current refugee crisis in the European nation; in regards to ethnicity and post-immigration experiences, compared with Fazel, Wheeler and Danesh (2005). It should, therefore, be reasonably safe to assume the PTSD prevalence in European refugees is between 20% and 25% when accounting for the fact that the highest prevalence of PTSD was found in refugees with an African heritage, and most of the conflicts are still ongoing. A similar conclusion should be made regarding the prevalence rate of depression, resulting in an estimate of approximately 28% prevalence rate. In the Western European region, the average post-traumatic stress disorder prevalence is 2,3% (Koenen et al., 2017) and an average prevalence rate for depression is 3,77% (WHO, 2017). Refugees are, therefore, approximately eight to ten times more likely to be affected by post-traumatic stress disorder and/or depression. As previously advocated by Miller and Rasmussen (2010); trauma exposure might not account fully for the mental challenges the refugee population is facing; daily stressors, either stressor indirectly caused by the conflicts and stress as a result of the resettlement process and corresponding acculturation. The third, unmentioned, meta-analysis conducted by Alemi et al., (2014) investigated levels of distress and subjective experiences from Afghan refugees resettling in industrialised countries. Their findings included both



(Chet et al., 2009;Statistical Office of the European Communities, 2018)

Fig: 3- Nation of origin and prevalence of depression and PTSD

stressors as an indirect result of war such as; recurring nightmares (Lipton, 1991), survivors guilt, the avoidance of hearing news from home country (Lipson, 1993; Lipson, Juliene G., Omidian, 1997). High-levels of frustration, hopelessness and despair was also reported (Omeri, Lennings and Raymond, 2006). Coping mechanisms such as keeping busy, thus avoiding to 'thinking too much' have been highlighted as a general coping mechanism, within the refugee community, to distance oneself from rekindling traumatic memories/ thoughts (Feldmann, Bensing and de Ruijter, 2007; Sulaiman-Hill and Thompson, 2012). The recalling of past-memories deterring effect on mental well-being is still prevailing in refugee after long-term resettlement and associated with an increased sensation of loneliness and isolation (Feldmann, Bensing and de Ruijter, 2007).

As illustrated by the examined literature; depression and post-traumatic stress disorder (PTSD) is two widespread psychological- and/or neurological disorders within the current refugee population seeking asylum within the European nations. Prevalence rates of these disorders were indicated to affect between a quarter and a fifth of the population group, thus significantly exceeding the European nation average prevalence rates of these disorders, therefore indicating that both disorders are applicable lines of inquiry for user-focused healthcare architecture.

Post-traumatic stress disorder

Post-traumatic stress disorder is an anxiety disorder rooted in the disconnection between sensory- and contextual information, resulting in increased watchfulness for potential danger (APA, 2013). As proposed by Heidegger (1950;1955), safety is the essential property of the environment. Post-traumatic stress disorder is, therefore, a fascinating psychological/neurological disorder to use for the establishment of further inquiry in the correlation between the human emotional system and architecture, as an increased fear response combined with a deficit in context-dependent memory might highlight a possible correlation between architecture and post-traumatic stress disorder. This following chapter purpose is of constructing inquiry of post-traumatic stress disorder neurological-and psychological abnormalities. This inquiry will improve the understanding of the user group and might also provide fruitful knowledge upon general functions of the brain, which might be correlated with the neurological underpinning of the experience of architecture.

As defined by the DSM-V (American Psychiatric Association, 2013) Post-traumatic stress disorder (PTSD) results from; "a history of exposure to a traumatic event […] that meets specific stipulations and symptoms from each of four symptom clusters; intrusion, avoidance, negative alterations in cognition and mood, and alterations in arousal and reactivity" (APA, 2013). The National health service (2018) have divided symptoms of PTSD into three summarising categories:

i) Re-experiencing of traumatic nature inform of flashbacks, nightmares or repetitive occurrence of distressing images or physical sensations such as; pain, sweating or trembling.

ii) Avoidance and emotional numbing, actively avoiding potentials reminders of the trauma (e.g., places, people and items) and becoming inactive due to reduced desire to interact with people and activities which that individual regularly enjoyed. The individual's attempts of dealing with their emotions by avoiding to fell anything.

iii) Hyperarousal, a constant vigilance of potential threats and easily being startled, irritability, anger outburst and problems with sleep and concentration.

As illustrated by the National Health service, the symptoms of post-traumatic stress disorder comprise both psychological- and physiological changes, due to exposure to traumatic episodes. Further inquiry of the psychological- and neurological changes responsible for the PTSD symptoms will be made, in order, to search for possible focal areas for architectural interventions which might be able to support the treatment of PTSD and cultivate mental health and well-being for the patients. As proposed by various authors (e.g., Esearch and Lanius, 2006; Lanius et al., 2011), PTSD patients can be divided into two subtypes; dissociative and non-dissociative (van der Kolk et al., 1996; Waelde, Silvern and Fairbank, 2005). Dissociation consists of disruptions and fragmentation of the integrated functions of consciousness;

memory, autobiography, identity, body awareness, the perception of self and the ambient environment (American Psychiatric Association, 2013). One commonly accepted heuristic approach to understanding how these mental alterations occur, resolving in dissociation, is due to the complexity and vastness of the emotional reaction from the traumatic experience, resulting in issues with insufficient memory encoding and retrieval, resulting in uncontextualised memory; fragmented in its understanding and proper future application (Speigel and Cardena, 1991). The dissociation subtype is often observed in individuals post-exposure to chronic psychological trauma, but have also been linked to traumatic events, such as individuals who experience threats to their live shows alteration in their perception of time, attentional focus, awareness of pain and their surroundings (Birmes et al., 2001; Morgan et al., 2001), similar experiences have also linked to depersonalizations (Loewenstein, 1997). These alterations in the individual's definition of self and perception are referred to as peritraumatic dissociation. Cognitive fragmentation of the memories associated with the traumatic episode, can result in emotional detachment from the episode and restrict proper effective processing of perceived information; external and internal, following the episode (Speigel and Cardena, 1991; Marmar et al., 1999). The first hypothesise, regarding two subtypes of post-traumatic stress disorder were proposed by Bremner (1999) he suggested that PTSD is facilitated by two different reactions either; dissociative or consisting of intrusive and hyperarousal symptoms. Studies using neuroimaging has revealed support for these two different neurological reactions patterns in PTSD patients when exposed to trauma reminders (Esearch and Lanius, 2006; Frewen and Lanius, 2006; Hopper et al., 2007). These patterns are not entirely distinct, individuals who have PTSD can simultaneously display both response patterns, to a traumatic stressor, or either alternate between response patterns over a duration of time (Lanius et al., 2011). One of the previously cited studies used a traumatic script of the patient's own episode(s) and measured resulting neurological activity. In the study, the test subjects were asked to read and cognitively re-experience their personal traumatic episode while the researchers perform an fMRI scan of the test-subjects brain activity and monitor their heart rates. The findings study showed that 70% of the patients experienced elevated heart rates during recallment of the traumatic incident. The remaining 30% showed no elevation of heart rate during the same task. The difference in stress response was linked to these two sub-types of post-traumatic stress disorder - dissociative and non-dissociative. Individuals not eliciting elevated levels of stress (heart rate) were associated with the dissociative PTSD subtype - emotional detachment from the episode. The distinction between the two different subtypes was further explained with the findings of the fMRI scannings; revealing differences in brain activity in the two groups. Distinct differences in activation patterns were found in the medial prefrontal cortex, the anterior cingulate cortex and the limbic system (Esearch and Lanius, 2006). Patients with PTSD associated with the symptoms of re-experiencing and hyperarousal (non-dissociative subtype) displayed abnormally low activation in the medial anterior brain areas (ventromedial prefrontal cortex and the rostral anterior cingulate cortex); areas associated with modulation of arousal and regulation of emotions (Esearch and Lanius, 2006; Etkin and Wager, 2007). The reduced activity in the cortical areas corresponded with increased activation in the limbic system, and especially the amygdala (Esearch and Lanius, 2006). Reexperingcing

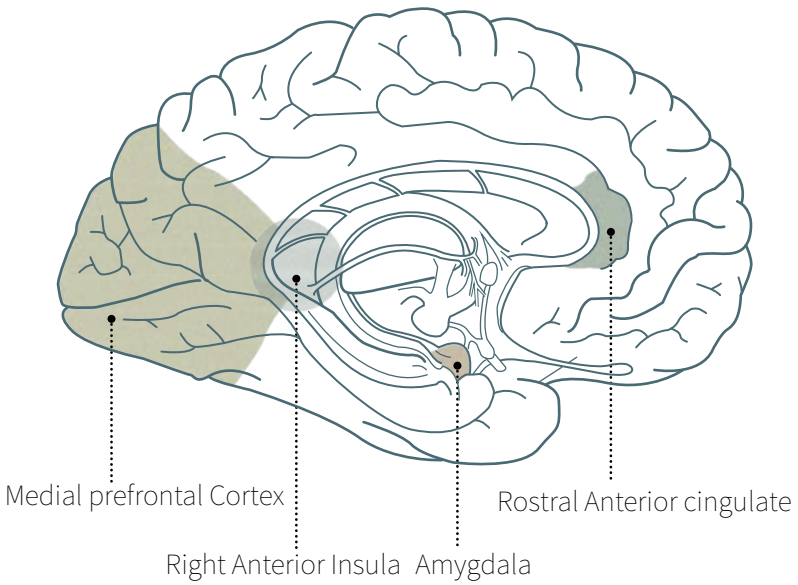


Fig: 4 - Regions affected by subtypes of PTSD

and hyperarousal symptoms of Post-traumatic stress disorder can, thus, be seen as a deficit in emotional modulation, due to a failure of prefrontal areas to inhibit the limbic regions (Lanius et al., 2011). The inverse relationship in neural activation was displayed in the PTSD subtype associated with dissociative symptoms (disengagement from content with emotional value, and depersonalization), they exhibited abnormally high activation in the medial anterior cingulate cortex and the medial prefrontal cortex. The dissociative symptoms in PTSD can be conceptualized as emotional overmodulation during exposure to trauma, does rendering a depersonalization and derealization responses from the limbic regions due to inhibition from the midline prefrontal areas (Lanius et al., 2011). These subtypes of PTSD correspond with the stress response syndromes proposed by Horowitz (1986a); he suggested that responses to events with high stress respond, resolves in two different states; intrusive state consisting of intrusive emotional response and compulsive actions, or a state of denial a state corresponding with the dissociative PTSD subtype, were the individual experience emotional numbing and depersonalization.

The intrusions of traumatic reminders , as present in the re-experiencing symptom, is thought to be an instance of involuntary memory retrieval, the contrary of a cognitive effort of search, despite appearing as consciousness images (Bertsen, 2007; Mace, 2007). Experimental research has indicated these visual intrusions tends to be repetitive, uncontrollable and elicit a strong distressing emotional response (Holmes and Mathews, 2005). As defined by Hackmann et al., (2004) these instructions of imagery are "content of consciousness that posses

sensory qualities", which contain various sensory qualities; visual, auditory, olfactory, gustatory and movement (Kosslyn, 1994), and they can be described by the patients in term of content, clarity, colour, shading, shapes, movement, foreground, background, configuration and other spatial description (Horowitz, 1970). The re-experiencing can both be a reconstruction of real events and/or a hypothetical situation (Martin and Williams, 1990). These traumatic events are not just reimagined but experienced as occurring in the present (Ehlers and Clark, 2000; Brewin, 2003). The distortion in the perception of time and place, due to involuntary recallment of tramatic can vary based on the severity of post-traumatic stress disorder, and be elicted by minor association from sensory inputs from the ambient environment and result in episodes where the individual loses all relation to the present, autobiographical self and current surroundings (Brewin, 2007). A study performed by Hackmann et al., (2004) described these intrusions to consist of one to four highly traumatic incidents being repeated. A study conducted by Holmes, Grey and Young (2005) found that 77% of the intrusions were a reimagining of the 'hot spot' of the traumatic experience. 42% of PTSD patients in the study of Reynolds and Brewin (1999) reported that at least one of the patient's instructions were an 'out-of-body' experience, were the relived the trauma as experienced in a third-person perspective. Similar findings were reported by McIsaac and Eich (2004), who found that 36% of their sample size had similar intrusions experienced in the third-person perspective. This external perspective re-imaging has been argued to correspond with a biologically hard-wired freezing response (Nijenhuis, Vanderlinden and Spinhoven, 1998) as a defence mechanism in order to reduce the emotional and physiological effect from a traumatic experience (van der Kolk, van der Hart and Marmar, 1996). Intrusive memories incorporate two areas of cognitive psychology; involuntary memory and autobiographical memory (Brewin et al., 2010). Generally, involuntary memory retrieval is described as a process of association, in which contextual cues trigger retrieval, especially negative associated cues have increased potential triggering intrusions (Schlagman and Kvavilashvili, 2008), and as described previously; influence the emotional state and a resulting in a corresponding bodily reaction (Berntsen, 2007). Moscovitch (1995) postulated that the involuntary association is a normal neurological function of the hippocampus and the medial temporal cortex. In combination; reinstating the mental state corresponding with the associated episode; by activating the neural networked associated with the initial perception of the traumatic episode. The ability to reinstate neurological states is autobiographical memory. Autobiographical memory refers to the subset of information relating to the individuals understanding of self and corresponding personal history resulting in this self-understanding (Baddeley, 2001). The imaged based intrusions of the traumatic episodes are believed to support functions resulting in recollective experience (Brown and Kulik, 1977); when an emotional narrative, in the present tense, is experienced corresponding emotional respond is produced (Pillemer and White, 1989; Pillemer, 1998). The Dual representation Theory, formulated initially by Tim Dalgleish (2004) and later revised by Brewin and colleagues (2010) revised to include a neurological model of intrusive memories, helps to understand how individuals encode traumatic episodes, and why these potential deficits in the memory process result in reexperiencing.

In the preliminary theory presented by Dalgelish (2004) are traumatic episodes represented in two parallel memory systems; the situationally accessible memory (SAM) and the verbally accessible memory (VAM).The SAM system contains detailed sensory- and perceptual information, which only can be retrieved involuntary. The SAM systems are believed only to support the neurological functions regulating perception and not involved in cognitive control, due to the lack of neurological system responsible for cognitive control, such as the hippocampus. The sensory information, is gathered by the perceptual brain structures, thus uncontextualised and will be perceived with a 'now-ness' at involuntary retrieval (flashbacks). The contrary and supporting system; the VAM system contains conscious experiences that can be retrieved automatically or deliberately (the autobiographical memory). Verbally accessible memory is regulated by cognitive controlling neurological structures, such as the hippocampus and prefrontal areas of the brain. This system allows proper communication, reappraisal and proper alteration of life goals due to involvement of limbic regions, allowing the flexibility to access and control information that is appropriate for the current situation. Abnormal function of these systems is believed to play an essential role in the memory deficits and correspond with the symptoms of post-traumatic stress disorder (Brewin et al., 2010). Indicated by the study of van der Kolk and Fisler (1995), who displayed that trauma victims initially struggle to formulate their experience into words, due to deficits in verbally accessible memory system, thus lacking sufficient memory retrieval to account for information gathered by the SAM system. Proper social support and the passing of time, is thought to assist the contextualisation of situationally accessible memory, thus making the information verbally accessible (VAM). A similar conclusions are made by Conway (2009) who proposed that the characteristics of post-traumatic stress disorder, by intrusions of traumatic episodes into consciousness mind, is due to the lack of a sufficient frame to understand the traumatic episode, does rendering the information without a proper conceptual- and contextualised framework.

A theory, suggested by Barsalou (2003) proposed that a primary function of the memory systems is to run simulations, that interprets sensory and emotional information to equip individuals to construct a broader understanding of the perceived sensory information, thus, facilitating the ability to construct of interpretations of sensory information applicable for improvement of behavioural actions in future scenarios. As suggested by Brewin et al., (2010) if the reconsolidation of reactivated memory is disrupted, then the newly learned associations would be lost – non-contextualized and unapplicable for future encounters. The construction of new positive or null associations (VAM) of negatively associated situationally accessible memory, through simulation, would require a stable and stress-free environment (Brewin et al., 2010). Barsalou, Byrne, Becker and Burgess (2007) proposed a model on spatial memory; their suggested model proposes two types of spatial memory; egocentric (view-point dependent) and allocentric (view-point independent). The division of memory into egocentric and allocentric, has been adopted by Brewin et al., (2010) and incorporated into the Dual representation theory (Dalgleish, 2004). Brewin et al., (2010) propose that the egocentric representation corresponds with the SAM system, where information, derived from either

perception or imagery (e.g. flashbacks), is presented in the brain in a less flexible form and correlated with associated cues. In contrast, the more flexible allocentric spatial understanding (VAM) is independent of viewpoint, thus more flexible, allowing the facilitation of cognitive controlled adaptive behaviour. Interestingly, in accordance with the findings of Brewin (1999) and McIsaac and Eich (2004) a substantial portion of the intrusive imagery is viewed in a third person; spatial memory associated with allocentric spatial memory, and thus not memories purely associated with egocentric spatial memory. Suggesting, that allocentric spatial representation is also associated with involuntary retrieval. In correspondence with Barsalou (2003), Brewin et al., (2010) suggest a combined memory model where the combination of egocentric SAM's, and allocentric VAM's allows the brain to make a simulation to predict outcomes of unknown situations, based on prior knowledge. The VAM/allocentric memory systems allow declarative representation within the individuals autobiographical context and allow deliberated retrieval and manipulations to address new and confronting challenges and allow cognitive supporting functions such as; planning; narration and communication. Contrary, the SAM systems contain low-level memory representation, tightly bound to their emotional and sensory qualities. Exposure to violence, torture and other traumatic experiences associate the perceptual/sensory information with a negative emotional response - stress. At extreme cases of stress, the responsible neurological functions fail to construct VAM's to contextualise the sensory and corresponding emotional response. These uncontextualised association will thus be uncontrollable and can be trigged, involuntary, by environmental- and internal cues, without proper consolidation with the autobiographical and environmental context. Brewin et al., (2010) have suggested that re-experiencing (e.g., Flashback) of the traumatic episodes is an adaptive behaviour, were stored information in the SAM system is involuntarily represented consciously, thus being forcefully processed in greater depth by the conscious memory system (VAM), when the danger is gone. Application of the VAM system to account for the information contained in the SAM system, therefore, provides the sensory information a contextual frame, making the sensory information valuable and precise for adaptive behaviour. Post-traumatic stress disorder can, therefore, be viewed as mental alteration occurring as a result of failing to contextualise sensory information, as the VAM systems are deprived in function as a result of an extremely stressful situation (Nijenhuis, Vanderlinden and Spinhoven, 1998). The degree of involuntary retrieval of memories in third-person perspective might, therefore, be a reflection of increased contextualisation of the sensory information or an indication of the function of the memory system during the trauma exposure. The prevalence of post-traumatic stress disorder is, therefore, associated inhibition to associate the traumatic experience with proper context, due to an extreme emotional reaction.

The hippocampus is believed to conduct an essential role in this process and be the source of deficit that resulted in no initial contextualization of the sensory information associated with the traumatic episode. In 1937 James W. Papez published the influential hypothesis that the hippocampus plays an essential role in the neural circuit responsible for emotional processing. This hypothesis was later to be known as ''The Papez Circuit' (Andersen et

al., 2007). The relevance of this hypothesis became evident in the 1950s with a study performed by William Scoville and Brenda Milner in 1957 on brain-damaged patients (Scoville and Milner, 1957). One of their patients had severe epilepsy and underwent surgery to remove the hippocampus to treat the patient epilepsy. After the surgery, the patient was unable to construct new memories (Andersen et al., 2007). Besides hippocampus involvement in the construction of new memories, hippocampus function has also been associated with regulation of the fear response, such that a learned adaptive fear response is only facilitated within the physical context in which the response was initially experienced (Kim and Fanselow, 1992). Hippocampus involvement in memory-formation and contextualization of emotional and sensory information and thus correlated with facilitation of a context-appropriate adaptive behavioural response, make hippocampus abnormalities an essential aspect of post-traumatic stress disorder, and presumably also correlated with the emotional response generated by exposure to architecture/environments. Studies of structural brain abnormalities in PTSD have, therefore, focused on the hippocampus – a grey matter structure in the limbic system (Karl et al., 2006). As brought forward by Scoville and Milner's experiment; the hippocampus plays an essential role in explicit memory (O'Keefe and L Nadel, 1978; Squire, 1992), and memory of episodic events (Eldridge et al., 2000). Various studies have displayed evidence that high levels of stress have harmful effects on hippocampal functioning, while simultaneously enhancing the effect of the amygdala (Metcalfe and Jacobs, 1998; Elzinga and Bremner, 2002; Vyas et al., 2002; Payne et al., 2006). High stress responds in a situation results in SAM's associated with high somatic value (stress response) and improvised VAM's. Increased levels of arousal directly from the traumatic episode, does not account for the full development of PTSD, as noted by various authors; prolonged periods of stress following the traumatic experience, might increase the intensity of the PTSD symptoms (Andrews et al., 2007, 2009; Brewin et al., 2010), supporting the aforementioned claims of Miller and Rasmussen (2010) that PTSD severity is not purely correlated with the initial trauma exposure but a result of both direct and indirect stressors. Conditions such as chronic stress or depression might impair hippocampal function to provide contextualisation (VAM's) for the traumatic stimulant (SAM's). Low mood and alternated cognitive biases due to depression or chronic stress, further enhance the traumatic episode by enhancing the negative associations with the traumatic episode, thus creating a negative spiral, were the uncontextualised traumatic experience and the autobiographical memory is associated with stronger and more diverse negative emotions, resulting in a stronger negative mood associated with the initial SAM. One possible mechanism the hippocampus could exploit to differentiate the past, and current representation of the context and autobiography is through neurogenesis – creating new neurons (Aimone, Wiles and Gage, 2006); neurogenesis effect on the severity of post-traumatic stress disorder is currently just speculations (Brewin et al., 2010). Comparing these postulation on hippocampus abnormalities association with post-traumatic stress disorder with volumetric studies of Hippocampus, in correlation with PTSD, brings forward mixed results; some studies have displayed bilateral reduced hippocampal volumes in PTSD patients (e.g. Bremner et al., 1997, 2003); other studies did not (Magill et al.,

2010); some only in the left hemisphere (e.g. Gurvits et al., 1996) and some findings only revealed a reduction of the hippocampus in the right hemisphere (e.g. Bremner et al., 1995). A meta-analysis conducted by Karl and colleagues (2006) included twenty-seven studies (N=941). The meta-analysis found a significant reduction bilateral in hippocampal structural volume in PTSD patients, compared with healthy controls. Their study also reported a comparison between trauma-exposed patients with PTSD and trauma-exposed non-PTSD patients. A significant reduction was found in the hippocampal areas of the left hemisphere when comparing PTSD patients and trauma-exposed non-PTSD patients. Another meta-analysis conducted by Smith (2005) reported, across 13 studies of adults with PTSD (N=540), a combined average of 7,2% and 7,0% volumetric reduction of the hippocampus, respectively in the right- and left hemisphere, compared to healthy controls. Their study also reported that trauma-exposed, non-PTSD, patients had a reduction in right and left hippocampal volumes, respectively of 4,3% and 4,5% compared to healthy controls (Smith, 2005). The findings of the meta-analyses, despite lack of homogenity, indicates that post-traumatic stress disorders associated deficits in the memory systems are correlated with the reduced structural integrity of the responsible neurological structure – the hippocampus.

As indicated through the previous text, PTSD is arguably one of both memory consolidation and stress-related behaviour. (Bisby et al., 2010; Miller, 2016; Zhang, Li and Hu, 2016). Jacobson and Sapolsky (1991) found that the hippocampus plays an essential role in the regulation of the hypothalamic-pituitary-adrenocortical axis (HPA) – a regulator of the physical stress responds in mammals. Alteratered hippocampal regulation of the HPA, due to neurodegeneration, might shine some light on the hyperarousal symptom and the emotional numbing symptoms of PTSD. This inquiry might also describe how chronic stress influences the severity of post-traumatic stress disorder.

During exposer to a stressor, the paraventricular nucleus in the hypothalamus releases corticotrophin hormone (CRH), which stimulates the anterior pituitary, resulting in a release of adrenocorticotrophin (ACTH). The ACTH stimulates the anterior pituitary and releases glucocorticoids (primarily cortisol in humans) from the adrenal glands. Glucocorticoid intercepts with two different intracellular receptors; the mineralocorticoid- (MR) and glucocorticoid receptors (GR). The MR's function is related to the appraisal process and the acute reaction to a stressor, in contrast, the GR's promotes adaptation and assures recovery from the stress response (Mehta and Binder, 2012). The saturation of the mineralocorticoid- and glucocorticoid receptors are correlated with memory performance, suggesting that both receptors play a vital role in memory formation and cognitive functions and the concentration of cortisol at both receptors are essential as offsetting the balance will reduce the performance of declarative memory and cognitive functions of the hippocampus (Lupien et al., 2007). Animal studies have provided insight into how early stressors have lasting effects on the HPA-axis and corresponding cortisol receptors. Rats separated from their mothers showed decreased amounts of glucocorticoid receptors (GR) in the hippocampus, hypothalamus, and frontal cortex (Ladd, Owens and Nemeroff, 1996). Other animals findings have shown that stressed

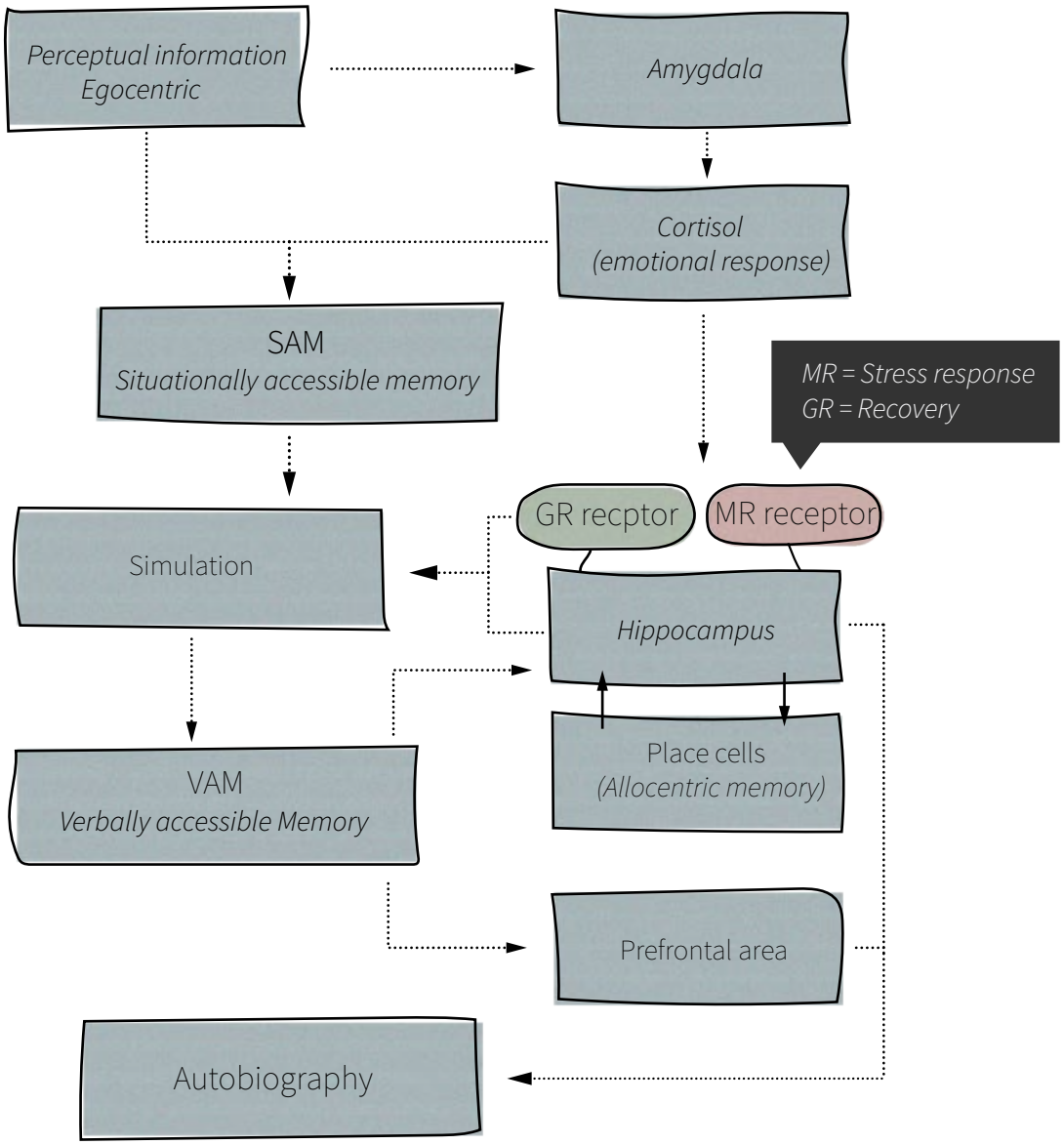


Fig: 5 - Construction of autobiographical understanding

The perceptual- and sensory systems construct situationally accessible memory tagged with somatic markers produced by the amygdala. The cortisol released by the HPA-axis modulates the functions of the hippocampus through GR- and MR-receptors; MR associated with acute stress response and GR-receptors ensures recovery from the stress response. The place cells of the hippocampus form allocentric memory (see chapter xx.xx) and applicable for the simulatation of the SAM's to ensure contextulisation and constructing verbally accessible memory, ensuring the construction of correct autobiography and knowledge to prepare for future encounters. During extreme and chronic stress the MR receptors overwhelm the hippocampus, and sufficient reaction from the GR-receptors is not provided to ensure allocentric memory and learning (simulation) from the combination from ego-centric- and allocentric memory. Persumably resulting in neurodegenration of the hippocampus.

animals had reduced ability to terminate the glucocorticoid response to stress, in other words; failing in providing the negative feedback mechanism for the hypothalamic-pituitary-adrenal axis, therefore, resulting in increased stress responds due to reduced cortisol sensitivity in the hippocampus (Sapolsky, Krey and Mcewen, 1983; Sapolsky, Krey and McEwen, 1984; Makino, Schulkin and Smith, 1995). These observations in animal studies suggest that prolonged and high levels of stress is having the potential to influence the function of the HPA-axis, promoting HPA-axis reactivity and negatively affecting memory performance. A meta-analysis conducted by Klaassens et al., (2012) reported no significant alterations in basal cortisol levels, in healthy controls compared to trauma-exposed (no psychopathology). A similar conclusion was made when comparing trauma-exposed (no psychopathology) to PTSD patients with adulthood developed trauma. These conclusions were drawn from 37 studies (N=2468) measuring cortisol in saliva, plasma and urine, concluding that no alteration in the baseline cortisol levels due to PTSD stress disorder could be illustrated. These studies as mentioned earlier compared the cortisol levels that regulated normal function (circadian rhythm) but did not include studies concerning HPA-axis abnormalities when PTSD patients exposed to stressors. Post-traumatic stress disorder correlation with unprocessed traumatic episodes is at this point well established, and as observed by Elzinga et al., (2003) PTSD patients experience a high elevation of cortisol when exposed to traumatic reminders (trauma script exposure) or during involuntary memory retrieval. Similar findings are found in the study of Gola et al., (2012), who reported increase salivary cortisol concentration in PTSD patients under interviews concerning their trauma experience. Bremner et al., (2003) found no PTSD related hyper-responsive reaction due to cognitive tasks; no altered cortisol reactivity nor abnormal increase of heart rate or blood pressure, compared with healthy controls. Using the Tier social stress test (TSST)-paradigm (Wichmann et al., 2017) reported hypo-responsiveness in PTSD patients, compared with healthy controls. These findings correlate with previous findings on hypo-responsive in studies using the TSST-paradigm (e.g., Simeon et al., 2007; Pierrehumbert et al., 2009; Zaba et al., 2015), and studies using the cold pressor task (e.g., Santa Ana et al., 2006). The studies using trauma-related stressors yielded elevated stress responds, and findings using 'neutral' stimuli did not display an elevation of the stress responds, compared to the healthy control group, These findings correlate with the notion that PTSD is psychiatric disorder consisting of deficits in memory association, were associations with trauma would provoke an elevated stress response, were neutral stressors will either result in a blunted stress responds, or neutral response. It is important to note that the stress response to a stressor might be altered due to comorbidity of psychiatric disorders, as highlighted in the meta-analysis by Fazel, Wheeler and Danesh, (2005), some studies have found above 40% of refugees diagnosed with post-traumatic stress disorder also were diagnosed with major depression. (e.g., Sach, Clarke and Him, 1993; Mghir et al., 1995; Favaro et al., 1999). Depression has been linked with hyper-reactivity to stressors (Wichmann et al., 2017). Activation of the HPA-axis, to a stressor, in PTSD-patients, could therefore either be blunted, neutral or potent, all depending on the nature of the stressor and if the patient is dealing with a combination of psychiatric disorders such as; depression, substance abuse and other anxiety disorders (Brady et al., 2000).

Threating post-traumatic stress disorder

Treatment methods for Post-traumatic stress disorder are comprised of cognitive-behavioural intervention, psychotherapy such as; psychoeducation, stress reduction, trauma cue and memory exposure and cognitive reconstruction. These treatment types are divided into two well-established psychotherapeutic approaches; exposure-based intervention and cognitive intervention (American Psychiatric Association, 2013).

Exposure-based interventions force the patient to re-experience memories associated with the trauma (i.e. objects, thoughts and places) in a safe environment. Through this approach, the fear associated emotional response is contextualised or re-contextualised in a safe environment. Successful treatment will result in extinguishing or reduce the fear response to the traumatic stimulus, through re-encoding of the 'fear-network' associated with the resulting emotional response (American Psychiatric Association, 2013). Studies, as mentioned earlier, displayed increased of activation of the HPA-axis (e.g. Elzinga et al., 2003; Gola et al., 2012), during trauma exposure. Therefore, is patient's levels of distress monitored through verbalisation of their subjective perception of discomfort during the session. The information regarding the patients perceived discomfort allows the psychologist to monitor progress and control the pace and intensity of the treatment, assuring that the patients are experiencing the margin of the acceptable and desired in-session level of anxiety (American Psychiatric Association, 2013).

Cognitive intervention therapy for post-traumatic stress disorder patients is based on the assumption that thoughts foreshadow mood and thus, negative thoughts and beliefs affect the individual's mental states. The information processing theory supports this assumption, in which individuals construct associative networks to organise and interpret information to improve the efficiency of adaptive behaviours. The schemata of thoughts allow efficient everyday usefulness to save time (acts as cognitive shortcuts). The same systems can lead to errors and false assumption if wrongful and not reflex according to the true nature of the world and the individual's current life. The therapy sessions purpose is to identify the negative and distorted beliefs that the patients are having and replacing them with positive thoughts to evoke a more balanced and healthy state of mind. In post-traumatic stress disorder, the negative thoughts are commonly comprised of; anger; shame; self-blame and survivors guilt. The cognitive intervention is comprised of multiple sessions, involving the reexperience and re-writing of their trauma script, accounting for their traumatic experience(s) and 'homework' where the patients are instructed to reflex upon their traumatic experience, current life state and their experience during the therapeutic session. The cognitive intervention approach also incorporates training the patient with anxiety management strategies, to allow them to cope with distress (American Psychiatric Association, 2013).

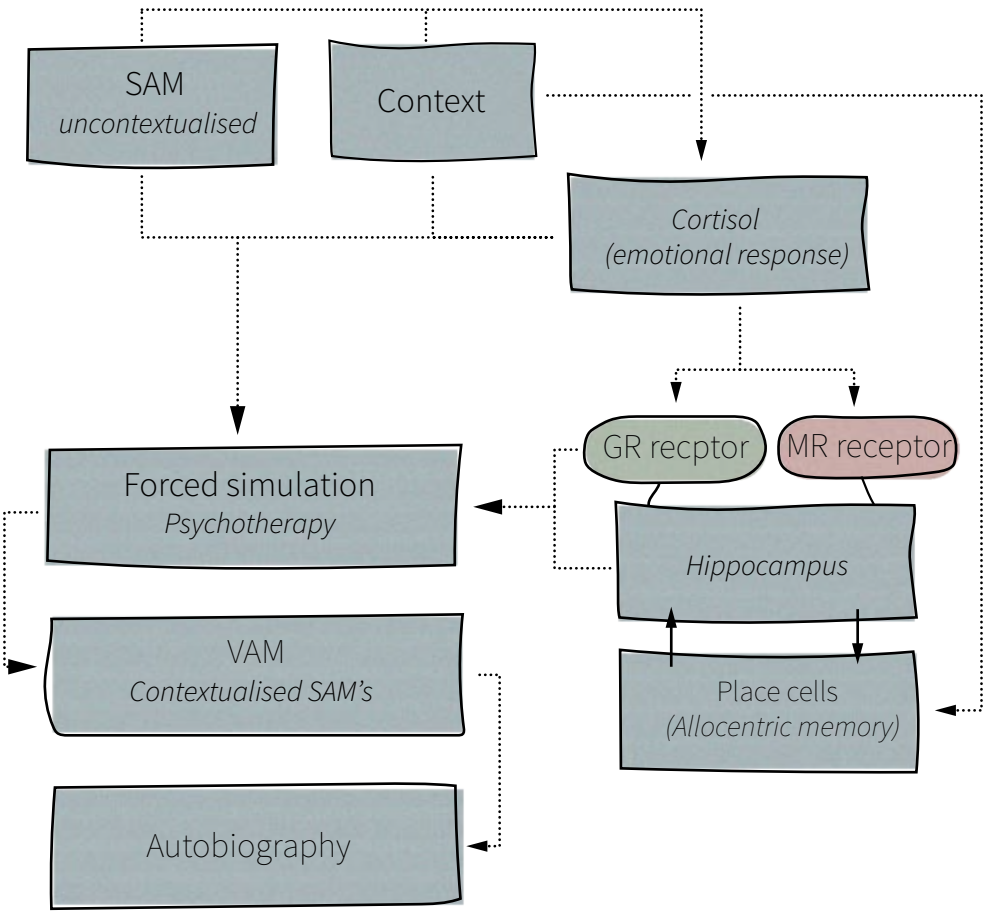


Fig: 6 - Psychotherapy - context, SAM & VAM

In correlation with the dual representation theory (Dalgleish, 2004; Brewin et al., 2010), the psychological- and neurological abnormalities of post-traumatic stress disorder occur as a result of failure to contextualise sensory information from the traumatic experience(s). The inhibition is indicated to be caused by cortisol oversaturation of the mineralocorticoid (MR) - receptor of the hippocampus, disrupting memory- and cognitive performance. Uncontextualised sensory information associated with the traumatic episode is subject of involuntary retrieval by environmental- and internal cues, resulting in a conscious re-experience of the sensory information and emotional response associated with the initial traumatic episode. The conscious intrusions of sensory- and emotional information are believed to adaptive neurological alteration, forcing the sensory information to be re-experienced, thus processed by neurological systems of cognitive order (VAM system), thereby making the sensory- and emotional information applicable for simulation for further encounters. As hippocampus atrophy has been correlated with PTSD and its memory- and cognitive performance is correlated with the saturation of cortisol at the MR and GR, architectural interventions should, therefore, be aimed at reducing the concentration of cortisol in the bloodstreams during involuntary retrieval (flashback and associative cues); therapy sessions and during everyday events. In correlation with the

subtypes, recallment of sensory information has been associated with two interchangeable patterns of neurological coping mechanism; dissociative (30%) and non-dissociative (70%), respectively, either a depersonalization and derealisation response due to increased neurological activation in the midline prefrontal areas and corresponding inhibition of the limbic region (especially the amygdala); or the vice versa pattern of neurological activation, with reduced activation of medial anterior brain areas (ventromedial prefrontal cortex and the rostral anterior cingulate cortex) and increased activation of the limbic region, resolving in emotional under modulation and hyperarousal. Currently, no empirical findings have investigated how these neurological coping mechanisms interfere with the emotional response generated by the patient's interaction with architecture. The project is, therefore, restricted to construct a hypothesis upon the subtypes neurological abnormalities potential effect on environmental perception, this hypothesis requires an inquiry into the neurological underpinnings of the architectural experience. The hypothesis will, therefore, first be constructed after the following chapters' inquiry upon the neurological systems governing environmental- preference and perception.

In correlation with the preliminary theoretical frame, the dual representation theory illustrates the neurological underpinnings of schemas involvement in the conduction of adaptive behaviour; where perceptual information and associated emotional response is contextualised, constructing autobiography memory, in order to facilitate simulation to improve conduction of behavioural actions in future scenarios, thereby applying information from previous encounters to inform adaptive behaviour. Interestingly, the two memory systems of the dual representation theory (SAM's and VAM'S) has been associated with the two types of spatial memory; egocentric (view-point dependent) and allocentric (view-point independent). Verbally accessible memory and allocentric spatial memory are both associated with the function of the hippocampus, were allocentric spatial memory has been directly correlated with place cells; neurological area, bilateral in the hippocampus, associated with cognitive mapping of environments humans and animals experience through their lifespan (O'Keefe and Dostrovsky, 1971; O'Keefe and L Nadel, 1978). The inclusion of allocentric memory and place cells into the understanding of verbally accessible memory constructs the hypothesis that perceptual and emotional information is directly associated with a given location in the physical world, and not merely contextualised in accordance with autobiography independent of the physical world. As PTSD is associated with decreased function of the memory systems and correlated with reduced hippocampus volume, PTSD patients might, therefore, also be subjects of deficits in allocentric spatial memory, thereby reducing their ability to efficiently navigate environments demanding allocentric spatial memory. Furthermore, reduced ability to associate sensory and emotional value to a physical location might, therefore, alter the emotional response generated by physical surroundings, as environments will be experienced with increased novelty. Further inquiry upon PTSD influence on allocentric spatial memory should, therefore, be made to address these hypothesis.

Aesthetics – the neurological underpinnings

The sensory experience of architecture (or an object) are studied under the term 'aesthetics'. The eighteenth-century German philosophiser Alexander Gottlieb Baumgarten changed its definition into the delight of sensory experience – how our brains interpret a perception; do we like it or do we not? (Hekkert, 2006). The concept of aesthetics applies to all interaction. Our sensory system is under constant activation; trying to make sense and evaluate the world occurring around us and how the individual should act accordingly, resulting in everyday experiences such as the sensory stimulation of the comforting warmth, taste and smell of a freshly brewed cup of coffee served in a smoothly surfaced mug, slowly warming the hands on a cold winter day, and the experience of viewing the works of the worlds most celebrated painter, all experiences subjectively associated with delight or distaste and heavily associated with the complexity of the human psyche. Various theories have been constructed to understand how and why we find pleasure from various sensory experiences; evolutionary psychology has been widely adopted to account for the correlation between sensory stimulus and resulting pleasure or distaste. The aim of this chapter inquiry is to investigate the neurological- and psychological underpinnings of the aesthetic experience and how sensory information is converted into an emotional response.

Evolutionary psychology accounts for aesthetics through the previously mentioned 'by-product' hypothesis. The theory states that aesthetic experiences are a by-product of motivation for adaptive behaviour. The primary purpose for all species is to survive. The insurance of survival would have required human ancestors to solve various adaptive problems; problems with immense complexity and distal rewards, e.g.., selecting mates for reproduction; avoiding predators; finding nutritious food and understanding and evaluate interaction others (Hekkert, 2006). The better an individual would be at choosing the correct behavioural strategy towards survival the more likely would it be that their genes would survive and been passed along to offsprings, whose survival correspondingly benefited from a prior genetic mutation. The logic and hypothesis of the evolutionary psychological theories are, therefore, that natural selection has evolved a psychological/neurological mechanism governing the evaluation of sensory information providing an emotional feedback (aesthetical emotional response) to guide successful adaptive behaviour (Barkow, Cosmides and Tooby, 1992; Pinker, 1997; Tooby and Cosmides, 2001). Preference for specific environments, could, therefore, be argued to correspond with the 'by-product' hypothesis, were the environments ability to ensure fulfilment of biological goals and motivation would be correlated with preference (a positive emotional modulation). A classic example of the aesthetics guidance for distance rewards is symmetry, which is believed to be associated with preference as a by-product of mate selection, due to facial- and bodily symmetry indication of healthy body development. It could, therefore, be argued, through evolutionary biology, that there exists a universal schema, developed through human evolution to be applied for interpretation of environments, governing emotional modulation facilitating adaptive behaviours, ensuring biological goals, thus resulting in offsprings with corresponding genetic mutations. This hypothesis is

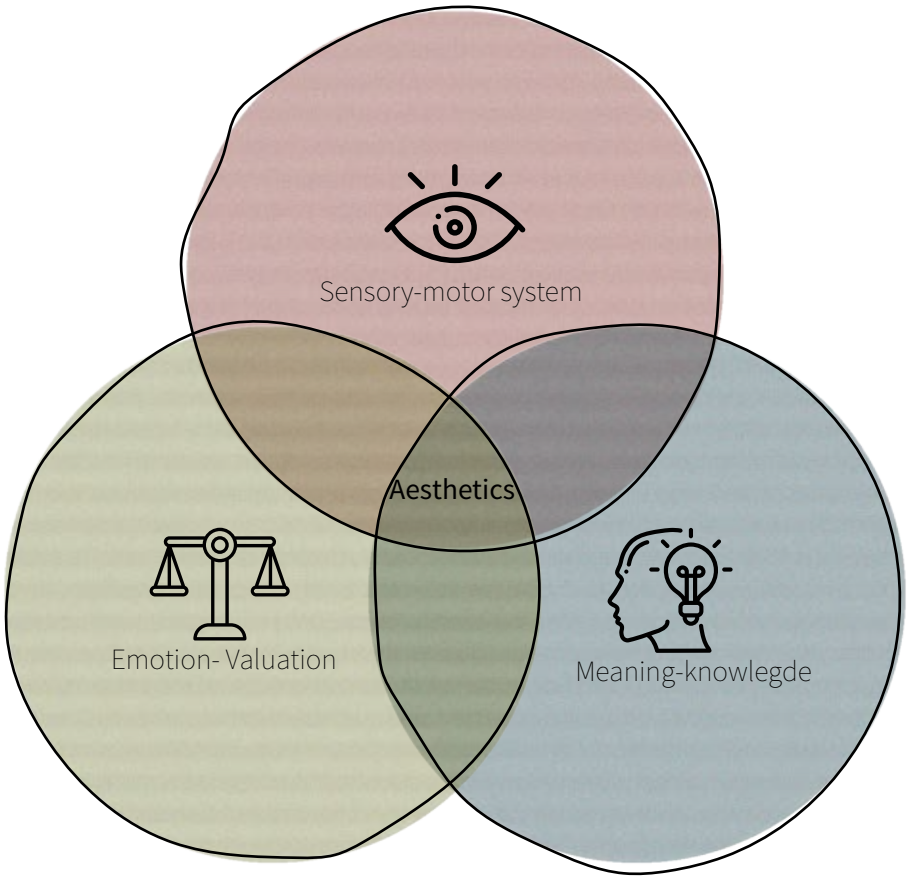


Fig: 7 - The Aesthetic Triad

required to be challenged; do various features of architectural composition varies in its correlation with a universal schema for interpretation and corresponding motivational association. A common phrasing 'beauty lies in the eyes of the beholder'; some people might dislike the taste of coffee, prefer the works of Vincent van Gogh over Jackson Pollock's expressionistic art style, individuals might differ in the preference of environments too - ruling no universal preference for environments. To explore this essential question and answer the preliminary question, attention is prior required to be assigned addressing how perception converts into an aesthetic response. As proposed by Chatterjee and Vartanian (2016), the aesthetical experiences result from three different neural systems; meaning-knowledge-; emotion valuation-; and the sensory-motor system – the aesthetic triad.

Sensory-motor system

Architecture is perceived, experienced and understood through the engagement of the sensory network, including; visual-, somatosensory-, auditory-, the vestibular system-, auditory- and olfactory perception (Coburn, Vartanian and Chatterjee, 2017). Vision is regarded as mankind's dominating sense: "the eyes are more exact witness than the ears"(Heraclitus, 1993), and Plato viewed visions as humanity's greatest gift (Pallasmaa, 2013), it should, therefore, come as no surprise that vision, in western culture, are regarded as the dominating human sense, resulting in it being the most researched sensory system in correlation with architectural understanding. This paper will follow within these footsteps, rescriting the inquiry to visions influence on the aesthetic experience of architecture. Simple attributes of architecture, such as; luminance, colour, feature groupings and motions are processed in its corresponding neurological areas before being processed by higher-level neurological systems such as the parahippocampal place area, the retrosplenial cortex and the occipital place area (Chatterjee, 2004; Marchette et al., 2015). Especially the parahippocampal place area is of interests as it has been correlated with increased activation when processing spaces, compared with objects, thus indicating its specialized function in the evaluation of environments (Epstein and Kanwisher, 1998; Kravitz, Peng and Baker, 2011). Furthermore, the parahippocampal place area has also shown to play a vital part in navigation (Mégevand et al., 2014), a function conducted in collaboration with the hippocampus and entorhinal cortices (Spiers and Barry, 2015), therefore, also linked to manipulation of spatial memory. The occipital place area has been suggested through recent work to process architectural features such as; materials and elements (Coburn, Vartanian and Chatterjee, 2017). Various theories have been conducted to account how visual information from the environment predict preference, theories such as; the permeability theory; prospect-refuge theory; the preference matrix. A common determinator for these theories is how much information is perceived, how fluent and accurate environmental information can be processed (Reber, Schwarz and Winkielman, 2004), these prominent theory correlates with David Kirsh (2000) notion of cognitive congeniality (addressed in chapter xx). The visual system reacts strongly to contrast, grouping and symmetry (Ramachandran and Hirstein, 1999), this increased activation from visual contrast correspond with retinal cells and neurons located in the occipital cortex increased activation for edges and areas with high levels of visual contrast, compared with areas with more homogenous luminance (Ramachandran and Hirstein, 1999; Brady and Field, 2000; Geisler, 2007). The increased reactivity towards regions with high contrasted have been demonstrated as a function to migrate the human limited visual attention towards areas with increased information, assisting the perceptual system to increase its efficiency in identify objects and surface boundaries, as these areas contain more declarative information (Ramachandran and Hirstein, 1999; Alexander, 2002; Hagerhall,

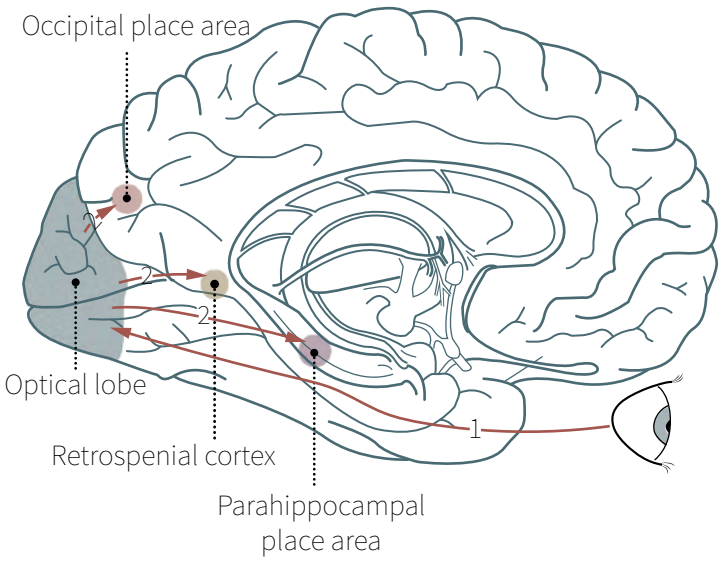


Fig: 8 - The visual system

Purcell and Taylor, 2004; Helmut et al., 2004). Grouped features and repetition of architectural features, increases the efficiency of scene processing, as these features are processed by associated neurons responsible for processing those elements (Coburn, Vartanian and Chatterjee, 2017). Similarly, symmetry is argued to be an evolutionary by-product of mate selection, as symmetry in facial- and bodily features correspond with the healthy development of the body; indicating good genes and a healthy individual (Jacobsen et al., 2006). Patterns including more symmetry have also been linked increased recognition, and processing efficiency (Coburn, Vartanian and Chatterjee, 2017), combined with the strong relationship with the human preference of sexual partners might explain why symmetry is a common design feature in all branches of design (Alexander, 2002). Environmental design features, such as symmetry can ease the individual in processing the information afforded to them through visual perception, but what information is there to be learned in an environment? As described in mathematical terms; complexity is defined as "the volume of information present in a space" (Dosen & Ostwarld, 2016, p.3). Spaces with deprived complexity deny individuals the ability to seek meaningful information (Salingaros, 2003). Research has demonstrated that individuals prefer interior settings that afford a moderate level of complexity, allowing the information-seeking visual systems to gather new information of the environment, resulting in increased understanding of the context (Helmut et al., 2004; Dosen and Ostwald, 2016). On the contray, settings with high-levels of complexity have shown to overwhelm the perceiver, by overstimulating the visual system, resulting in the information being perceived as disorganised and displeasing (Salingaros, 2003, 2007; Kotabe, Kardan and Berman, 2016). As postulated by (Berlyne, 1970, 1971) the preference for complexity follows an intervened u-shape, where either under- or overstimulation of the information-seeking visual system will be, respectively, boring or chaotic, resulting in reduced preference.

Meaning-knowledge system

The meaning-knowledge system is comprised of previous personal experiences, including culture and education; affecting the liking of a given environment (Chatterjee and Vartanian, 2016). An fMRI study performed by Wiesmann and Ishai (2011), displayed that there is a difference in activation of the cortical area when comparing architecture students and lay-persons neurological activation as a result of visual stimulation with architectural photographs. A similar study has revealed that architect students had higher activation of the reward circuitry, including the medial orbitofrontal cortex, the subcallosal cingulate gyrus, the hippocampus and the precuneus when they were asked to make aesthetic judgments of architecture, compared to control subjects (Kirk et al., 2009; Coburn, Vartanian and Chatterjee, 2017), suggesting that visual stimulant associated with higher needs (self-actualization) or schemas associated with the profession of architecture alters the neurological activity from environmental stimuli. The involvement of the rewards systems indicates an emotional response, and together with activation of the hippocampal and precuneus; areas involved with episodic memory, spatial processing and reflection relating to the autobiographical self and consciousness, indicating that the resulting emotional response towards environmental stimulation is affected by the emotional value of previous environmental encounters. Therefore, past experiences in built environments affect the present interactions with architecture and spaces (Chatterjee and Vartanian, 2016). Place- and grid cells in the hippocampus is believed to perform the function of constructing a cognitive map (O'Keefe and L Nadel, 1978), allowing enhancement in the efficiency of navigation for future encounters (Astur et al., 2002), through encoding of environments location in correlation with the knowledge of events and places in which they occurred (Edelstein et al., 2008). Various studies have regarded the parahippocampal place area, as an essential neurological area for assigning emotional value to spaces. A study performed by Chan et al., (2013) showed that participants exposed to a fear-conditioned room, during navigation task, displayed increased activation in the posterior portion of the parahippocampal gyri, compared to emotional neutral settings, when exposed to the same setting the following day without the fear response present in the stimuli. The posterior portion of the parahippocampal gyri is near the aforementioned parahippocampal place area (Epstein et al., 1999), suggesting that the posterior portion of the parahippocampal gyri encode emotional value to the environmental features computed by the parahippocampal place area, were emotional value is produced by the amygdala. The signal from the amygdala is then associated with perceptual and contextual memories of the fearful stimulant in the hippocampus and parahippocampal gyrus (Ledoux, 1992; Kilpatrick and Cahill, 2003). Interestingly, the study fMRI scans revealed no elevated activity in the amygdala or the hippocampus when participants were re-exposed to the setting in which they previously have experienced a fear response, only increased activation in the

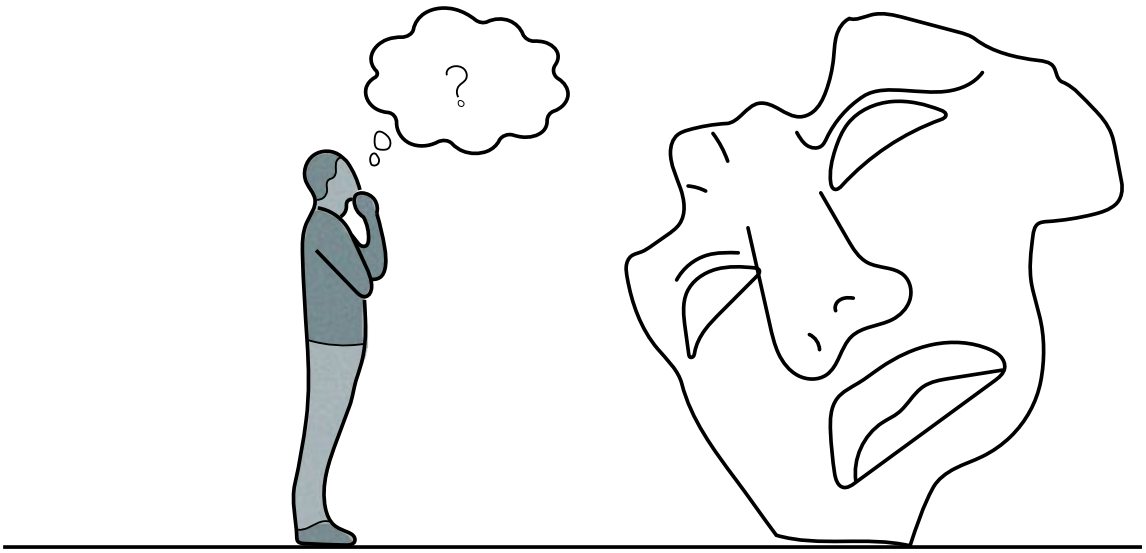


Fig: 9- Meaning -knowledge

posterior portion of the parahippocampal gyri (Chan et al., 2013). These findings indicate that the posterior portion of the parahippocampal gyri might play an essential role in regulating environmental behaviour based on prior experiences.

Cultural and societal standards have indicated to interfere with preference, as demonstrated in the study by Kirk and colleagues (2009); individuals were more likely to judge work of arts as beautiful if they are told that they were gallery pieces, compared with being told that the artwork is generated by a computer (Kirk, Skov, Humle, Christensen, & Zeki, 2009). Social- and cultural factors, therefore, have the potential to bias individuals to prefer specific designs if correlated with cultural, societal or economic value(Chan et al., 2013), indicating support for the claim that preference is govern by motivation beyond primal needs.

Emotion-valuation system

The emotional response from architecture is suggested to be regulated by the brain's reward circuitry, this is demonstrated in a meta-analysis conducted of neuroimaging studies assessing aesthetic appraisal; Brown and colleagues (2011) linked the emotional feedback from aesthetic appreciation to neural circuits involving; the orbitofrontal cortex, the basal ganglia, the anterior cingulate cortex and the anterior insula. The orbitofrontal cortex is associated with cognitive processing of decision-making (Kringelbach, 2005). A function facilitated by projections from the medial dorsal nucleus of the thalamus, thus incorporating emotions and reward into the decision-making process (Fuster, 1997). The basal ganglia functions include control of voluntary motor movement, procedural learning, habit learning, eye movements, cognition (Stocco, Lebiere and John, 2010) and emotions (Weyhenmeyer and Gallman, 2007), functions working with strong interconnection with the cerebral cortex, thalamus and the brainstem (Weyhenmeyer and Gallman, 2007; Stocco, Lebiere and John, 2010). The anterior cingulate cortex provides function of regulating blood pressure and heart rate (Gianaros et al., 2005), but also is involved in functions such as attention (Pardo et al., 1990), reward anticipation, decision-making (Bush et al., 2002) and performance monitoring and error detection (impulse control) (Hewitt, 2013). The anterior insula, a subpart of the insular cortex, receiving signals from the ventral medial nucleus of the thalamus together with a feedback mechanism with the amygdala by both receiving and providing projections, resulting in a multi neurological feedback mechanism (Mufson, Mesulam and Pandya, 1981). The anterior insula is linked to interoceptive awareness, by conveying information regarding homeostatic information to consciousness (Martino et al., 2006; Xue, Xhonglin and Levin, 2010). The anterior insula coneys this function by monitoring pulse. Furthermore, increased grey matter volume of the anterior insular have been correlated with an increased consciousness understanding of the inner body state (Critchley et al., 2004), this claim has been illustrated concerning both physiological- (Lamb et al., 2007) and psychological distress and corresponding regulation (Critchley et al., 2004; Sander and Scheich, 2005; Xue, Xhonglin and Levin, 2010). Studies in environmental psychology have revealed that participants emotional-valance towards either exiting or entering a room were associated with activation of the anterior midcingulate cortex (Vartanian et al., 2015), these findings were based on a behavioural comparison between participants in either an enclosed or open spaces. As aforementioned the anterior midcingulate cortex has strong connections to the amygdala (Mufson, Mesulam and Pandya, 1981; Vogt and Pandya, 1987), an area controlling fear processing (Whalen et al., 1998), suggesting that neurological circuitry monitoring and producing fear is likely involved in the aesthetical response towards architecture. Using virtual reality and a TSST psychological stress paradigm, researcher Lars Brorson Fich and colleagues (2014) were able to show a correlation between the human stress response and

spatial encloser. In their study, test subjects occupying a space with vistas through large windows, had reduced saliva concentration of cortisol (an indicator reduced activation of the HPA-axis), during and following the TSST-paradigm compared to participants undergoing the same TSST-paradigm in a fully enclosed space. These two results as mentioned above indicate that the design parameters of enclosure predict fear and stress response of the occupants, presumably due to emotion-regulating by limbic structures, like the amygdala, modulating the activation of the neuroendocrine and autonomic nervous system (Ulrich-Lai and Herman, 2009). As proposed by Ulrich, (1983) the emotional response from environmental perceptions is procced rapidly by the visual- and limbic system, resulting in an automatic and unconscious produced environmental evaluation. This claim is supported by various empirical studies indicating that positive and negative emotional response to architecture and environments are rapidly and automatic (e.g., Hietanen and Korpela, 2004; Valtchanov and Ellard, 2015; Joye and Dewitte, 2016). It has been suggested that a rapid emotional response relieves individuals from the allocation of resources required to explore and learn the environment, before making a judgment, thus facilitating an efficient and fast adaptive behaviour (R. S. Ulrich, 1983; S. Kaplan, 1987; Joye, 2007). Previous claims have illustrated that the functions and activation of the parahippocampal place area are associated with recalling episodic information of fear-conditioned environments, studies have also indicated that activation of the parahippocampal place area is associated with the preference of novel scenes (Yue, Vessel and Biederman, 2007). Besides increased activation of the parahippocampal place area, activation of the ventral striatum was also correlated with preference, indicating that positive emotional response towards environments is a function of the conventional rewards system (Yue, Vessel and Biederman, 2007). No research investigating neurological activation by recalling positive emotional associated environments was able to be located. Inquiry of this scenario will illustrate if positive emotional memories of environments are processed by the parahippocampal place area isolated from other structures involved to facilitate adaptive behaviour, as it has been demonstrated with environments associated with fear. From an evolutionary perspective, isolating approach/avoid behaviour purely or strongly by positive emotional tagged episodic memories could lead to dangerous situations, following the classical evolutionary analogy; it is safer for a human to mistake a blade of grass for a snake than to not perceive the snake and mistake it for a blade of glass. The same can be said for environmental perception, as behaviour acting out of purely positive associated memories could render a dangerous situation, due to reduced perception of the current state of the environment, compared to learned fear response from environment, resulting in more vigilant approach or avoidance behaviour. Despite this analogy, emperical findings and the neurological underpinnings of the architectural experience has displayed strong correlation between associated assigned emotional value and corresponding emotional modulation from exsposure to architecture, indicating a strong correlation between the memory system and preference.

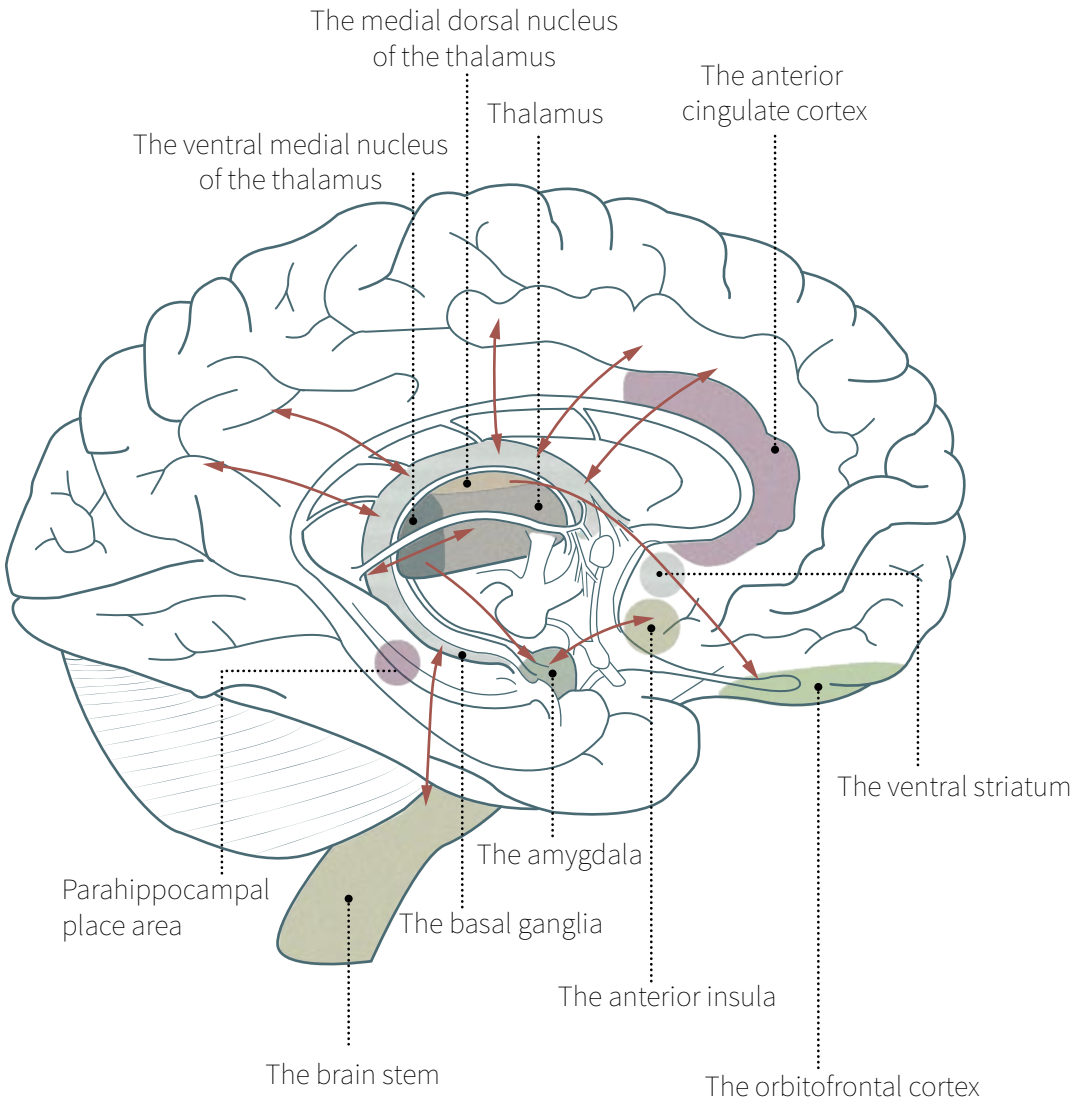


Fig: 10 - The emotion-valuation system

Emotions and the homeostasis balance

As expressed in the model of aesthetics proposed by Chatterjee and Vartanian (2016), the response elicited by architecture is comprised of an aesthetic evaluating, resulting in an emotional response. This correlates with previous models accounting for the aesthetics responses, but excludes cognitive mastering as a component in the aesthetic response (e.g., Helmut et al., 2004; Hekkert, 2006). The variables in the prediction of aesthetic preference and emotional valence are comprised both of information-related features such as complexity and coherence, and environmental spatial features, which both have shown to affect the aesthetic response. Spatial features such as spaciousness and openness, have both displayed findings indicating an effect on the nervous systems and alter behaviour through modulation of emotions, facilitated by both the reward system, the amygdala and neurological areas associated with spatial and episodic memory. As firmly demonstrated in the model Helmut et al., (2004), and the empirical findings included in Chatterjee and Vartanian (2016) model of the aesthetic process; aesthetic evaluation and resulting emotional response is affected by memories tagged with emotional value and cultural influence, and the current mental state of the perceiver; indicating a personal bias towards preference. This claim is supported by the neurological functions of the parahippocampal place area, the posterior portion of the parahippocampal gyri, hippocampus and the precuneus. The involvement of emotional value assigned to memories and the engagement of the nervous systems are especially interesting in the role of constructing architectural settings with the purpose of housing individuals with reduced health and well-being, in this case, patients with post-traumatic stress disorder. To account for how the aesthetic process affects health and well-being the concept of homeostasis is required to be included. As expressed by Charles Robert Richet (1850-1935); "The living being is stable. It must be in order not to be destroyed, dissolved or disintegrated by the colossal forces, often adverse, which surround it. By an apparent contradiction, it maintains its stability only if it is excitable and capable of modifying itself according to external stimuli and adjusting its response to the stimulation. In a sense it is stable because it is modifiable – the slight instability is the necessary condition for the true stability of the organism" (Richet, 1900 cited in Cannon, 1929). This quotation leads Cannon to define 'the homeostasis balance', he defined it as an organism physiological reaction to maintain a steady-state of the body, by keeping an internal biochemical balance, through adaption, due to external factors threatening the balance (Cannon, 1929). Cannon definition of the homeostasis balance resulted in Wiley and Karl R. Popper (1975) definition of health as "health is the perfect, continuous adjustment of an organism to its environment". These adaption mentioned in all authors definitions have been isolated to three interplaying mechanisms that monitor and alter the biochemical balance in the body; the endocrine-, immune- and nervous system (Damasio, 2000, p. 40).

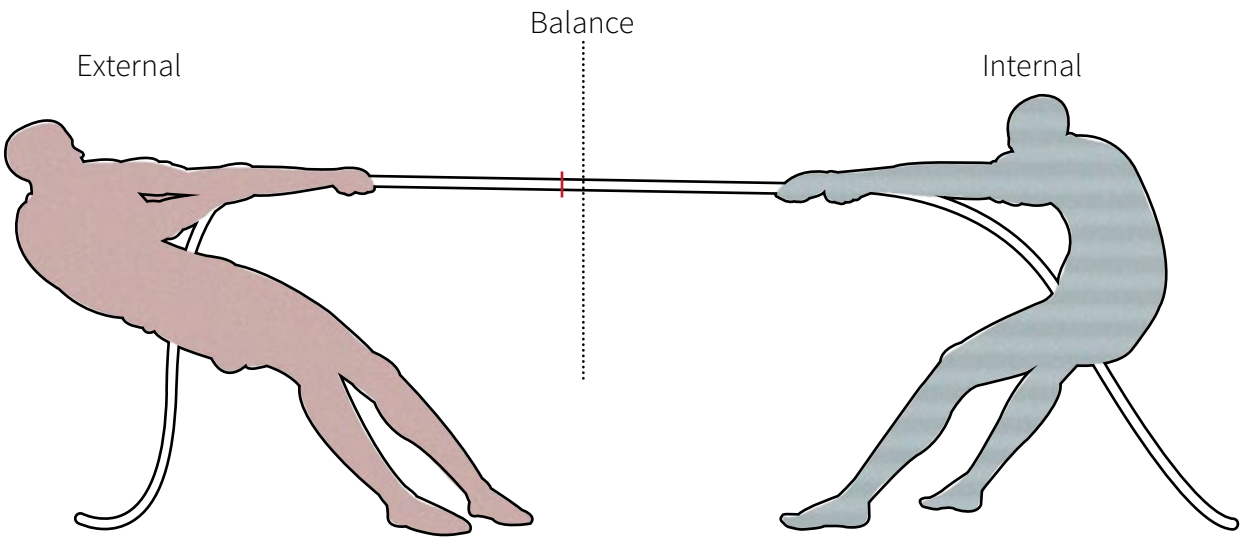


Fig: 11 - The homeostatasis balance

As defined by Damasio, emotions are "complex, largely automated programs of actions concocted by evolution." (Damasio, 2000, p.44). Emotions can, therefore, be viewed as an evolutionary program enabling an organism to regulate homeostatic imbalance, by intervening based on an appraisal of the threatening situation and facilitate actions to restore homeostatic balance (Damasio, 2000). Emotional actions programs, such as behaviour; approach/ avoid, allows an individual to assure their safety by bringing them self into a situation that promise increased chances of fulfilling biological objectives – health and well-being. As expressed in the early chapter, the emotional response is based on information perceived from the ambient environment and schemas, following Damasio, information regarding the current state of homeostasis also affects the emotional response; further enhancing evidence that the effect of subjective mental state influence the emotional response in from environments. In this way, the emotional response resulting from the aesthetic evaluation can be reviewed as the process of the body and mind conducting behavioural programs, facilitated by emotions, to ensure survival and well-being for individuals in correlation with ambient enviorment and the individuals autobiographical knowledge.

Emotions and perception

Following the superoptimality principle of evolutionary development, behaviour facilitation and the premise that aesthetic valance is a by-product of evolution evolved to facilitate adaptive behaviour through modulation of emotions. If these theories hold, well-adapted creature, such as humans, might have developed a universal preference for certain environmental features, that supports our biological goals. These claims support the 'psycho-evolutionary' framework proposed by Ulrich (1983). In his perspective, preference plays an essential role in behaviour modulation, through modulation of emotions, a psychological mechanism of ensuring proper management of the body and mind affected by internal and external forces - ensuring restoration and the conduction of an appropriate stress response. He postulated that the emotional response was immediate and unconsciously, and thus, emotional valance of environments, therefore, not a function of the conscious brain (Ulrich, 1983). The postulation of the unconsciously emotional regulation from environmental features has been supported by various authors such as; Kaplan (1987) and Bar (2004). Empirical studies have found that participants can comprehend visuals scenes after 100 ms exposure (Biederman, 1974; Potter, 1976; Intraub, 1981) and extract semantic information from environment stimulus as fast as 80 ms (Davenport and Potter, 2004). Similar to a computer; the more information needed to be transferred and processed; the longer computation time this would require. The lesser information required to analyse, the faster the emotional response could be facilitated, the achievement of an efficient neurological mechanism for governing environmental interpretation must, therefore, strike a perfect balance between sufficient information interpretation to conduct a meaningful response with the minimal amount of resources allocated for the task. Bar (2004) proposed that rapid emotional valence response is mediated by global visual cues conveyed by low spatial frequencies (e.g., Schyns and Oliva, 1994, 1997; Oliva and Torralba, 2001). Low spatial frequencies contain global shape information, defining the context frames and the shape of objects in the scene (Palmer, 1975; Biederman, Mezzanotte and Rabinowitz, 1982; Bar and Ullman, 1996; Bar and Aminoff, 2003). Functional magnetic resonance imaging and magnetoencephalography studies have registered increased activation of the parahippocampal cortex around 130 ms after exposure. The activation pattern is followed by a second wave of activation around 230 ms after the stimulus (Bar and Aminoff, 2003). The functional significance of the second wave could not be determined by Bar (2004). However, he used this activation pattern in the argumentation for the perception of visual stimulant is divided into the two subsets of activation correspondence with the division of visual information into a low-spatial frequencies subset (context and object frames) and high-spatial frequencies subset (details), a division which facilitates a fast and efficent emotional modulation from environmental stimulants. The rapid unconscious activation of emotional responses from the

Fig: 12 - Spatial frequency representation

environment could, therefore, be argued to be affiliated with visual information perceived in the low-frequency subset. As the preliminary computation of visual information regarding the context frames and edges of objects, within the context, is computed by areas of the parahippocampal cortex, such as; the parahippocampal place area and the parahippocampal gyrus. Two areas associated with emotional value markers of environments. This argumentation proposes two hypotheses:

i) The preliminary low-frequency response, computed in the parahippocampal cortex, affords rapid recalling of value stamps associated with the context- and object shape cues in the environment, thus, applying previous knowledge to facilitate behaviour.

ii) The low-frequency response is an evolutionary developed information strategy to convey the most relevant information the fastest, to ensure a rapid context-appropriate behavioural response through emotional modulation.

The low-frequency representation of environment could, therefore, contain the most relevant information to ensure homeostasis. This claim is supported by increased activation of the visual system towards regions with high contrast; allocating visual attention towards areas associated with increased biological value (Ramachandran and Hirstein, 1999; Brady and Field, 2000; Geisler, 2007; Alexander, 2002; Hagerhall, Purcell and Taylor, 2004; Helmut et al., 2004)). From an evolutionary perspective, this adaptiveness of information-processing is well captured in the quotation from Macleod and McLaughlin (1995) "It may well be more adaptive to ascertain the physical location of and trajectory of an attacking predator's teeth and claws than to discriminate the particular genus to which that species belongs" (p.12). Their perspective supports the notion that detailed depiction of the environment might be less valuable for survival compared to the low-frequency representation of the physical location of objects and boundaries. This notion should not exclude the full visual representation influence on preference and emotional valence for environments, as the full aesthetic experience also is affected by cognitive processes (e.g., S. Kaplan, 1987; Leder et al., 2004; Coburn, Vartanian and Chatterjee, 2017) and visual information associated with high spatial representation is associated with the occipital place area (Coburn, Vartanian and Chatterjee, 2017), a neurological area associated with cognitive decision-making (Kringelbach, 2005), a function conducted based on emotions and rewards anticipations facilitated by projections from the medial dorsal nucleus of the thalamus (Fuster, 1997).

The neurological underpinnings of aesthetic appreciation are linked to complex systems of neurological areas, resolving in the assumption that the emotional response from the aesthetic experience can be described as the result of a cognitive decision-making process based on reward anticipation, affecting the activity of the amygdala and regulating voluntary motor- and eye movements. The decision-making process includes consideration of interoceptive awareness of the psychological- and physiological body state (homeostatic-state) and takes into account the emotional value assigned to the environment and objects, based on previous encounters. Following the aesthetic triad (Chatterjee and Vartanian, 2016), the aesthetic sensation can be divided into three underpinning neurological networks; sensory-motor system, meaning-knowledge and emotion-valuation systems. These subdivisions correspond with the preliminary theoretical framework, in the notion the resulting emotional response from architecture is an adaptive behaviour facilitated by interpretation of sensory information in correspondence with the occupant's schemas. As indicated by the Lars Brorson Fich and colleagues (2014), the emotional response from architecture effects cortisol concentration. The emotional response from architecture can, therefore, be viewed as constant, rapid, unconscious evaluation of homeostatic state in correlation with the environment. Empirical findings indicate that the emotional response is based on low-spatial frequencies, represented in the parahippocampal cortex. Intressingly; retinal cells and neurons in the occipital cortex are associated with increased activation to visual stimulant with high contrast. This increased activation is associated with migration of visual attention, towards areas with high contrast, to increase the efficiency of interpretation of the environment. The occipital cortex, thereby, supports the function of the parahippocampal cortex, and improve the efficiency of conduction of adaptive response by allocating attention resources towards areas of the environment associated with representation by low-spatial frequencies. This paper will, therefore, be restricted its further inquiry primarily on environmental features perceivable by low-frequency representation, as these features are suggested to correlate strongly with the emotional response, therefore, more essential for reducing cortisol concentration.

In correlation with David Kirsh (2000) notion on cognitive congeniality; coherence and symmetry, increases the efficiency of spatial processing, as replicable spatial elements can process by associated neurons. In contradiction to the ease of processing; the intelligent creatures desire to know and understand the world (Maslow, 1943), is also reflected in the aesthetic experience; were complexity ("the volume of information present in a space" (Dosen & Ostwarld, 2016, p.3)) is associated with increased preference, if the complexity is of a moderate level. As coherence and complexity are descriptive notions on the environment and its objects and not physical objects, its influence upon preference, must; therefore, both be correlated with the biological- and emotional value assigned to the described spatial features and to the occupant's schemas applied for interpretation of the sensory information. Complexity is associated with the biological desire to understand the world, and thus improve adaptive behaviours (Maslow, 1943), complexity must, therefore, be a relative unit, depended upon the beholders understanding of its associated value and meaning. A Similar notion could be described in regards to coherence; where previous understanding and knowledge is applicable to assign the features of the environment into distinct categories, applying associations with previous knowledge to improve the processing efficiency of the visual information. Coherence and complexity as predictors of preference is, therefore, logical in its association with the efficiency of processing information and the desire to improve understanding, but also, presumably, subject of significant subjective variation, in regards to its correlation with preference. Empirical findings and theories on environmental preference shall be included in the following chapter to investigate how coherence and complexity predict preference (positive emotional response).

Environmental preference – theories and empirical findings

The savanna hypothesis proposed by Balling and Falk (1982) suggests that environmental preference is derived through humans early evolutionary development in the biomes of Africa. The hypothesis was extracted from their study, which found that children and teenagers in east-America preferred landscape depictions of an African savanna over woodlands (the natural biome of east-America). Their study revealed a general preference for the savanna landscape over other biomes; deciduous forest; coniferous forest; tropical rain forest and desert. Adults were the only participant's group that did not display a uniform preference for the savanna biome; they regarded the native woodlands of east-America of equal preference as the savanna. The savanna hypothesis, therefore, proposes that there exist a common, genetic developed, preference for environments, and suggest that familiarity influences preference. Interestingly, familiarity only showed to equal out preference between the African savanna and woodlands of east-America, when participants reached adulthood. This chapter will, therefore, turn attention towards various theories and corresponding empirical findings to extract universal predictors of environmental preference.

The preference matrix

The preference matrix, developed by Kaplan and Kaplan (1989), consists of four empirically derived variables for the prediction of preference; coherence; complexity; mystery and legibility. Their theory alines with the 'by-product' theory based on the assumption that the aesthetic appraisal process was evolved to encourage adaptive behaviour. The preference matrix was preliminarily developed to construct an empirical framework to investigate the four parameters influence on landscape preference, as they found that humans had a general preference for natural settings, compared with urban environments (Kaplan, Kaplan and Wendt, 1972). The term mystery is by Kaplan & Kaplan defined as an environmental indicator of further information and space available if the individual desires to explore the perceivable unexplored spaces. Example of 'mystery' given by Kaplan (1987); is either a trail disappearing around a bend or a brightly lit glade partly visible through some obscuring foliage. As noted by Kaplan (1987) a clear distinction between mystery and surprise is required to be made; mystery is the promise of further information and space which corresponds with the information present in the already explored environment, mystery will thus be a predictable continuation of the preliminary information in the unexplored environment. On the contrary; surprise would be correlated with an unexpected setting, where the unexplored environment does not correspond with the preliminary environment. An architectural example of this could be a closed-door: A closed-door does not grant the individual any information regarding the environment behind, individuals can only assume that the room behind the door would correspond with the environment they currently occupy, but this is only revealed when the

	Understanding	*Exploration*
Immediate	Coherence	Complexity
Inferred	Legibility	Mystery

(Kaplan and Kaplan, 1986)

Fig: 13 - The preference matrix

door is opened, and the new environment is perceived. Spatial-configuration of mystery, on the contrary, could be a bend around a corner or a glance through a window where the individual can get an initial impression of the unexplored environment, and herby allows evaluation before moving towards it. Coherence is the second variable of the preference matrix, as previously described; perception of an environment includes the usage of associated neurons (Coburn, Vartanian and Chatterjee, 2017), environments with redundancy, will thus require less mental effort to be perceived and evaluated, as multiple objects in the scene can be classified to be one of the same, reducing mental taxation by increasing processing efficiency. Following Mandler (1975), Kaplan (1987) hypothesised that scenes consisting of 5 +/- 2 elements would have increased preference, compared to less coherent scenes, as scenes with reduced redundancy would be more challenging to organise and would thus be of less preference. Coherence in scenes could, therefore, be a predictor of environment preferences as factors affecting mental processing. As previously described, complexity is defined as "the volume of information present in a space" (Dosen & Ostwarld, 2016, p.3). This definition corresponds with the definition proposed by (Kaplan and Kaplan, 1989, p.53) "Complexity is defined in terms of the number of different visual elements in a scene; how intricate the scene is; its richness". Landscapes and works of architecture are comprised of various sensory information, and the more complex and diverse this information is, the more content it provides for the perceiver to detect meaning from, through exploration, thus enhancing the perceivers understanding of the environment. Kaplan and Kaplan, (1989) follow the postulation by Berlyne (1970, 1971) that there exists an intervened u-shape relationship between complexity and preference, as too much information could be overwhelming and too little would result in boredom.

The three extracted variables of environment preference; complexity, coherence and mystery. Were combined into a matrix to express their similarity and differences. Complexity and mystery both comprise the element of exploration; gathering information from the environment. Complexity is immediate information available to the perceiver, were as mystery is the promise of enhanced understanding and indication of a potentially superior environment. Mystery thus require interference with the environment to obtain improved understanding. In contrast to this; coherence contributes to the immediate understanding of the scene. Kaplan and Kaplan (1989) adopted the term legibility from the works of Lynch, (1960) to describe the variable associated with an understanding of the environment through inference with the scene. These four variables resulted in the final preference matrix (see fig. 13).

The preference matrix has since become stable in the field of environmental psychology and resulted in vast amounts of empirical studies investigating its variables effect on environmental preference. Stamps (2004) conducted meta-analyses comprising of a total of 28 articles to characterise its validation and its variables corresponding correlation with preference. The included studies comprised a total of 6288 participants and 1820 scenes, varying in type from nature (50%), built environments (22%) and a remaining mixture of both, including zoos. The meta-analysis displayed large heterogeneity in the correlation between the variables of the preference matrix and preference; ranging from r=-0.33 to r=0.84 for coherence; r=-0.70 to r=0.58 for legibility; r=-0.11 to r=0.97 for complexity and r=-0.45 to r=0.95 for mystery. The lack of homogeneity of findings suggests that claims of the preference matrix are not repeatable - not valid predictors of environmental preference. However, noted by Stamps (2004) the lack of homogeneity in correlations might not be an issue of the underlying theory and the preference matrix selected variables, but might lay in the research methodology used in the studies. In the 28 articles included, a total 248 labels were created to describe the stimulant and only 1,6% of the labels were present more than ones in the 28 studies, thus, reducing the reproducibility of the studies. The resulting collective correlation resulted in; coherence (r=0.45); legibility (r=0.22); complexity (r=0.32) and mystery (r=0.43). The collective correlation indicates that the four variables of the preference matrix are accountable for environmental preference (Kline, 2000). However, large heterogeneity and vague descriptions of stimulant and correspodinding measure and definiton of coherence, legibility, complexity and mystery do not do justice on validating or denying the claims of Kaplan and Kaplan (1989) on the four variables correlation with environmental preference (Stamps, 2004). A more contemporary study, conducted by Jagt et al., (2014), aimed at combating the methodology issues as suggested by Stamps (2004).Their study included 100 participants who were asked to rate the various depictions of environments (nature, urban and mixed) on the Likert scale (1-7) in regards to their preference of the scene and the scenes amount of coherence; mystery; legibility; natural character; built character and familiarity. A predefined definition of all the terms was written next to the depiction of the scene during the task. The results from the study resulted in Cronbach's alphas for preference rating of (α=0.853), coherence (α=0.242), complexity (α=0.562), legibility (α=0.253) and mystery (α=0.763). Suggesting good internal consistency in regards to preference rating, acceptable internal consistency in regards to 'mystery' and poor and unacceptable internal consistency of the remain variables. To test the correlation between the variables and preference rating, the researchers applied an ordinal mixed model (OMM) to display the correlations (See fig 14). The strongest predictors positively associated with preference was mystery, followed by coherence. The amount of complexity also showed correlation with preference, mostly on the extremes of the Linkert scale. Legibility showed a low correlation with the perceived preference; no increase in preference as a result of a legibility score above approximately 3,5 was displayed. Similar relationship as legibility, was found in regards to familiarity were a score above approximately 2,7 was not associated with a corresponding increase in preference. The amount of natural content was associated with increased preference, and the amount of built content was associated with decreased

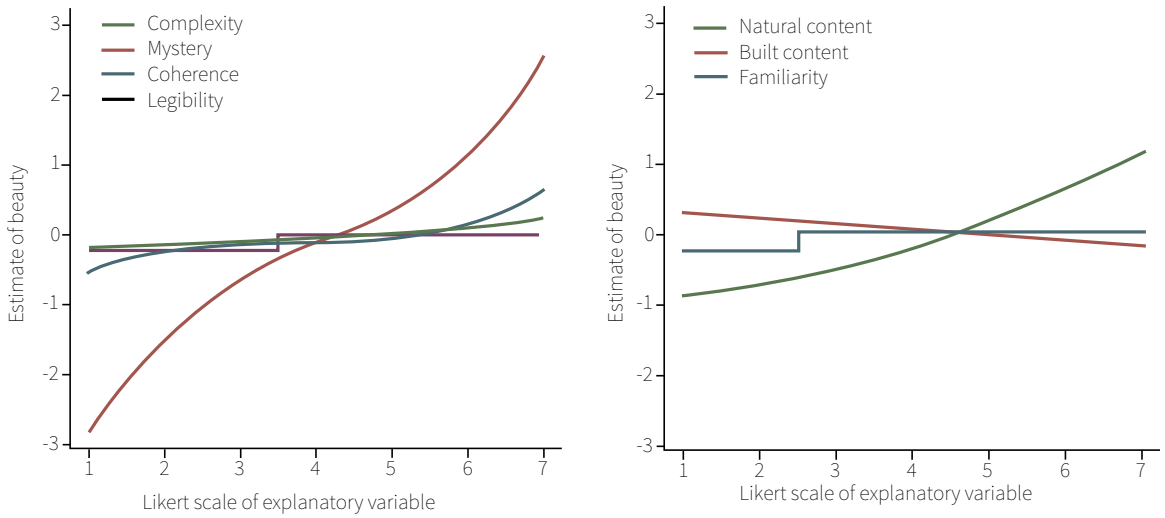


Fig: 14 - OMM analyse from Jagt et al., (2014)

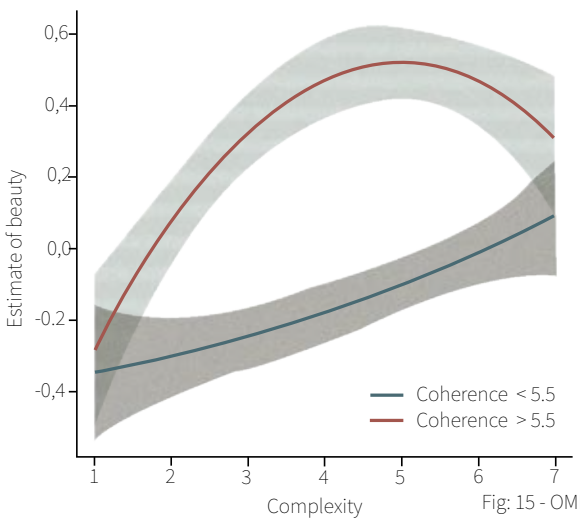


Fig: 15 - OMM analyse from Jagt et al., (2014)

preference. Interestingly in regards to the postulation by Berlyne (1970, 1971) an inverted u-shaped curve was depicted when comparing levels of coherence and complexity with the estimate of beauty (fig 15). As displayed in the OMM's; coherence scores above >5.5 resulted in the inverted u-shaped curve, displaying that a median amount of complexity is preferred in scenes with above-average levels of coherence. As suggested by the meta-analysis by Stamps (2004) and the findings of Jagt et al., (2014); the preference matrix is still questionable in regards to its variables influence on environmental preference. Jagt et al., (2014) study displayed mystery as the only variable with above questionable internal consistency and was also the most significant predictor of preference, indicating mystery at this point, might be the only variable currently sturdy enough to be reliable for predictable implication in architectural design. Something also noteworthy from the underpinning theory of the preference matrix is the general preference for natural environments over built environments (Kaplan, Kaplan and Wendt, 1972; Kaplan and Kaplan, 1989) and also evident by the Jagt et al., (2014) study, were natural content was a stronger predictor of preference compared with other factors of the preference matrix, besides mystery.

Nature

Kaplan and Kaplan (1989) conceptualised a theory to describe how and why nature was strongly associated with preference. The model draws parallels to William James (1892) definition of attention; involuntary attention and voluntary attention. The division between the types of attention is the difference in mental effort required to maintain them. Involuntary attention requires no effort and voluntary attention required effort to maintain focus. In terms of William James (1892) involuntary attention is caused by a stimulus having a "direct exciting quality", such as "strange things, moving things, wild animals, bright things, pretty things, metallic things, words, blows, blood, etc.". Contrasting it; voluntary attention which is the maintains of focus by inhibiting other stimulants. The avoidance of distractions, or in the words of Williams James (1892) "resisting the attractions of more potent stimuli" results in mental taxation. Maintaining voluntary attention is hypothesized to be associated with mental fatigue, and to replenish energy for voluntary attention the brain requires stimuli perceived with involuntary attention system (Kaplan and Kaplan, 1989); such as watching an episode of your favourite show on Netflix before continuing writing your master thesis. Mental fatigue, exhausted by voluntary attention, is primarily restored through sleep. Environments capable of replenishing resources of voluntary attention, during the waking hours might, therefore, theoretically optimise task performance in the given environment. Based on their wilderness study, described in The experienced of Nature (Kaplan and Kaplan, 1989), they found that natural environments possessed some therapeutic properties associated with mental fatigue and involuntary attention. Various authors have studied this correlation between nature and restoration; one of the most renowned studies correlating nature and restoration was conducted by Ulrich (1984). His study compared the recovery process of post-cholecystectomy surgery patients; comparing recovery speed and pain levels between the two patient groups. The only difference between the two patient groups was the view granted by the windows in their rooms; either the view brick façade or the view of a small group of trees. The patients who had the natural view was discharged earlier, requested less pain medication and also reported to be of improved mood, compared to patients with the view of the brick façade. The supposedly restorative properties of nature have sparked vast scientific interest, and various empirical studies have correlated nature with various positive psychological alterations such as; neighbourhood parks reducing emotional problems in children (Flouri, Midouhas and Joshi, 2014); reduced aggressive behaviour in adults after visual stimulant of natural scenes compared to depictions of built environments (Poon et al., 2016); increased happiness, vitality, vigour and creativity by having access to small private green garden (Korpela et al., 2017); increased concentration and cognitive task performance from view of small natural elements (indoor plants and green rooftop) (Raanaas et al., 2011; Lee et al., 2015); reduced psychological stress from a visit to an urban park compared to the visit of an urban plaza (Ulrich et al., 1991; Tyrväinen et al., 2014) and improved stress recovery from driving along roadside trees (Jiang, Chang and Sullivan, 2014). Natures psychological- and physiological benefits and its well-established preference over built environments had led various

researchers to subscribe to the biophilia nature of humans – an evolutionary biased preference for nature and greenery. Besides the aforementioned Attention Restorative Theory (ART) proposed by Kaplan and Kaplan (1989), other theories such as Stress Reduction Theory (SRT), proposed by R.S. Ulrich (1983), are following this biophilia notion, to account for the psycho-evolutionary framework governing human cognitive function. The SRT states; "[…] individuals experiencing stress or anxiety, most unthreatening natural views may be more arousal reducing and tend to elicit more positively toned emotional reactions than the vast majority of urban scenes, and hence are more restorative in a psychophysiological sense" (Ulrich, 1983, p.116). The SRT follows the previously established notion that emotional response triggered by the environment, governs our behaviour and thus facilitate a conscious feeling. Interestingly, Attention Restorative Theory does not share this account with SRT, as ART states that the restorative properties of nature are comprised of its ability to replenish depleted cognitive resources, through alteration of our attention. According to the SRT, the emotional preference towards unthreatening nature is a by-product of evolutionary development; following a stress response, the body goes into recovery mode, restoring fatigue and facilitating mechanisms counteracting the deleterious effects of the stress response. As human ancestors developed this mechanism, through evolution, in a natural environment, then this mechanism must be stronger associated with natural environmental compared with urban environments (Ulrich, 1983; 1993). Despite the absence of any threats, what function did nature provide that were essential to survival? Within the research field of restorative environments is it generally agreed upon that nature provided two vital functions; opportunities for safety, and access to water and food (Joye and van den Berg, 2011). On an evolutionary timeline, human ancestors would over millions of years been exposed to natural environments, providing, to varying degrees these vital functions, thereby developing a hardwired evolutionary psychological mechanism governing behaviour through emotional regulation to either; facilitate approach behaviour, alternating attention (ART), allow stress recovery (SRT) and/or environment selection. Constant emotional valence would, through natural selection, result in genetic traits, further improving the gene survivability by enhancing the ability to facilitate an appropriate environmental response. The constant development of a fine-tuned psychological mechanism to govern our environmental behaviour would logically aid the thrive of genetic traits, further increasing the chances of survival and reproduction, thus, cultivating a genetic and universal preference for nature, through evolution (Ulrich, 1991, 2008; Joye and van den Berg, 2011). As argued by Joye and van den Berg (2011) the presence of natural content, might not be the sole provider of positive valence towards the nature, as our ancestors would continuously have occupied areas with more or less vegetation, thus, the mechanism governing emotional valence, would more or less be continuously activated, thereby granting no significant evolutionary advances. Heidegger (1950;1955) suggested that safety is the essential function an environment can provide, as expressed earlier safety can be regarded on multiple accounts; spatial configuration and access to life depending resources. Various researchers have suggested that the preference for vegetative elements, is correlated with their signalling of resource

Fig. 2 - The nature of Hammerbakker

availability, indicating that the area supports continuity in the availability of food and water. (e.g., Heerwagen and Orians, 1993; Ulrich, 1993). As demonstrated in the Jiang, Chang and Sullivan (2014) study, the environment effect on stress recovery and the density of streetside forestry, followed an inverted u-curve, thereby illustrating both a correlation between spatial configuration, amount of vegetation and levels of stress. Interestingly 60% tree coverage (the highest amount of tested greenery) had less stress-reducing properties compared with 0% vegetation. This finding, contradict the Stress Reduction Theory, where the presence of nature increased the levels of stress in the participants, relative to no vegetation. As noted by Joye and van den Berg, (2011) the preference for a group of trees might not be derived from the mere fact that they are elements of nature, but that the trees are organized in a specific configuration that provides safety. The findings of Joye and van den Berg (2011), should not exclude vegetations effect on cognitive function and stress recovery, as it has been demonstrated in studies, such as; Raanaas et al., (2011) and Lee et al., (2015), who displayed findings that the introduction of natural elements, increase task performance, corresponding to the attention restorative theory; improving cognitive function, without altering the spatial configuration of the room. Repetition of the Jiang, Chang and Sullivan (2014) using non-natural elements, of same physical dimensions as the previous study placed along the roadside, could yield essential results for this discussion; by displaying a potential difference in stress reduction between the two studies. A potential difference in stress reduction, between these studies, would illustrate how much of the stress reduction occurs as a result of the nature content, and how much stress reduction is a result of the alteration of spatial configuration surrounding the roadside. Correlating this discussion with the Preference matrix and corresponding theory proposed by Kaplan and Kaplan (1989); mystery displayed to be a stronger predictor of environmental preference, compared to nature content in the Jagt et al., (2014) study. Mystery in is definition is "how much does a scene promise if you could walk deeper into it" (Kaplan and Kaplan, 1989; Stamps, 2004, p. 2). Indicating that the predictor parameter of mystery accounts both for visual information and potential locomotive behaviour, thereby factors that are strongly related to the spatial configuration of the environment; how much visual connection there is to adjacent spaces, and how easily one could move towards it. Mystery, therefore, is a complex describtive notation; both describiting spatial confirguration, potential reward and information processing. These factors could all be potential varibles affecting the roadside trees influence on stress reduction as a result of alteration of spatial configuration.

Prospect-refuge theory

Appleton (1975) proposed his 'prospect-refuge' theory, initially to construct a framework to describe the aesthetic qualities of landscape painting. His theory has since echoed in various theories of environmental psychology, such as in the work of Arthur E. Stamps (his theory and findings will be discured later), to describe and predict preference of environments. Appleton (1975) believed that attention was a scarce resource, and spatial features effected how sufficient an individual could allocate his/her attention to maintain safety. Resources are allocated for attention through vision and other senses used to observe the surrounding environment and detect potential threats. How well the environment facilitated surveying the environment is prospect - the ability to detect a threat. The more area and distance the environment afforded the individual to survey, the better. The other aspect of Appleton's (1975) theory is refuge; the ability to hide from vision. Refuge provides the function of remaining unnoticed by threats. Attention is a scarce resource; environments provide refuge through affording allocation of attention resources to be focused solely on a reduced portion of the 360-degree field of vision surrounding an individual would, therefore, be of increased preference as the sensation of safety is granted with a reduced requirement of resources allocation as a result of the environment spatial configuration. Example of this; a wall behind an individual detracts the requirement to attain attention to the area behind the individual; as no threats would be able to see the individual through the wall or attack the individual from behind. The usage of the environment, to reduce the required amount of attention to ensure safety is demonstrated in the renown documentary social life of small urban spaces by Willia H. Whyte (1980). As depicted in his documentary, the vast majority of the stationary occupancy of urban spaces is conducted along the sides of the plaza's, where adjacents building provide walls that enclose the plaza. Occupancy along said walls enables the occupants to allocate full attention towards the area in front of them, overlooking the large urban space; surveying other people behaviour (prospect). Similar conclusion on environmental behaviour has been made by Gehl (2007) in this work Life between buildings. These two works illustrate how environments predict behaviour, indicating a universal emotional modulation and display that humans tend to occupy spaces that affect the required allocation of attention to ensure safety through prospect and refuge. Interestingly, Woodcock (1982) conducted a study including both the explorative and understanding variables of the preference matrix; mystery and legibility, and prospect and refuge. Woodcock (1982) subdivided prospect and refuge into subsets of primary and secondary, were primary is defining if prospect or refuge are achieved, and secondary as a visual indication of a

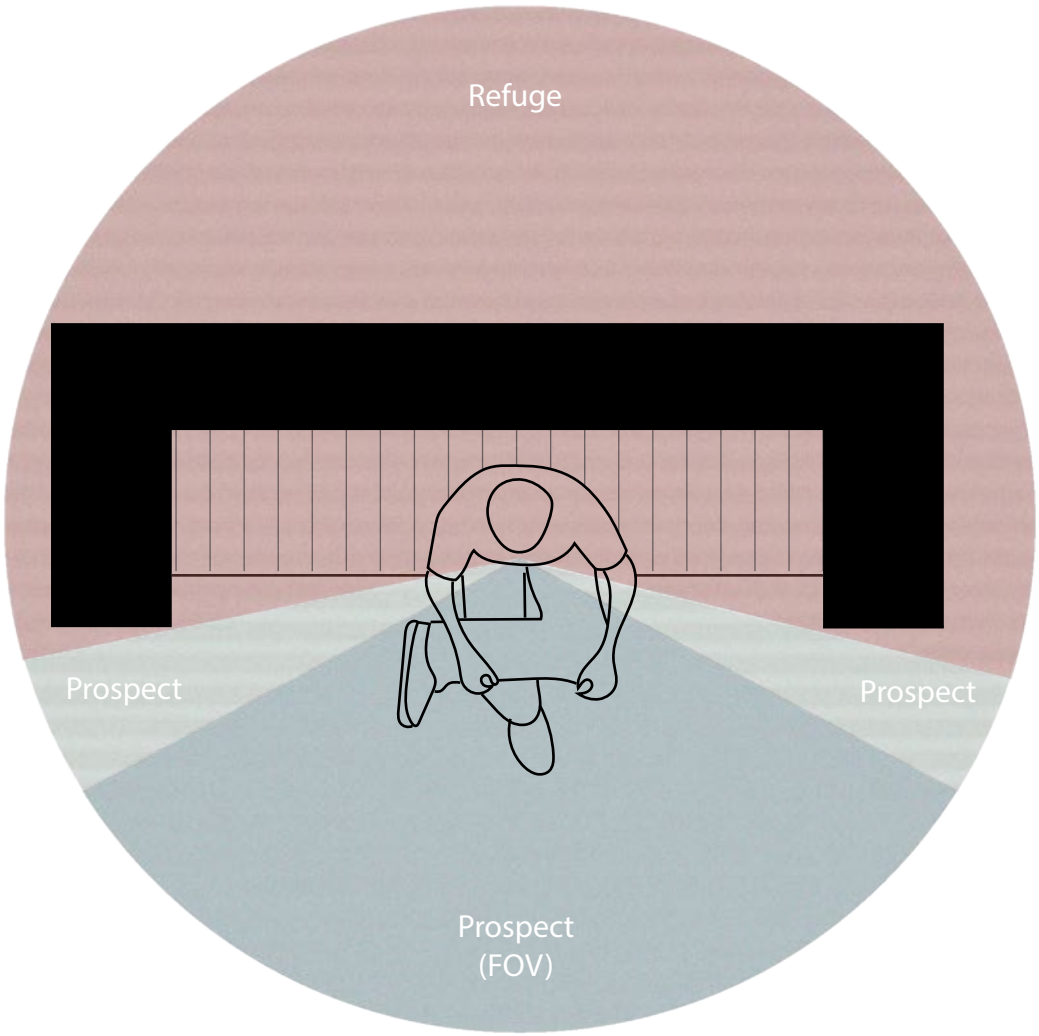
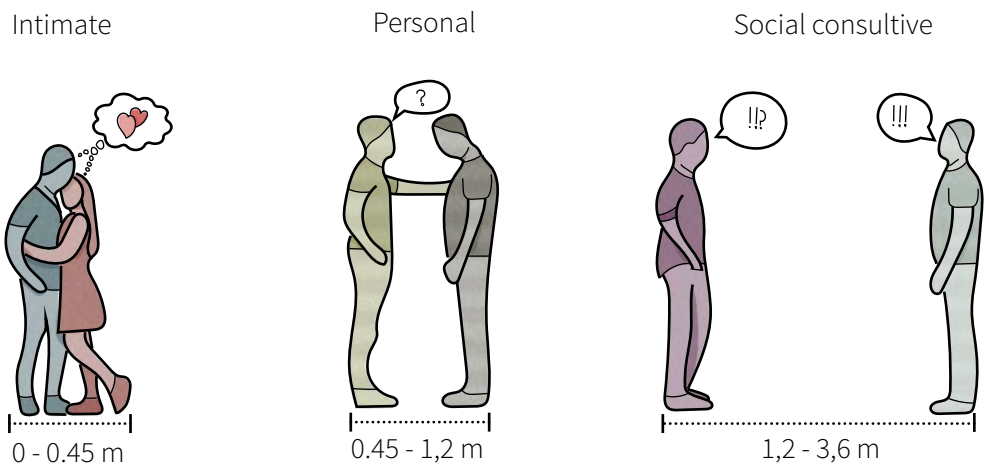


Fig: 16 - Prospect - Refuge

nearby area that provides refuge or prospect. Mystery, legibility and primary prospects, were the strongest predictor of preference in his study. The study displayed interesting interaction between the variables; scenes with high rating of mystery were significantly improved by high rating of legibility; indicating that preference of the environment is both facilitated by the environment affordances of visual connections to adjacent environments, and the locomotion within the area and towards the adjacent environment were perceived to be of ease. In regards to scenes with the high primary prospect, no improvement of preference was correlated with the amount of legibility of the scene. As noted by Woodcock (1982) in Kaplan (1987, p. 19) "Grand vista[s] can be so engaging that the possibility of getting there and back is not a consideration". As expressed by the Woodcock (1982) environmental preference might be viewed as an evolutionary mechanism to govern adaptive behaviour which positions the individual in a context that provides the greatest fulfilment of biological goals – primary prospect. Mystery provides visual information regarding adjacent environments, which signals a potential promise better living condition or a potential route of escape from threats, thereby creating a

concern of getting there - legibility. When the primary prospect has been obtained, then no consideration is made in regards to locomotion; the individual has obtained a superoptimal state, were the environment best facilitate the functions and biological goals of the individual. Refuge in the Woodcock (1982) showed no significant effect on preference, as displayed in Gehl (2007) and Whyte (1980). It could be argued that this is a result of the media in which the environment was perceived. Woodcock (1982) used pictures of scenes; primary refuge cannot be depicted in this medium, as noted by Appleton (1975) the preference of environments described in the 'prospect-refuge' theory is derived from the environment effect on the allocation of attention. Using 2D images, the participant, therefore, could be argued to be unable to relate to the environment that lay outside of their visual attention (the area behind the camera), the area required to afford refuge. The resulting emotional valence, might, therefore, derived from the assumption of the area outside of the photo or be based on their current perception of refuge, within in the environment in which the study was conducted. Unfortunately, no study was able to be located, where primary refuge, as an indication of preference, was measured using a 3D virtual environment. Prior to the conduction of these studies, primary refuge should not be excluded as a parameter for environment preference, because the desire of refuge has been observed to alter behaviour (Gehl, 2007; Whyte, 1980) and must, therefore, parameter affecting emotional modulation.

The third component of the previously mentioned 'prospect-refugee theory', described in Appleton's (1975) The experience of landscape is 'hazards' ; the things that an individual desires to hide and seek protection from. This third component is typically overshadowed by consideration on prospect and refugee, hence the name of the theory, when his works are included in academic works of environments influence on preference and corresponding emotional modulation. The concept of the threat is essential to be included in environments influence on the homeostatic balance, as it could be argued that if no threats were present in any environment, there would be no corresponding requirement for environments to afford safety. In Appleton's (1975) definition; hazards are comprised of all potential threats affecting the homeostatic of the individual; human and non-human. The original functions of buildings were to protect the human from the elements - physiological needs. More interestingly is the buildings restriction on the interpersonal distance occupants can maintain/obtain to familiar and unfamiliar persons within said environment. Edward T. Hall (1969) describes in this work; The hidden dimension, how social relationships and culture affect interpersonal distance; the distance people maintain between each other during an interaction. Interpersonal distance, affect how much sensory information is communicated consciously and unconsciously, between people. The classic example of non-verbal communication is body-language which reflects the individual resulting mental state from the interaction and corresponding situation. Body language is something that most people are aware of and consciously can interpret and to some extent consciously regulate. Another non-verbal communication occurs through bodily regulation, such as; blushing; breathing; odour and facial expression. These non-verbal ways of communicating are significantly harder to control consciously



(Hall, 1969)

Fig: 17 - Interpersonal distance

and are primarily controlled by our unconscious mind – a direct and true reflection of our psychological- and physiological state. Through regulation of interpersonal distance, people can regulate how much information the other person can detect from the opposing individual and regulate how much response time an individual would have if a nearby person would decide to engage an attack. An interesting notion can be drawn from the consideration of reaction time, the bodily posture of the interacting individuals; sitting, standing, lying, might, therefore, also interfere with the spatial requirements of a space to be perceived preferable, as standing interaction allows faster conduction of a flight or fight response from both individuals, compared with sitting or laying down. Mismatch of the counterparts bodily postures, might, therefore, also interfere with the environments modulation of emotions. Perceived violation of interpersonal distance has been associated with increased activation of the amygdala (Kennedy et al., 2009). Furthermore, the anterior insula has previously been correlated with the neurological underpinnings of the interpretation of environmental stimuli. One of the functions of this neurological area is to ensure interoceptive awareness of individuals physiological- and psychological state (Critchley et al., 2004; Sander and Scheich, 2005; Martino et al., 2006; Lamb et al., 2007; Xue, Xhonglin and Levin, 2010). Regulation of interpersonal distance, and presumably corresponding environmental preference, can, therefore, be view as regulation of the homeostasis balance – through the facilitation of a stress response and interoceptive awareness. Interpersonal distance is, therefore, insurance both of physiological safety (avoiding an attack) and safety of social status and relations (avoiding a nearby person to undesirable interpret the psychological state of the individual). Edward T. Hall (1969) divided the measurements of interpersonal distance into four cultural- and social depended intervals; intimate (0 – 45 cm); personal (45cm – 1m); social-consultive (1m – 3m); and public (>3m). An environment which provides insufficient space to allow maintains of a context corresponding interpersonal distance could, therefore, be viewed as an environment, that would be perceived undesirable, as it would provoke negative emotional valence facilitated by a stress response produced by the amygdala (Kennedy et al., 2009).

Permeability theory

As displayed in the works of Appleton (1975) and Kaplan and Kaplan (1989); visual connection and ability to conduct locomotion are vital factors of environmental preference. These claims are the foundation of the permeability theory proposed by Arthur E. Stamps (2007). His theory follows the notion proposed by Heidegger (1950, 1955) that the most vital property of an environment is its ability to assure safety for the occupants. Stamps (2007) isolates the sensation of safety into two parameters; the ability to move and the ability to see. The permeability theory, thus, consists of two parameters; visual permeability and locomotive permeability, respectively the ability to see through and in an environment, and too move through and in an environment. Describing the environment in regards to its affordance of visual- and locomotive permeability results in two spatial properties; enclosure and spaciousness. Stamps suggested that perceived spaciousness is the strongest predictor of environmental preferences as humans, and animals alike will have increased stress response from environments providing insufficient space. The permeability theory, therefore, corresponds with the previous findings such as; mystery proposed by Kaplan and Kaplan (1989) and prospect, as proposed by Appleton (1975). The permeability theory suggests that the most vital factors of environmental preference are visual- and locomotive permeability. Environments can, therefore, be comprised of four extremes, in regards to the theory. (1) Neither locomotive- or visual permeability is possible. (2) Both locomotive- or visual permeability is possible. (3) Visual permeability is possible, but not locomotive. (4) Locomotive permeability is possible but not visual. Arthur E. Stamps (2012) tested these extremes, in multiple experiments, to compared how either hindering locomotive- or visual permeability would interferer with the perception of environmental spaciousness, thus affecting preference. The first experiment was conducted on atmospheric permeability in urban and in a landscape environment, to see if a reduction of visual permeability by the introduction of fog would alter the perception of spaciousness. The study comprised of twenty-four participants rating nineteen scenes, with or without fog, on a scale from (1) open to (8) enclosed. The experiment showed that foggy scenes appeared more open, compared to bright lighted scenes (M=4.12 and 4.41, respectively). As noted by Stamps (2012) the fog only accounted for 1% of the variance in rating, interestingly, Stamps (2012) did not comment in regards to how the hard shadows cast in the brightly lighted scenes would affect the perception of spaciousness. As indicated by the stimuli samples, depicted in his article (Stamps, 2012), hard shadows were present in the brightly lighted scenes, these could be argued to interfere with the sensation of spaciousness, as the significant difference in illumination between areas lit by sunlight, and the shadowed areas could conceal information of potential threats. Following the notion that safety as the most vital aspect of environmental preference, then the substantial difference in illumination could alter the perception of safety, thus, alter the sensation of spaciousness. A second experiment was conducted, substituting the nature and urban scenes with residential areas, resulting in similar results. The fog accounted for 0% variance in rating difference, and the foggy, evenly lit scenes, was rated more open (M = 4.32) compared

with brightly lit scenes (M=4.57), suggesting support for the claim that even distribution of illumination increases the perception of spaciousness, as hard shows could conceal potential vital information for safety.

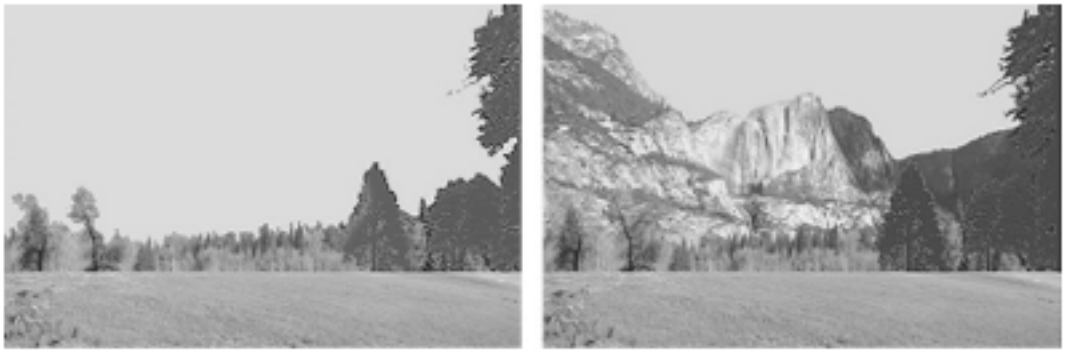
A third experiment compared visual and locomotive permeability interference with the perceived spaciousness, using the same methodology of the two previous experiments. In the third experiment, the environmental stimuli were changed to a depiction of an urban plaza. Three variables were used in this experiment; visual permeability expressed in the presence of fog or not, alternation of locomotive permeability; expressed by either walkable ground coverage (street pavement) or water. Four different architectural styles were also included in the study, resulting in sixteen different stimuli. Interestingly, architectural style accounted for the most variance in rating (19%), and fog accounted for (7%) variance. Similar to the previous two experiments foggy scenes were rated to appear more spacious (M = 3.96 vs 4.48), and paved stress also appeared more spacious (M=3.84) compared with water scenes (M=4.6). The fourth experiment aimed at excluding the familiarity of architectural styles as a potential influencer on the perception of spaciousness, by using artificially generated environments consisting of pillars of various thickness and height. The pillars were placed in either water or on a flat green surface. Both environments had two different light configuration (dusk and mid-day) and varied in visual permeability by either having fog or no fog. The results revealed that the fog accounted for 2,6% variance in perceived spaciousness, horizontal support resulted in 2% variance and time of day 2%. Similar to the previous experiment; horizontal support increased the sensation of spaciousness (M=3.36 vs M=4.0) and fog increased the perception of spaciousness (M=3.36 vs M=4.05). The time of day also affected the rating; midday reported a mean rating of 3.9 compared with 3.47 for dusk. The fifth and final experiment in the Stamps (2012) compared how street width and building recess in an artificial generated urban landscape affected preference. The study compared a twelve meters width street with a street of three meters width, and how recess differences of two meters affected the sensation of spaciousness compared with thirty centimetres recess, fog versus clear air was also included in the study. The findings revealed that fog accounted for 0% variance, street width accounted for 28,8%, and recess of the façade accounted for 2%. The urban scenes with a street width of twelve meters were rated to appear more spacious, compared with three meters (M 2.79 vs 5.82, respectively). Increased recess size enhanced the perception of spaciousness, M=3.40 for the recess of two meters and M=4.39 for thirty-centimetre recess. The results from Stamps (2012) study reveal support for the permeability theory two components; visual- and locomotive permeability, as both factors seem to interfere with the sensation of spacious. The most profound parameter was street width; affecting the possibility of conducting lateral locomotion in the environment. Locomotive restriction from reduced groud support (water) revealed reduced effect on spaciousness; drawing parallels to the prospect-refuge theory proposed by Appleton (1975), this decreased effect could be argued to be comprised by the fact, that the perceiver has already granted, the area in question, visual attention, and the

restriction in locomotion also would apply to a potential threat. Following Appleton (1975), then the environment outside of the visual attention should provide refuge to create a prefered environment. The variables included to restrict visual permeability revealed a small correlation with spaciousness, were concealment of information by shadows seems to interfere with the sensation of safety. Architectural styles interference on perceived spaciousness, as expressed in experiment three, could be suggested to be correlated with the findings in experiment five, where recess dimensions altered the perception of spaciousness, this should not exclude the potential effect of familiarity of the architectural style influence on preference.

As expressed in the previous study, the floor area is strongly correlated with spaciousness, as the more area allows both more substantial visual permeability and locomotive permeability. Environmental parameters, which affect the perception of spaciousness, without increasing the horizontal floor area, would be exciting findings. As the requirement of high-density development of urban areas (Meier, 1975, from Stamps 2011) and similar political goals to reduce global warming (Calthrope & Fulton, 2001; Williams, Burton, & Jenks, 2000, from Stamps, 2011), would require design strategy with conservative usage of space and materials.

Arthur E Stamps have since 2005 published twelve articles concerning the permeability theory testing various spatial properties influence on perceived spaciousness and enclosure. Stamps apply the mathematical definitions correlation (r) and standardised differences between means (d) to account for the environmental features influence of spaciousness and enclosure. Using these mathematical definitions allows for easy comparisons between the impact of environmental features. In Stamps (2000), an infographic influence measurement has been described, to illustrate these mathematical definitions correlation with effect on preference. (see fig 18 (from Stamps, 2007) . d=1.1, r=.54 correspond with adding a mountain to a scene; d=0.8, r=.37 is the difference between a gas station and a Beaux Art building; d=.35, r=.17 is similar to adding street trees and d.05, r=0.02 is the same effect as a molehill. The following text will survey the studies conducted by Stamps, and report in regards to their correlation (r) and/or standardised differences between means (d).

Stamps (2011) experimented with a digital designed, Japanese inspired, street setting. Three variables were included in the study; setback area; the aspect ratio of the setbacks and building height. The 25 participants were asked to rate the scenes from (1) not spacious, too (8) spacious. The findings revealed that building height accounted for the larges variance (8,7%) followed by setback ration (6,6%). The street appeared more spacious with 1:4 rationed setback (the longest side was parallel with the street) (M =4,57), compared with M=3.71 for the 1:1 rationed setbacks. The horizontal area had the smallest correlation with perceived spacious (6.2%). According to the theory proposed, the increased horizontal area should enhance the possibility for locomotive behaviour, but this factor was the smallest correlating with perceived spacious (r=.31), were setback ratio and building height both had more significant effects (r=.49). Increased building height both provide potential spots for threats and covers the visual connection with the sky. Similar obscuring of visual permeability



d = 1.1, r = .54

d = .80, r = .37

d = .35, r = .17

d = .05, r = .02

(Stamps, 2007)

Fig: 18 - Examples of differences (d) or correlation (r)

is provided by the 1:1 rationed setbacks, when the resulting building corners conceal more visual information of the deeper setbacks, compared to the 1:4 rationed setback. The depth of setback, therefore, resulted in a correlation of r=-.32. Similar to the visual obstruction from the setback in the Japanese street study, Stamps (2007) experimented using virtual models of an art gallery with free-standing solid partition walls. Twelve scenes of different views were selected within the model, varying by how much visual occlusion there was caused by the partition walls. Further two different light settings (300 and 600 cd/m2) was included as variables. The 26 included participants were asked to rate the stimuli on a scale from (1) enclose to (8) open. The visible horizontal area had the most substantial effect on perceived spaciousness (d=0.54), followed by a doubling of light levels (d=0.40). The visual occlusion by the subdividing partition walls decreased the perceived spaciousness by d=-0.46. The study was repeated, changing 2D depiction with a VR model, allowing participants to walk within the environment and then rate how spacious they perceived the environment. Similar to the 2D study, increasing the floor area from 77,5m2 to 115 m2 increased the perceived spaciousness (d = 0.943, r=0.426). Increasing the light levels from 300 cd/m2 to 600 cd/m2 had also significant effect (d=0.39, r=0.19). The strongest correlation with perceived spaciousness was the absence of the subdividing partition walls (d=1.37, r=0.56). The three subdividing walls, placed in a fashion which allows locomotion around both sides, thus not hindering locomotive behaviour; therefore, the strongest effect on perceived spaciousness was associated with reduced visual permeability.

Stamps (2010) experimented with how visual permeability through the exterior walls and roofing would affect the sensation of enclosure and spaciousness. The study comprised of a total of three different variables; the percentage of the exterior- and roof cladding substituted with transparent glass (25%, 50% or 75%); Floor area (77,25m2 or 309 m2) and time of day (night or day), together resulting in twelve different alterations of the octagonal room. Forty-six participants, subdivided into two groups of seventeen and twenty-nine participants. The subgroups was shown 2D images of the twelve rooms, one subgroup was asked to rate the stimuli from a scale of (1) open to (8) enclosed, and the other subgroup on a scale from (1) not spacious too (8) spacious. In regards to the perception of enclosure percentage of transparent surfaces in the exterior wall and roofing accounted for the highest variance (20,3%, r=-.55), were increased amount of glass surfaces made the room appear less enclosed. Floor area accounted for 4,2% variance, were increased floor area decreased the enclosed sensation (r=-.51). Time of day only accounted for 1,7% variance; daylight made the room appear less enclosed (r=.17). For spaciousness visual permeability through the rooms defining boundaries accounted for 13.9%, were increased visual permeability made the space seem more spacious (25% to 50%, r=.20; 50% to 75%, r=.91), the increase of floor area enhanced the perception of spaciousness, thus accounting for 22,5% variance (r=.56) and time of day 3,9%, were the hard shadows of direct sunlight made the room appear less spacious (r=-.27). Similar findings regarding enclosure were found in the following experiment, conducted

in a square-shaped room. The perceived enclosure as a function of visual permeability of the exterior facades was correlated effect size of r=-.83 and r=-.33 for the floor area. Study using a non-architectural setting; an open area with pillars displayed findings that perceived spaciousness is not correlated with the distance to the object hindering view r=.03, but more strongly correlated with visual permeability provided by the structures (r=.62). Windows, as displayed in the previously mentioned studies, allows an occupant to perceive the ambient environment. Windows, therefore, is an essential architectural tool to construct visual permeability. Stamps (2005) experimented with how window placement and size affect the perception of the enclosure and perceived safety. The study revealed that windows placed in the middle (eye level) made the room appear more open and safer, compared with placement along the edges (r=.47). The study used four different windows to exterior wall proportions; 14,3%, 28,6%, 42,9%. Interestingly, the increase from 14,3% to 28,6% increased the sensation of safety significantly (d=.46, r=.22), a lesser effect was displayed when increasing from 28,6% to 42,9% (d=.11, r=.05). The correlation between window placement and spaciousness is also expressed in Stamps (2006) encloser were more significantly correlated with vertical visual obstructions of view (r=.8), compared with overhead boundaries (r=.42) (Stamps, 2006).In the study of Brorson (2013), stress reduction was displayed from the introduction of large window panes, exceeding the dimensions used in Stamps (2005) study. As indicated by the Stamps (2005), the perception of safety and window area do not follow a linear curve and preference is correlated with providing a horizontal view. Repetition of the Brorson (2013) study, using variance in the window area, between test subject could potentially further illustrate the correlation between window area, and the perception of safety – stress response.

Other factors such as wall roughness, have displayed influence on perceived spaciousness, as demonstrated by Stamps and Krishnan (2006) open bookshelves, with or without books made the small square space of thirty-two square meter room appear larger, compared with flat walls (d=.37). This finding is interesting, as the floor area was reduced in size by the introduction of the bookshelves, but still was perceived larger. Stamps and Krishnan (2006) argued that the introduction of new three-dimensional spaces (the selves) as an alternative to the flat wall surface, made space appear larger by allowing vision to penetrate through the "boundary" of the room and into the shelves, and onto the behind laying wall. This argumentation follows the finding, that the introduction of books, covering around 50% of the shelves, reduced the perceived spaciousness, but was still rated higher, compared to the setting without shelves. Returning to locomotion: A study on the elongation effect on spaciousness was conducted using eighteen depictions of similar dull room, varying by three different floor areas (12, 16 and 20 m2); three different width-length rations (1:1, 1:2 and 1:9) and two different heights (2,44 m and 3,66 m). The result from this study revealed that elongation had the most substantial effect on the sensation of spaciousness (10,3%), followed by floor area (4,3%). Room height was reported not to affect the sensation of spaciousness (r=0). No difference in

perceived spaciousness could be reported between the 1:1 or 1:2 width-length rations, indicating that reduced sensation of spaciousness is only occurring when spatial locomotion, by the 1:9 ration environment, is restricted to only back- or forward motion (r=.40). A similar conclusion was made in a study, was elongation ratio varied from 1:1 to 1:2, with two points in between (1;1.26 and 1;1.587). Elongation and height of the room accounted, respectively, for 2% and 1% of the variance of perceived spaciousness, and respectively resulting correlation of .14 and -.26. The correlation of room height suggests that small rooms appear smaller when increased in height. These findings indicate elongation ratio is only a concern when the dimension of the environments restricts the occupants from lateral locomotion (Stamps, 2011). As suggested by literature and empirical findings of the permeability theory; visual permeability and locomotive permeability are essential properties of environmental preference. Visual permeability area obtained through high and even lumination (Stamps, 2012;2007), visual connection with the sky (Stamps, 2011;2010), reduction of visual obstruction of nearby environments (Stamps, 2011;2007), visual connection with adjacent environments (Stamps, 2010;2006;2005), interestingly familiarity also interfered with the perception of spaciousness (Stamps, 2012). In regards to locomotive permeability; floor area logically provided a more spacious environment (Stamps, 2007), interestingly elongation had a more substantial effect on perceived spaciousness (Stamps, 2012; 2 011). Indicating that there exists a threshold of required floor area and restricting locomotion to bidirectional had a more significant negative effect on perceived spaciousness (Stamps, 2012;2011).

Mystery, refuge, visual- and locomotive permeability (prospect) will, therefore, be extracted as vital parameters for environmental preference, and therefore also environmental features which correspondingly affects emotional modulation and corresponding behavioural response. The selection of prospect/visual- and locomotive permeability correlates with findings of Dosen and Ostwald (2016) meta-analysis of predictors of environmental preference of in interior-; landscape-; and urban settings. Mystery and refuge as parameters of environmental preference were also included in their meta-analysis; both parameters displayed supporting and demising evidence and primarily neutral findings. The majority of the studies included on mystery and refuge from the Dosen and Ostwald (2016) study, has been mentioned in this chapter, and the same scepticism on the methodology applied to investigate refuge as a parameter of environmental preference applies to the included studies in Dosen and Ostwald (2016). Refuge will, therefore, not be excluded as a parameter of environmental preference before the suggested alteration of the methodology is applied.

Subconclussion

The notion that architectural preference is the result of a cognitive decision-making process, resulting in an emotional response to facilitate adaptive behaviour, primarily based on low-frequency spatial representation, with the motivational goal to ensure safety is evidently supported by the previously reviewed theories and its corresponding empirical findings. As demonstrated by Jagt et al., (2014), high consistency was associated with preference ratings on a novel stimulant (α=0.853), indicating that emotional response from environments could be associated with universal biological hardwired schemas applied for interpretation, thus supporting for the preliminary theoretical framework on the existence of evolutionary developed universal schemas. When this is said, it is important to note that test subject in the vast majority of the reviewed empirical findings was university students at the researches own institution; thus large homogeneity in the test subjects age, ethnicity, cultural background and current environment of occupation exists within the test subjects and indicated by the Balling and Falk (1982), and Stamps (2012) familiarity is strongly correlated with preference. Further studies, with increased diversity in age, ethnicity, cultural background and the current environment is therefore required to confirm the existence and magnitude of a universal biological hardwired schema for interpretation of environments influence on emotional modulation.

As indicated by Woodcocks (1982) study; settings granting the occupant the ability to surveil the ambient environment is correlated with the superoptimal principle; the ideal position in which a creature most efficiently ensures the fulfilment of its biological goals. This notion correlates with Arthur E. Stamps (2007) permeability theory and Appleton's (1975) prospect-refuge theory, in that; environmental preference is strongly correlated with the ability to detect potential threats through vision. The empirical findings underpinning the permeability theory indicates preference is correlated with the amount of visual permeability (prospect) provided, primarily in the horizontal plane, both within the interior space and through the building envelope. Increased levels of illumination and uniform distribution of light, also displayed findings indicating its correlation with preference. The empirical findings of the permeability theory also displayed evidence that the second component of the Arthur E. Stamps (2007) permeability theory; locomotive permeability, is correlated with environmental preference. As indicated by empirical findings; preference for environments is correlated with the ability to conduct movement multidirectional. Locomotive permeability can be viewed as the environments affordance of providing opportunities for a flight response, were restricting locomotion to bidirectional would, theoretically, increasing the

concentration of cortisol in the occupant, as the environment could render potentially dangerous situations as a result of reduced options for conducting a flight response.

It is important to note that the methodology applied to display a correlation between visual- and locomotive permeability and emotional response is based on the hypothesis that the sensation of spaciousness is correlated with increased preference as a result of an alteration of mental state. As displayed by Brorson (2013) allowing visual permeability through the building envelope reduces the concentration of cortisol in the bloodstream, thereby providing evidence for the aforementioned hypothesis, and highlights visual permeability as an essential environmental parameter to reduce the potency of a stress response. Jiang, Chang and Sullivan (2014) study on the roadside trees influences on cortisol levels displayed an inverted u-curve correlation between tree density and cortisol reduction, the alteration in tree density alters the amount of visual permeability; increase the amount of natural content, provide refuge from potential threats behind the treeline (Appleton, 1975) and grant visual connection to a secondary environment behind the tree line possible by locomotion. As suggested by the inverted u-curve shape displayed by Jiang, Chang and Sullivan (2014) and the study of Brorson (2013) modulation of emotions, as a response to environments, can not be fully accounted solely by visual permeability. This claim correlates with R.S. Ulrich's (1983) Stress Reduction Theory; the included empirical findings on natures positive effect on mental health and performance; the behavioural observations displaying refuge as spatial parameter influencing emotional modulation (Whyte, 1980; Gehl, 2007) and mystery as the strongest predictor of preference in Jagt et al., (2014) study, indicating that environmental preference and corresponding emotional modulation is based on multiple spatial parameters.

Coherence and complexity in the Jagt et al., (2014) study was associated with low impact on preference, but interestingly, an inverted u-shaped curve were displayed at coherence scores above 5,5 (1-7), and combination with poor and unacceptable internal consistency for both parameters, indicating that coherence and complexity is significantly affected by subjective variables (schemas and intelligence) but that its correlation with preference is governed by underlying universal preference for cognitive congeniality environments which provides new information for interpretation, information with might provide fruitful information for future adaptive behaviours.

Indecisiveness on the underlying reasoning behind natures positive influence on the emotional system and cognitive performance, still prevails strongly in the scientific community, despite this; natural settings and single elements of nature have displayed improvement on both accounts. Furthermore, the exposure to natural environments has also been correlated with positive health outcomes for PTSD patients (Wagenfeld, Roy-Fisher and Mitchell, 2013) Views of nature, and inclusion of natural elements into the interior- and exterior space is, therefore, an essential architectural design strategy to improve the health and well-being of the occupants (Sternberg, 2000).

Novelty, familiarity and spatial memory

As indicated by Balling and Falk's (1982) savanna hypothesis humans have an evolutionarily developed preference for the African savanna, compared with other biomes. As indicated by their underlying study; the preference for the African savanna is equalled out as the result of the test subjects familiarity with the individual's native biome. As illustrated by the dual representation theory, the conducting of adaptive behaviours; modulation of emotional response, is governed by information gathered from previous encounters. The contextualisation of sensory information and corresponding emotional value grants the individual a broader understanding of the world, thereby allowing the individual, through intelligence and knowledge to conduct well-informed actions. The individuals understanding of the world is, thus, represented in the dualism between order and chaos – the known and the unknown. Novelty is the unknown - sensory stimulants without previously emotional associations. The human encounter with novelty resolves into an ambivalent categorie of assessment outcomes; promise (hope) and threat (anxiety)–interpretations based on subjective schemas and current mental state (Peterson, 1999). The previously reviewed empirical findings on environmental preference are primarily based on stimulants of novel environments; environments the test subjects have no previous experience with. The reviewed studies and theories, must, therefore, correspond with the emotional response generated from exposure to novel environments. As indicated by Balling and Falk's (1982) and Stamps (2012), familiarity plays a substantial role in emotional modulation by providing an emotional reference frame for the visual stimulation. Visual permeability (prospect), in correlation with the notion of novelty, can be viewed as spatial parameters affecting the available visual information (prospect) applicable for evaluating the environment, were, as indicated by the empirical findings, increased visual permeability increases the preference of the environment; reducing the anxiety response (reduced concentration of cortisol) as more of the ambient environment is available for interpretation by the situationally accessible memory system (egocentric spatial memory), decreasing the amount of the environment required to be assessed by cognitive interpretation conducted by the verbally accessible memory system (allocentric spatial memory) to account for the areas not perceivable. When the environment is novel, no allocentric spatial memory are available for computing a precise depiction of the concealed portion of the environment, as this subpart is not accessible by the situationally accessible memory system. The concealed portions of the environment are, therefore, purely accounted for by cognitive simulation; conducting a risk and reward assessment (promise and threat) of the unknown. The

presumably biologically hardwired schemas for interpretation can thus be viewed as the neurological architecture developed to address these challenges of facilitating an efficient adaptive behaviour in response to a novel environmental stimulant. Familiarity (allocentric spatial memory) will in this account, provide emotional association, accounting for the unknown, thus governing the corresponding risk assessment.These claims that novelty affects emotional modulation is supported by neurological studies of Chan et al., 2013, which displayed alteration in neurological activation between reexperiencing environments previously associated with a fear response. During exposure to the fear-conditioned novel environment increased activity was displayed in the amygdala, hippocampus and the parahippocampal place area - suggesting that cognitive stimulation occurred in the hippocampus, in correlation with the parahippocampal place area, to facilitate a proper emotional response by the amygdala. When revisiting the space, reduced activation in both the amygdala and the hippocampal was displayed, suggesting that cognitive processing and the emotional response, is altered as a result of allocentric memory.

Interestingly, the emotional value assigned towards the unperceivable unknown could be argued to be a reflection of the individual's current mental state, as it has been demonstrated mental state influence preference (Chatterjee and Vartanian, 2016). In the sense that individuals with a positive attitude would be more likely to presume the best of the unknown, and the polar opposite would occur for an individual with a more negative mindset. This line of logic corresponds with the notion that autobiography foreshadows the individual's interpretation of the world and corresponding presumptions of its state. Mystery, the strongest predictor of preference in Jagt et al., (2014) study correlates with the notion of novelty as a predictor of preference, as it illustrates a desire to obtain information from the unknow to gain potentially valuable information for future adaptive behaviour. This motivation desire is evident in the theory of Maslow (1943) and displayed in as an essential function of the hippocampus to organize learned sensory- and emotional information in a flexible manner, making the gained knowledge applicable for future encounters. Similarly, the importance of exposing the individual to the unknown is an essential role of the emotional system, as displayed in the aforementioned quotations concerning the homeostatic balance; the stability and existence of a living being require conduction of modification of the being in correlation with external forces to ensure the organism continuous stability. The motivational desire to obtain knowledge through environmental engagement can thus be argued to be a physical manifestation of memory systems interpretation of the unknown, with the desire to assign concrete emotional value to the interpretation in correspondence with the real world by exploring the outcome of the interaction. Interestingly, as noted by Kaplan (1987) on the definition of mystery; a clear distinction between mystery and surprise were required to be made. Mystery is promise of more information which gradually reveals its self and is correlated with visual information in the currently occupied space. In correlation with Kaplan's (1987) definition of mystery and the correlation between coherence and complexity as displayed in the findings of Jagt et al., (2014) environmental novelty can be argued to be a reflection of the

same correlation; novelty is associated with preference within a certain margin, a margin which is presumably associated with the mental state, autobiographical memory and subjective motivation of the respective individual. Novel low- frequency visual information might, therefore, be a strong predictor of preference in correlation with the other attributes associated with mystery; such as visual- and locomotive permeability as long as the flow and novelty of the revealed information is consistent with the mental state of the occupant and is consistent with the individuals preexisting understanding of the environments and its elements.

Emotional modulation as the result of risk/reward assessment between the known and the unknown is also reflected in the active usage of space – interpersonal distance. As displayed by Edward T. Hall (1969), interpersonal distance is active use of space in correspondence with social relations and cultural background. The social relations between individuals is a reflection of trust: Are the actions of the other individuals predictable and are these activities favourable for the individual; a parallel to the dualism of novelty - promise and threat. The regulation of interpersonal distance is correlated with the function of the amygdala (Kennedy et al., 2009) and in correlation with Appleton (1975) 'prospect-refuge' theories notion that other humans are the primary source of danger to the homeostasis balance, both physiological and psychological. Therefore, the primary threat individuals seek protection from, through environmental preference. The project will assume the hypothesis that the association of environments with social connections; what individuals are expected to be present in the environment, is a function of spatial memory. No indication is available if the social connection to a given space is conducted by the parahippocampal place area or a function of the hippocampus.

Based on the previous accounts; the emotional response generated from environments are tightly connected with the memory system, which supports the evaluation of the stimuli; either by assigning direct associations with the space and its occupants or through simulation to conduct a decision-making process, assessing the potential gain and danger associated with conducting behaviours in or towards said environment. The previously extracted parameters of environmental preference; refuge; mystery; visual- and locomotive permeability are, therefore, essential components of architectural design to ensure the occupants are granted the sensation of safety and corresponding positive emotional modulation. The magnitude of these parameters influence the conducted emotional modulation, is presumably affected by the occupants previous emotional association of the environment, rendering positive or negative association to the given enviorment. Illustration of this corelation is depicted in fig xx.xx

As illustrated in the simplified diagram of the cognitive process; low-frequency representation of the visual information is processed preliminary in the parahippocampal place area and subsequently in the other neurological areas supporting the faciliation of a emotional responce based on visual stimulants of enviorments. The visual information will incorporate egocentric spatial memory (what is seen) and allocentric memory (what is known/assumed) into a combined emotional response. The generated emotional response, will resolve

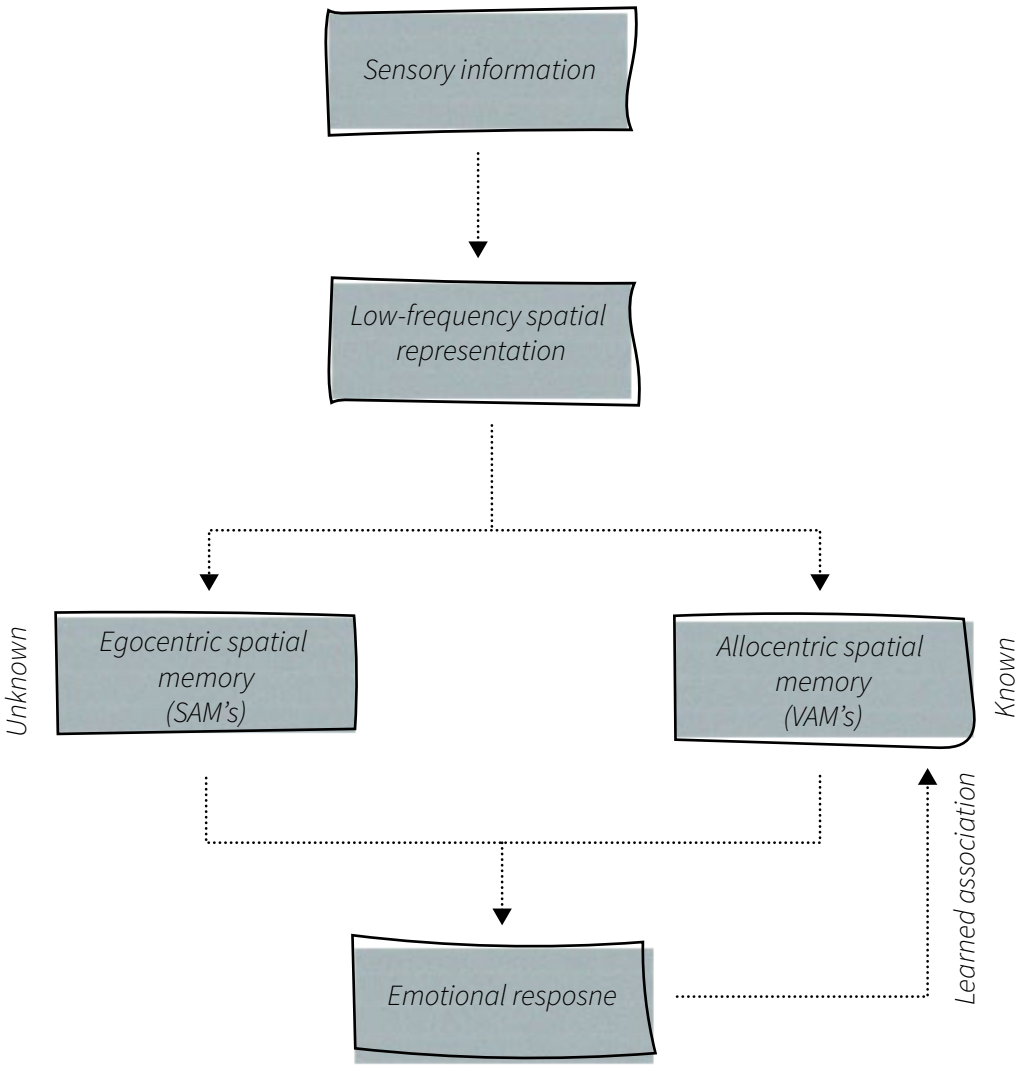


Fig: 19 - Emotional modulation memory

in emotional association with the space and stored as allocentric memory, making the result of the first encounter with the space applicable for future interpreation. This process is continious, resulting in everdeveloping emotional association with the environment, growing the amount of allocentric memory applicable for interpretation; making the enviorment for predictable. Postive experiences associated with the space will, thus result in increased preference and corresponding negative assocaitaion will render the space with reduced preference. This process, is postulated be the underpinning process resolving in familiarity being a strong predictor of preference, and as suggested by by Balling and Falk's (1982) study, resolving in the reduced requirement of spatial configuration to reduce the negative emotional response generated by the ambient enviorment.

Architecture and PTSD

Following the philosophical notion of aesthetics proposed by Hume (1757) or Kant and Smith (1952), and the personal bias involved in the aesthetics model of Helmut et al., (2004); Hekkert, (2006) and Coburn, Vartanian and Chatterjee, (2017), some general principles of aesthetic pleasure are universal for humans, and others are subjective. Following this statement, some architectural features do not automatically result in a uniform agreement in aesthetic appreciation, due to the involvement of memories and their emotional associations. Resulting in previous experiences can interact with the emotional response elicited by the perception of an environment, resulting in a potential difference in emotional responses to an architectural setting, just as expressed with the simplified example of tea versus coffee. Furthermore, the neurological alterations corresponding with the mental disorder of post-traumatic stress disorder might also interfere and affect the perception and evaluation of environments, as previously illustrated, there might exist some correlation between the disorder and the neurological and psychological mechanisms of the aesthetic experience. Post-traumatic stress disorder has so far shown to interfere with; grey matter volume of the hippocampus (Smith, 2005); modulating activation of the limbic and prefrontal areas (Lanius et al., 2011) and hyper-reactivity to traumatic stressors and potentially non-trauma related stressors, due to comorbidity with depression and other anxiety disorders (Wichmann et al., 2017; Brady et al., 2000). The psychology- and neurological abnormalities of post-traumatic stress disorders effect on emotional modulation by environments should, therefore, study to investigate if refugees divert from correlation broad forward in the previous chapter.

Emotional reaction from environmental perception

The two subtypes of Post-traumatic stress disorders as proposed by Lanius et al., (2011) is described either as an emotional under- or overmodulation when exposed to trauma cues. As previously described, these neurological abnormalities are not static; individuals can alter responses. Emotional undermodulation is facilitated by increased activation of the amygdala and right anterior insula and corresponding inhibition of the rostral anterior cingulate and medial prefrontal cortex. The anterior cingulate has previously been linked to monitoring homeostatic balance properties such as; blood pressure and heart rate and regulating impulse control and also involved in the facilitation of the emotional response generated by architecture. The medial prefrontal cortex has so far, in this paper, not been linked to perception and emotional response of architecture, but the orbitofrontal cortex, placed in proximity of the medial prefrontal, have shown increased activation as a result of the perception of environments. The functions of the medial prefrontal are thought to correlate with adaptive decision making (Euston, Gruber and Mcnaughton, 2013). As suggested by Earl Miller and colleagues, the prefrontal cortex receives both sensory and limbic inputs and the function of the prefrontal cortex is to integrate this broad range of

information to a combined response, thus facilitating contextually appropriate actions to obtain a particular desire (Miller, 2000; Miller and Cohen, 2001). The prefrontal cortex thus provides a 'top-down' regulation, influencing other neurological areas interpretation of the perception, to address the context and desired goal, in question (Miller and Cohen, 2001). As suggested by Alexander and Brown (2011), the medial prefrontal cortex creates neurological interconnection, constructing schemas associated with context and events and associate them with appropriate actions. The functions of these schemas are promoting positively adaptive behaviour through modulation of emotional and/or motoric response, in regards to both sensory and limbic information (Euston, Gruber and Mcnaughton, 2013). It could, therefore, be suggested that emotional over-/undermodulation subtypes of Post-traumatic stress response interfere with the emotional and motoric responses generated from the environmental stimulant; either inhibiting the functions of the medial prefrontal cortex, relying on the increased activation of the limbic regions to facilitate proper environmental behaviour - the emotional undermodulation subtype. Alternatively, the emotional overmodulation subtype, inhibit/reduce the limbic region's input to the processing by the medial prefrontal cortex function of facilitating proper contextual adaptive response and thereby increasing the novelty of the ambient environment, reducing consolidation with episodic memories and the autobiographical self. The majority (70%) of post-traumatic stress disorder patients respond to trauma cues with emotional undermodulation (Lanius et al., 2011). Following the previous claim; a postulation is, therefore, proposed that inhibition of the medial prefrontal cortex reduces the effect of egocentric representation of the context influence on emotional and motoric modulation, then a hypothesis can be constructed to explore this postulation:

i) The environmental variables linked to emotional modulation and preference have reduced efficiency on post-traumatic stress disorder patients eliciting emotional undermodulation during stress response occurring as a result of involuntary/voluntary retrieval of traumatic memories, compared to post-traumatic patients with an emotional overmodulation response.

Inhibition of the medial prefrontal cortex, will, therefore, result in the increased requirement of allocentric spatial memory to accounts for the emotional modulation associated with the context, thereby requiring to null-association is constructed with the given space prior exposure to trauma reminders to reduce cortisol concentration. Null-associations is constructed through positive experiences with the room. The room for therapy should, therefore, provide a significant amount of visual permeability and refuge and provide the necessary requirements of locomotive permeability in correlation with the interpersonal distances associated with the environments function and social value. In regards to emotional overmodulation, the same is true for the provision of refugee, visual- and locomotive permeability, but is less correlated with the requirement of constructing allocentric spatial memory prior to exposure, as the function of the limbic region is reduced during stress response due to emotional overmodulation.

Studies performed by Badura-Brack and colleagues (2017) showed that war veterans with PTSD had abnormally increased neuroactivity, during an eyes-closed resting-state task, compared to war veterans without PTSD. The alteration in activity was primarily concentrated in the medial temporal areas such as; the hippocampus, parahippocampal gyri and amygdala. These areas have shown to be essential for threat alert and emotion (Eckart et al., 2011; Morey et al., 2012; Meng et al., 2014) and as previously described these areas play a vital role in spatial perception and emotional valence of environmental settings. Corresponding with these findings; post-traumatic stress disorder has shown to interfere with the concept of personal space. PTSD patients have displayed altered behaviour in regards to interpersonal distance, such as; hiding, creating more distance to "intruder"; increased vigilance behaviour; increased verbal volume and reduced mood (Brown and Yantis, 1996). These behavioural alterations, from nursing literature, can be interpreted as non-verbal communications strategies applied by PTSD patients due to resulting stress response from the intrusions (Allekian, 1973; Bullock-Loughran, 1982). Unfortunately, no empirical findings have researched an environmental preference alteration due to PTSD, such as if PTSD patients having an increased preference of larger space with increased allowance for locomotion, thus restricting to a proposed postulation that there might exist a preference bias in PTSD patients for environments which allows greater control of interpersonal distances.

i) Patients with post-traumatic stress disorder will strongly prefer an environment which grants more significant control over personal distances.

ii) Environments granting more control over personal distance will reduce stress response from an intrusion of personal space and thus elicit a more positive associated behavioural response.

ii) Increased vigilant behaviour and increased activation of the hippocampus, parahippocampal gyri and amygdala could indicate increased attention towards the spatial properties of their surroundings to locate potential threats; increasing environments modulation of emotions.

As indicated by the abnormalities in neuroactivity, post-traumatic stress disorder patients have an alternated definition of interpersonal distances. Larger spaces are, therefore, required compared to healthy individuals to ensure the ambient environment does not result in increased cortisol concentration, due to insufficient space to maintain desired interpersonal distance through locomotion. Interestingly, the increased vigilant behaviour of post-traumatic stress disorder patients displays an alteration of mental state. This alteration, in correlation with the aforementioned discussion of novelty influence on architectural preference, results in the presumably increased requirement of the spaces to provide visual permeability, as the alteration of mental state presumably resolves in an increased sensation of threat from the unknown. The increased attention towards the environment influence on the sensation of safety is also reflected in the increased activation of the parahippocampal gyri; an area previously associated with environmental perception and fear.

Navigation and spatial memory

The hippocampus and other limbic regions, including the parahippocampal place area and parahippocampal gyri, have been linked to convey essential neurological functions in regards to spatial knowledge and navigation. Especially the hippocampus plays an essential role in these functions. This fact has been a staple in neurological research since the discovery of place cells in rodents, which had increased activation during navigation task requiring allocentric spatial processing (O'Keefe and Dostrovsky, 1971). Cognitive map theory suggests that place cells construct a cognitive map of the environments human and other animals experience throughout their lifespan. This information is an essential tool for the cognitive task associated with allocentric navigation, such as; taking shortcuts and planning routes (O'Keefe and L. Nadel, 1978). Modern neuroscience has isolated the place-cells to be located bilaterally in the hippocampi (Iaria et al., 2007). Alteration of the structural integrity of the hippocampus might, therefore, interfere with a individuals ability to orientate and navigate within an environment (Iaria et al., 2008). As previously described; meta-analysis has correlated post-traumatic stress disorder with bilateral reducing of grey matter in the hippocampus, suggesting a possible alteration in PTSD patients ability to perform navigation tasks. Researcher Jessica Kathrine Miller (2016) has made vast contributions to this inquiry by comparing navigation efficiency and behaviour over multiple test paradigms. Comparing her findings between three subject types; non-trauma healthy control group; a trauma non-PTSD group and a PTSD group. Her first test paradigm applied the four mountain task, developed by Hartley et al., (2007), to compared spatial memory on a static topographical test requiring allocentric spatial understanding to be completed successfully (Hartley et al., 2007; Hartley and Harlow, 2012). The test paradigm grants participants a 10-second depiction of a computer-generated mountain scene, followed by a two-second blank black image. Then the participants are then asked to select between four images of what image corresponded with the preliminary depicted picture. Three of the four images displayed during the task is variations of the preliminary depicted mountain but altered in regards to spatial and non-spatial features. The last of the four task photos is the same mountain as the previous stimulant but depicted from a slightly altered perspective. The testing paradigm was run fifteen times. Pair-wise comparisons between participants group showed that PTSD patients had a significantly reduced score, compared with healthy and trauma exposure non-PTSD test subjects. No significant reduction in mean score was evident between the healthy controls and the trauma exposure non-PTSD. Indicating that post-traumatic stress disorder affects short-term allocentric spatial memory and processing (Miller, 2016). Using an alternative route paradigm, originally developed by Wiener et al., (2013), active navigation abilities were compared between the same three subject groups. The alternative route paradigm measures both egocentric (viewpoint dependent) and allocentric (non-viewpoint dependent) navigational skills and are divided into six blocks to display learning progress. The findings from this study reported that the PTSD subjects performed significantly

worse using egocentric navigation compared with the two other groups; no significant difference in performance was reported between trauma-exposed non-PTSD and healthy controls. No significant increase in performance was displayed during the six blocks, indicating no egocentric navigation learning during the task; this result was universal for all subject groups. During tasks, requiring allocentric navigation strategies, the PTSD participant group performed significantly worse, compared to trauma-exposed non-PTSD and healthy controls. No significant difference in performance between trauma-exposed non-PTSD and healthy controls was reported, suggesting that PTSD and not trauma exposure affect allocentric navigation skills. During the six blocks, the performance was increased for all testgroups; this result indicates allocentric spatial learning and also contributed to participants alternating their navigation strategies to increase performance. Performance increased as participants applied allocentric strategies instead of egocentric strategies, avoiding the usage of associative cue's and beacon strategy – two strategies that were primarily used by the PTSD groups (Miller, 2016). The findings suggest that PTSD affect navigational performance due to both reduced allocentric spatial understanding in perspective task and reduced performance on active navigation task due to impaired allocentric spatial understanding. These findings correspond with similar studies concluding the existance of impairment in allocentric navigation in PTSD patients (Smith et al., 2015). This findings correlates with the deficits in contextualisation of sensory information, as previously represented by the dual representation theory. As noted by Burgess (2008) the reason for applying egocentric navigation strategies is because it might be easier to compute proper behaviour, when confronted with simple information. When faced with a broader a spectrum of information such as; multiple locations and extended layouts, it can be harder to apply the associative strategies of egocentric navigation to compute the vast amount of information and thus requiring allocentric strategies to facilitate proper behaviour. Comparing this with the findings presented by Miller (2016) and Smith et al., (2015) and the underlying deficits in the emotional systems (see Chapter xx). PTSD-patients might be biased, to apply egocentric navigation strategies, not because they are the most efficient, but due to the fact, their psychiatric illness is developed as a response to deficits in the specific neurological areas responsible for allocentric navigation and contextualisation of sensory information.

The design of cognitive congeniality environments for treatment and housing of post-traumatic patients shall, therefore, be easily navigatable with egocentric depended strategies such as; associate cues (behaviours associated with landmark/ location) or beacon strategies (landmarks). The post-traumatic stress disorder bias for egocentric navigational strategies also correspond with neurological findings suggesting that other neurological areas, besides the hippocampus, is involved in the egocentric spatial processing, such as; the parietal cortex, caudate nucleus and striatal circuits (Andersen et al., 2007; Campbell et al., 2009; Banner et al., 2011), areas which have not been associated abnormalities

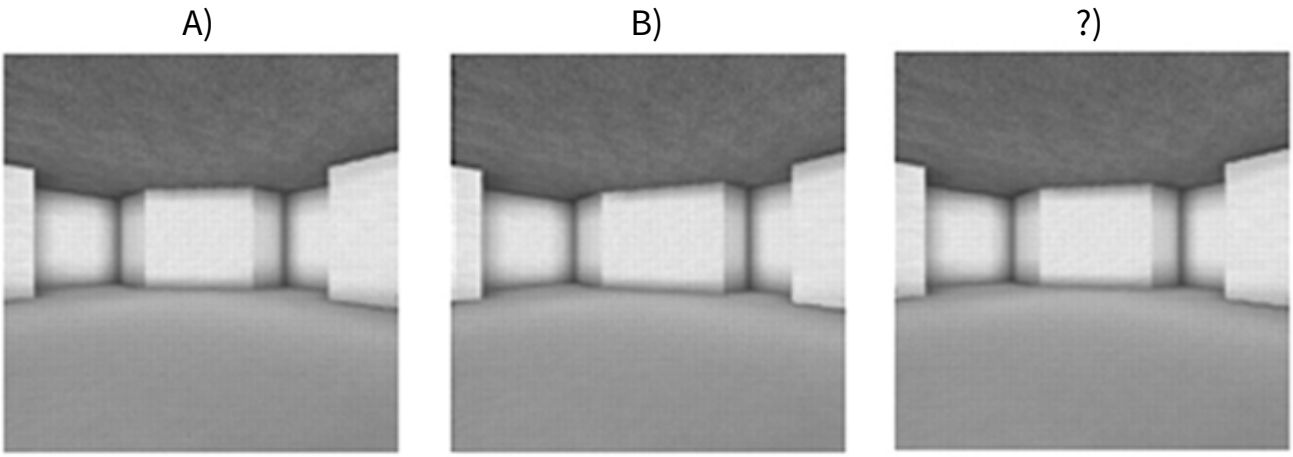
due to post-traumatic stress disorder. It should be noted that the previous studies only consisted of visual information effect on navigation. The inclusion of non-visual information could potentially alter navigation efficiency by enhancing the amount of sensory information associated with a given location. The hippocampus would assumably still be responsible for associating a non-visual stimulant with spatial memory, the inclusion of other sensory information might, therefore, not result in a significant alteration in allocentric navigation efficiency in PTSD patients as the deficits are the result of abnormalities in the function of the limbic region and not a result of impairment in neurological areas responsible for perception. The acute stress response, or in other words; fight-or-flight response, is the physiological reactions to threats. This system, in its commonly, known term, consist of two choices of adaptive behaviour to ensure the well-being of the individual; fight or flight. As mentioned earlier PTSD patients have displayed increased stress response due to an invasion of personal space. It could be argued that reduced allocentric spatial understanding restricts PTSD patients to coordinate a potential route for the flight response by egocentric representation purely. A hypothesis could, therefore, be constructed arguing that spaces allowing coordination of a flight response through egocentric navigation could reduce the stress response in PTSD patients. Egocentric navigation is view-point depend, then environments facilitating egocentric planning of escape routes would also be more open environments, two hypotheses can thus be constructed:

i) Environmental features allowing viewpoint depending navigational strategies to plan potential routes of escape could reduce the environment's influence on stress response in PTSD patients

ii) Environments efficiently navigated by egocentric navigation strategies would reduce the mental taxation of PTSD patients during a navigational task.

Further inquiry could be made to examine how navigation behaviour is affected by the stress response. As indicated by the abnormalities of PTSD increased levels of stress hinders the formation of allocentric spatial memory, stress response might, therefore, also affect the capacity for allocentric navigation in the moment of distress. No study could be located examining the correlation between cortisol levels and strategies of spatial navigation and corresponding performance; this question could foster an exciting line of inquiry to examine navigation ability, and spatial knowledge affects the human stress response from environments.

Spatial discrimination



(Graham et al., 2006)

Fig: 20 - Spatial disrimination task from Grham et al., (2006)

Hippocampal damage has in the study of Graham et al., (2006) been linked to a reduced ability to discriminate between spacial features. Their study included three patients with partial bilateral damage to the hippocampus. Two of the participants had hippocampal damaged induced by anoxia. The third test subject had experienced carbon monoxide poisoning. The test subject was given a task of discriminating between three images of similar computer-generated spaces; one of the images were slightly altered. The participants were measured on both the time and accuracy on discriminating between the three images to isolate what image was different from the two others. (see an example fig. 20). Compared to healthy controls, the hippocampal damaged subjects performed significantly worse, with a mean average accuracy of 66% over 30 stimuli, compared with 88% mean average accuracy for the healthy control subjects. Similar results were displayed when comparing reaction time; the hippocampal damaged participants completed each stimulus after approximately 3,5 second compared with the healthy controls which performed more

accurately and above one second faster. Interestingly, the same research paradigm was run with stimuli of faces. Discrimination between facial features yielded no significantly performance alteration between participant groups compared with discrimination of spatial settings (Graham et al., 2006). Similar conclusions on a reduced function of declarative memory associated with spatial discrimination task as a result of hippocampal damage have been made by other researchers such as; Lee, Buckley, et al., (2005); Lee, Busset, et al., (2005) and Lee et al., (2006). None of these studies included PTSD induced hippocampal damage. If the same findings apply for Post-traumatic stress-induced hippocampal damage requires PTSD isolated empirical evidence to clarify. This paper will assume the following hypothesis:

i) Post-traumatic stress disorder induced hippocampal damage might reduce declarative memory associated with discrimination of spatial features.

The assumed deficit in declarative memory associated with discrimination of spatial features interferes with the concept of novelty and the motivation desire to explore as a predictor of preference. The potentially reduced declarative memory of spatial features reduces the individuals capacity to distinguish between novelty and continuation of visual information, thus reducing the correlated preference and potentially increasing stress response elicited by the environment as the result of the increased sensation of novelty, despite the spatial configuration being largely a continuation of the already explored environment. The deficit in declarative spatial memory in combination with increased vigilant behaviour indicates that architectural settings designed for post-traumatic stress disorder shall contain a low variation in visual information, ensuring the exploration of the environment is perceived as a continuation of the known – reducing an anxiety response.

Emotional associations and spatial memory

The parahippocampal place area has previously been suggested to compute and contain information of emotional responses associated with an environment based on previous experiences and thus provide bottom up-regulation in regards to environmental valence. The previous section explored the abnormalities of hippocampus volume, cursed by PSTD, effect on spatial memory and displayed serve impact on allocentric spatial memory; a finding which correlates with the memory deficits of post-traumatic stress disorder patients. The function of the parahippocampal place area is to correlate contexts with emotional responses, and its proximity to the hippocampus could suggest possible abnormalities of the parahippocampal place area functions, due hippocampus abnormalities as a result of post-traumatic stress disorder. This postulation correlates with the previously mentioned study on spatial discrimination task, were hippocampus damage was correlated with decreased performance in a spatial discrimination task, but not during facial discrimination (Graham et al., 2006). These alterations could be bound by multiple factors such as alterations in activation patterns or reduced structural integrity of neurological structures, facilitating the function of the parahippocampal place area. Currently, no studies have investigated abnormalities in parahippocampal place area volume, function or activation in patients with PTSD, therefore restricting a conclusion regarding parahippocampal place area deficits to estimations based on the previously constructed inquiry of the neurological mechanism underpinning the functions of the parahippocampal place area, hippocampus and post-traumatic stress disorder. As suggested by Epstein et al., (1999) the parahippocampal place area is only involved in two functions; perceptual or emotional encoding of place information, and not directly involved in place recognition, planning routes or place encoding; functions with previously have been correlated with the place-cells of the hippocampus. These and previous findings could indicate that parahippocampal place area correlates perceptual and emotional information with place-cells in the hippocampus to inform spatial perception with somatic markers to facilitate successful adaptive behaviour. As illustrated by Epstein, Higgins and Thompson-Schill (2005) representation in the parahippocampal place area is primarily view-point dependent, but through learning, the representation is altered to view-point independent, suggesting spatial learning occurs; a neurological function associated with the workings of the hippocampus. It could, therefore, be suggested that hippocampal deficits, such as; volumetric abnormalities as presented in post-traumatic stress disorders patients; affect the function of the parahippocampal place area by restricting the recall of spatial information from the hippocampi (Burgess,

2002; King et al., 2002; Ekstrom et al., 2003). Restriction of recalling spatial information and associated emotional markers could result in the increased novelty of previously experienced spaces, compared to healthy individuals, as somatic markers is not sufficently correlated with contextual information facilitated by the place-cells of the hippocampus. This claim is supported by increased activation in the hippocampus during exposure to familiar environments (Maguire et al., 1998) and correlates with the dual representation theory. Hippocampal abnormalities restriction of parahippocampal place area functions in post-traumatic stress disorder patients could, therefore, result in reduced emotional association with environments, thus strengthening the perceptual information effect of emotional valence towards environments due to decreased bottom-up regulation by the parahippocampal place area to facilitate adaptive behaviour. Empirical studies are required to confirm or deny this claim, but this paper will result in the construction of the following hypotheses:

i) Post-traumatic stress disorder patients will have reduced ability spatial associations, resulting in reduced familiarity and corresponding reduced bottom-up regulation of emotional valence towards environments.

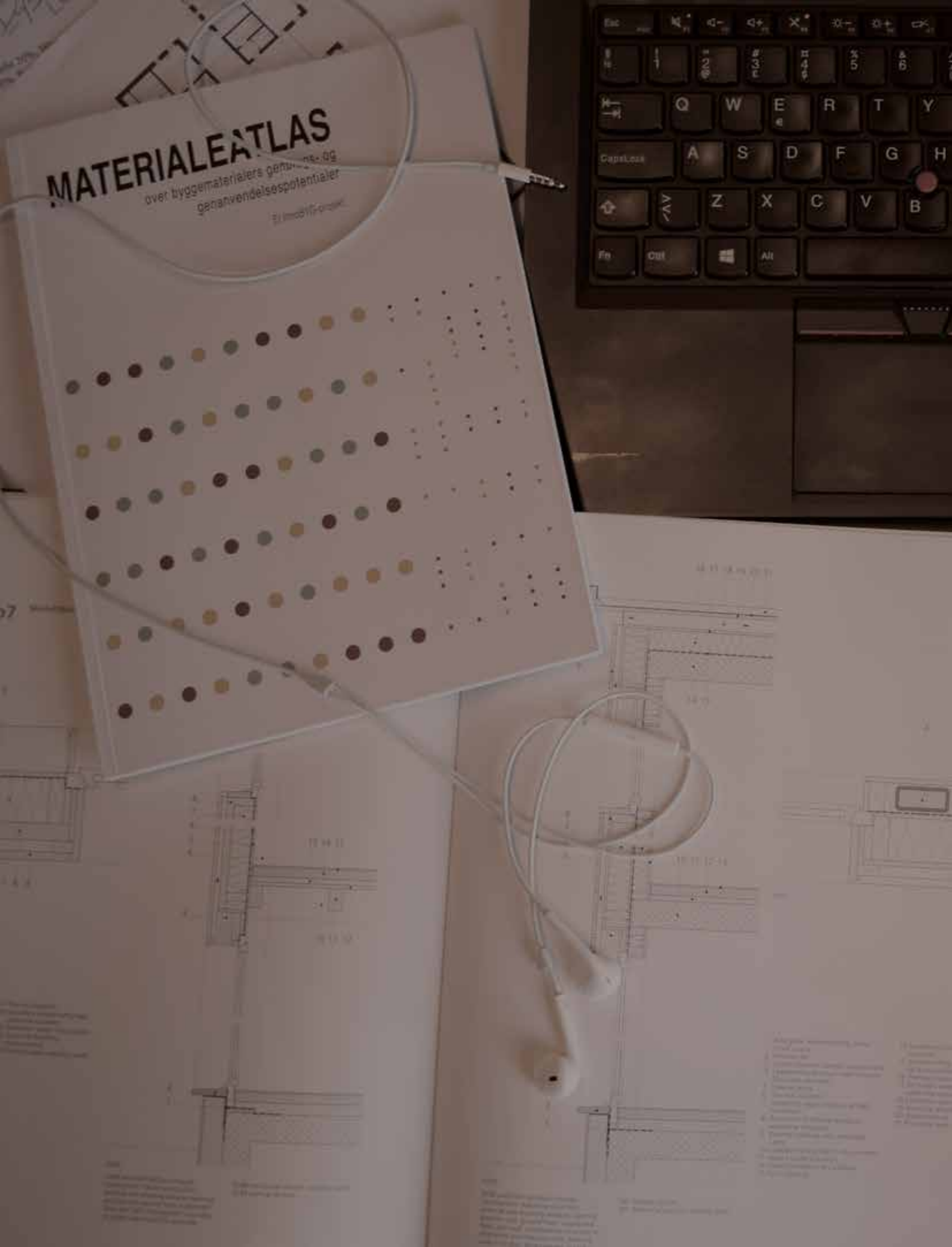
As indicated by the reduced structural integrity of the hippocampus in post-traumatic stress order patients, and corresponding reduced allocentric spatial memory. Post-traumatic stress disorder patients are presumed to reduced allocentric spatial learning, thereby restricting the ability to associate environments with social- and emotional value. In correlation with the remarks on novelty and familiarity effect on emotional modulation as a result of architecture, it must be assumed that post-traumatic stress disorder patients depend significantly more by spatial interpretation by egocentric spatial memory to facilitate adaptive behaviour, therefore, less likely to develop familiarity to an environment and have corresponding reduction in anxiety response from said environment. It is therefore essential that architecture designed for post-traumatic stress disorder patients is designed to provide a significant amount of visual- and locomotive permeability and refuge.

Autbiographical memory and preference

Autobiographic self consists of a framework of various memories associated with a somatic marker informing perception, resulting in memories with a 'value stamp', signifying the biological value of these memories (Damasio, 1994). Memory, imagination and thinking is a variation of re-arrangement of these previously associated memories stored in the crystallised memory, representing them in our working memory as thoughts and ideas (Brorson, 2013). As the majority of the Danish refugee population originate from middle eastern and African cultures, the implementation of architectural features associated with these native cultures could, therefore, affect the aesthetic valence of the architecture by introducing familiarity; mirroring cultural settings such as their native architecture styles, materials and the inclusion of symbols of cultural or religious value. The line of inquiry would require extensive research of subjective preference of the population group in question and could result in conflicting autobiographic preferences. The autobiographic memory influence on aesthetic preference could also be suggested to be altered due to Post-traumatic stress disorder as the experiences the individuals have encountered during trauma and post-trauma could be argued to affect the 'value stamps' associated with context features of environments, as traumatic experiences might have occurred in their native settings, potentially acting as a somatic marker releasing a stress response due to uncontextualised SAM's. The autobiographical effect on environmental preference is, therefore, excluded from the inquiry.

Conclussion

As demonstrated by the reviewed academic works, there exists a correlation between environments and humans emotional system; evidently, the neuroendocrine system is modulated by spatial configuration. This correlation indicates that architecture can assist the treatment of post-traumatic stress disorder by carefully architectural design. The spatial configuration of the architectural composition shall correlate with the universal desire to achieve a sensation of safety. The empirical works of environmental psychology indicate that architectures modulation of the neuroendocrine system is correlated with the environments ability provide prospect (visual permeability), refuge and locomotive permeability. The requirement of these spatial attributes is correlated with the occupants preexisting emotional- and social associations with the environment. Settings associated with unpredictability; a diverse range of people with low social connections or lack of previous understanding increases the requirement of spatial dimensions, refuge and visual permeability to migrate the anxiety response. The environments reduction of cortisol concentration in bloodstreams of its occupants is generally beneficial for the health and well-being of all types of occupants. In direct correlation with post-traumatic stress disorder; reducing of the ambient environments influence on cortisol concentration of in its occupants is indicated to have a positive effect treatment of post-traumatic stress disorder, as the result of reduction of the saturation of cortisol at the MR- and GR-receptors in the hippocampus. Alteration of the saturation has displayed to support memory and cognitive function; improving the individual's ability to contextualised the memories associated with the trauma exposure. As indicated by the psychological- and neurological abnormalities of post-traumatic stress disorder, the illness is associated with deficits in allocentric memory performance and alteration of mental state, therefore, also directly interfering with the neurological and psychological underpinnings facilitating the emotional response from environments. Architecture designed for individuals suffering from post-traumatic stress disorder shall, therefore, be designed to be navigatable with egocentric navigation strategies and provide the sensation of safety based on egocentric spatial memory through the environments affordance of refuge and visual- and locomotive permeability.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02

Design program

Vision

Architects has the possibility, and responsibility, to design a better world - one site at the time. And what a world we live in!? Currently, the world is experiencing two major crises: global warming and the refugee crisis, both of which are of tremendous concern.

The following architectural project shall, therefore, aim at combatting both issues. The main focus of the following phase is the design of an asylum centre positioned in 'Hammer Bakker'. The center is envisioned to be designed specialized for the treatment of post-traumatic stress disorder in asylum seekers. Post-traumatic stress disorder is, in combinitation of other mental abnormalities, a substantial constraint for the asylum seekers ability to integrate into their host nation or return productively to their native countries. In correspondence with the preliminary theoretical work; the architectural shall be designed with the desire to reduce the occupant's concentration of cortisol in the bloodstream. Cortisol concentration has displayed to be significantly correlated with the severity of post-traumatic stress disorder, and high concentration of cortisol has been correlated with reduced cognitive- and memory performance; two neurological functions which reduced performance is detrimental on the treatment of post-traumatic stress disorder. In correlated with the findings of the previous inquiry; the architecture shall be designed to ensure sufficient amounts of visual- and locomotive permeability and refuge. Similarly, the architecture shall take into consideration the neurological- and psychological abnormalities correlated with post-traumatic stress disorder; ensuring cognitive congeniality and ensuring the architecture is not an ambient stressor for the occupants.

The architecture shall be designed with conscious considerations on the buildings resulting environmental impact; embodied impact and its energy consumption; ensuring the proposed design is correlated with the international responsibility to reduce global greenhouse gas emission, and as buildings are on of the main sources of global warming this is an indisputable essential requirement (JCSS, 2018).

These considerations shall be combined into a design proposal for an approximately 13000 square meter asylsum center, which includes the required functions; accommodation; activities; healthcare and administration.

The asylsum process

Following the Dublin, regulation states that the immigration process is required to be conducted in the nation where a governmental authority registers the asylum-seeker for the first time, in Danmark, the police are assigned to this task. The immigrants are at their first encounter with the police required to state their identity and their reason for applying for refugee status in Demark. After the official registration, the immigration service accommodates the immigrant into one of the sixty-five refuge centres in Danmark, while they await the verdict on their application for asylum. The case process consists of a preliminary questionary, followed up with an initial interview. The first interview is conducted within three to six month after registration. The immigration service conducts the first interview, to establish information regarding the immigrants identity, nationality, family, travelling route to Denmark, and reason for seeking asylum. Approximately a half year later, a second interview is conducted. The second interview is conducted to firmly establish, in details, the immigrant personal motivations and reasoning why he/she should be granted asylum status in Danmark. If the immigration service will not grant asylum status, then the case is transferred to the Danish Refugee Council. This council possess the right to veto any decision made by the immigration service of Danmark if the verdict contradicts previous rulings or if The Danish Refugee council see a reason for granting the individual asylum status.

After the final decision, the immigrant will receive a letter with either an acceptance or a decline for their application of refugee status. When/if granted acceptance; the refuge will be assigned to a municipality and will be assigned a permanent place of residence, outside of an asylum centre. If the immigrant has is application declined, he/she will be transferred to a departure centre. The immigrant has the opportunity to appeal the verdict with legal counsel from the Refugee Appeals Board. If sent to a departure centre, the immigrant has to sign a document; stating the will leave the country voluntarily (DFH, 2019). In 2016, the process from registration to verdict lasted on average 550 days (Bendix, 2017). The individual asylum seekers, therefore, spend a substantial portion of their life in an asylum centre; the condition and treatment at the asylum centre's will, therefore, posses a considerable influence upon the health and well-being of asylum-seekers will waiting on the outcome for their ambiguous future.

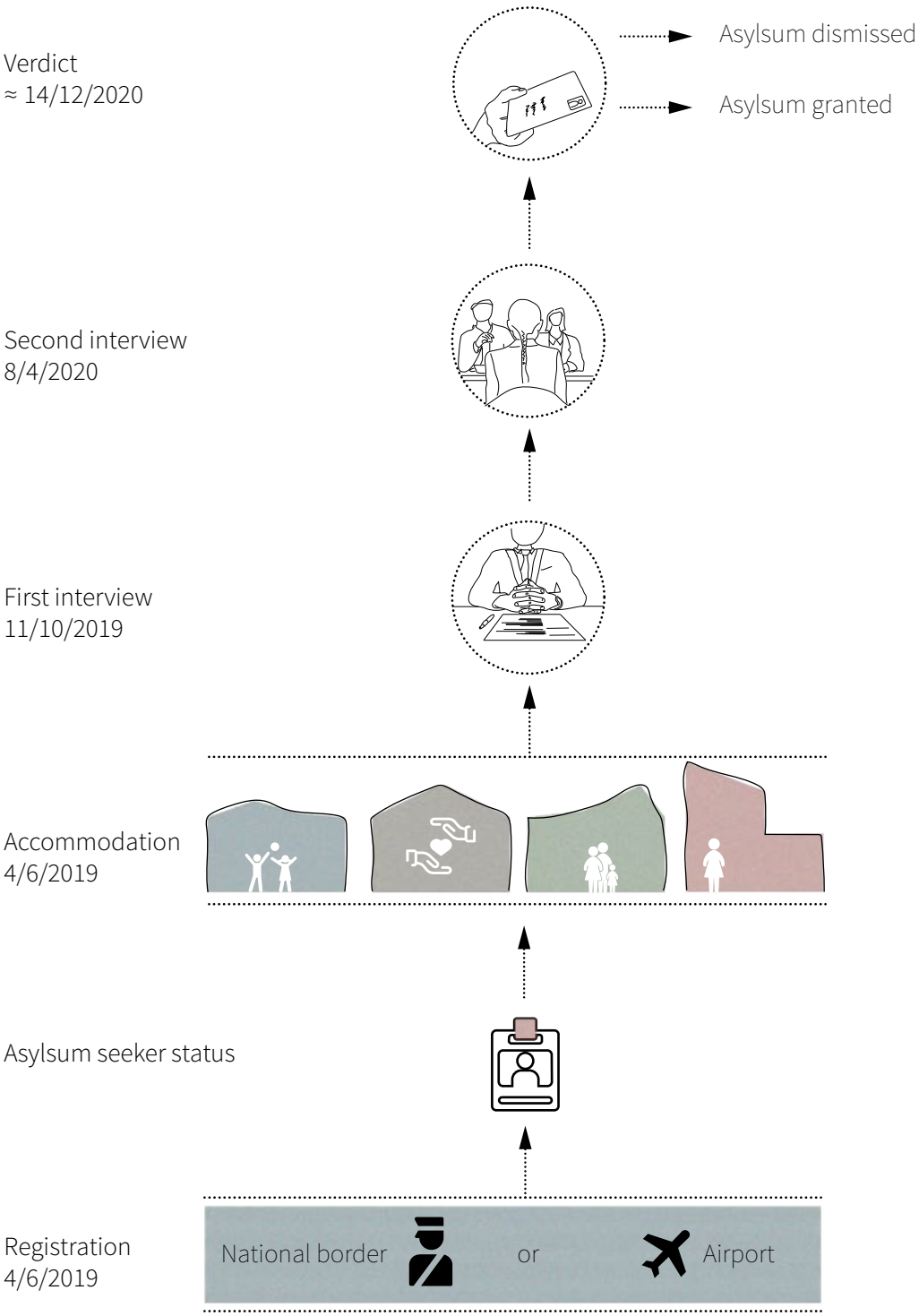


Fig: 21 - Asylum process

Asylum-centers of Denmark

Currently, sixty different asylum-centres operate in Denmark. The centres are scattered across the whole nation and are operated under the Danish immigration service, who outsourced the daily operation to other governmental institutions; the probation service and municipalities and NGO's. The non-governmental organisation Red Cross runs a substantial amount of centre's, some in cooperation with the respective municipality. The variation in management is perceivable in the variation of function, dimensions and focus in the various the asylum-centres of Denmark. The centres lead under Red Cross management is primarily focused on individuals with special requirements, compared to the general asylum-seeking population; these difficulties are both mental and physical. Red Cross centres also typically contain specialised education facilities; schools and kindergartens. The asylum-centres run by the municipalities uses already established public schools, for the eduction of asylum-seekers Sjælsmark is the only centre managed by the probation service, the function of Sjælsmark is to accommodate denied asylum applicants, while they voluntarily leave Denmark. The different functions affect the dimensions of the centres, which therefore vary drastically; ranging from 60 accommodated individuals to around 600 individuals in the largest centres. The Danish immigration service suggests that a minimum of three-hundred individuals accommodated per centre is required to assure cost-efficiency (Larsen, Whyte and Olwing, 2015).

The project aims to design an asylum-centre which supports the treatment of post-traumatic stress disorder, the project, therefore resembles the centres under the management of Red Cross. The typical Red Cross asylum centre contains; accommodation, recreative facilities, offices, reception, medical clinic, school, kindergarten, playground, playfield and carpark (Rødekors, 2019). Asylum-centres, therefore, almost resembles a small independent city; besides the lack of stores. This resembles is visible in the typical structure of the Danish asylum centre's, where the residential buildings are positioned around a central structure containing the common amenities; offices, school and the health clinic (Larsen, Whyte and Olwing, 2015).

Fig: 22 - Asylum-centres in Denmark

- Municipality of Jammerbugt (11)
- Municipality of Landland (9)
- Municipality of Tønder (4)
- Municipality of Thisted (2)
- Municipality of Vesthimmerland (5)
- Red Cross (17)
- Municipality and Red Cross (2)
- Probation Service (1)

Accommodation for asylum-seekers

I In broad terms; an asylum centre is a place of residence for asylum-seekers; granting them a place to call home and provide them with the necessary assistance; medical treatment; psychological treatment and social counselling. An interview with Karen Margrethe Bjørn, the healthcare manager at Jellinge asylum centre, was conducted to get a better understanding of the centre's functional requirements and its everyday life. In Karen Margrethe Bjørn optic; the essential task of an asylum centre is to allow the residents to obtain a regular and stable everyday life – the deepest motivation of the asylum seekers. The asylum centre cultivates this by facilitating a safe haven and providing the necessary assistance, such as; health clinic, administration, activities and assisting with any problems which could occur (Rødekors, 2019). The primary goal of this chapter is to establish a correlation between accommodation design and the psychological needs and mental abnormalities in asylum-seekers with post-traumatic stress disorder.

Asylum-seekers arrives in Denmark with considerable variation in accompany; either together as a joined family, friends, together with strangers or unaccompanied (unfortunately not data were able to be located illustrating the composition). The variation in social relations internally between asylum-seekers requires flexibility in accommodation possibilities; as the centre shall provide ideal accommodation for both families, group of friends and individuals who arrive in Denmark unaccompanied. In correlation with the preliminary phase; the preference for the spatial configuration is presumably significantly correlated with the social connections an individual have with the other occupants of said space. The social dynamics of the interior space are, therefore, closely correlated with environments emotional modulation. Furthermore, the architectural composition shall reflex the asylum seekers motivation to obtain a normal life. The project suggests three different conceptual compositions of accommodation; large family accommodation (fig. xx.xx); adjoined family accommodation (fig xx.xx) and accommodation specialized for unaccompanied individuals (fig. xx.xx). Common for the three compositions is that they are organized around a central gathering point; the kitchen - the hearth. The ability to cook food within the accommodation unit is an essential component of the concept of home and strongly correlated with the desire to grant the occupants the ability to obtain everyday habits, such as cooking a meal and sharing it with friends and the family. The guidelines provided by Rødekors (2019) suggest that one kitchen shall be provided for every tenth occupant. This suggestion is based on the common asylum-seeker and economic restrictions; this project will divert from the recommendation and suggest that the emotional value assigned to a private kitchen is worth the increased expenses, as post-traumatic stress disorder has been correlated reduced capacity for social interaction (e.g., Allekian, 1973; Bullock-Loughran, 1982; Brewin and Holmes, 2003). The kitchen should, therefore, be assessable for a reduced amount of individuals and only accessible for individuals of whom the user has social connections with; ensuring that the kitchen area is associated with a reduced anxiety response; increasing the likely hood of increased usages, better management of the kitchen facilities and ensuring the kitchens function as a central gathering point to cultivate social relations between individuals sharing the function.

Large family accommodation

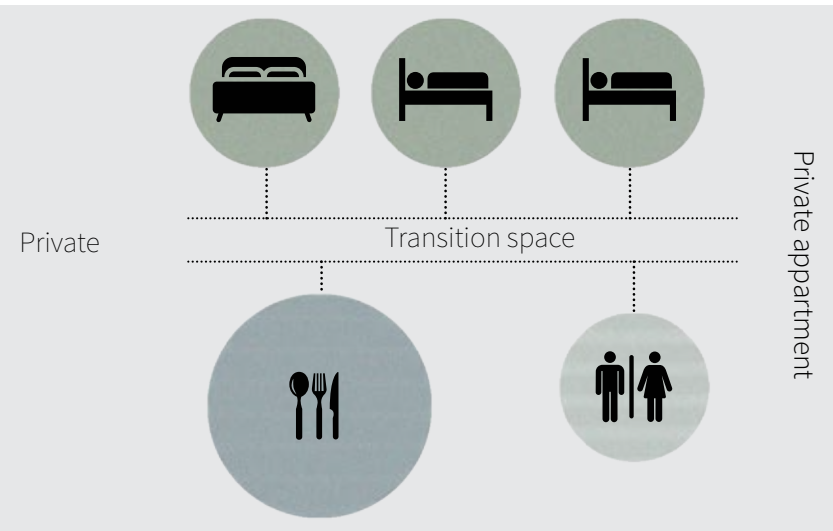


Fig: 23- Large family accommodation - Concept

The large family accommodation is designed to house between four and six individuals; divided into three separate bedrooms with access to private kitchen and bathroom. This composition resembles a common residental apartment; this is a conscious decision as the goal of the composition is to give the family the impression of their own private space – a highly functioning home. The design goal of this composition should be to minimize the floor area, to reduce the environmental impact and reduce the cost of construction. This should be achievable, as the social structure of this composition is associated with familiar social relations, hereby less requirement of locomotive permeability and internal visual permeability.

Adjoined family accommodation

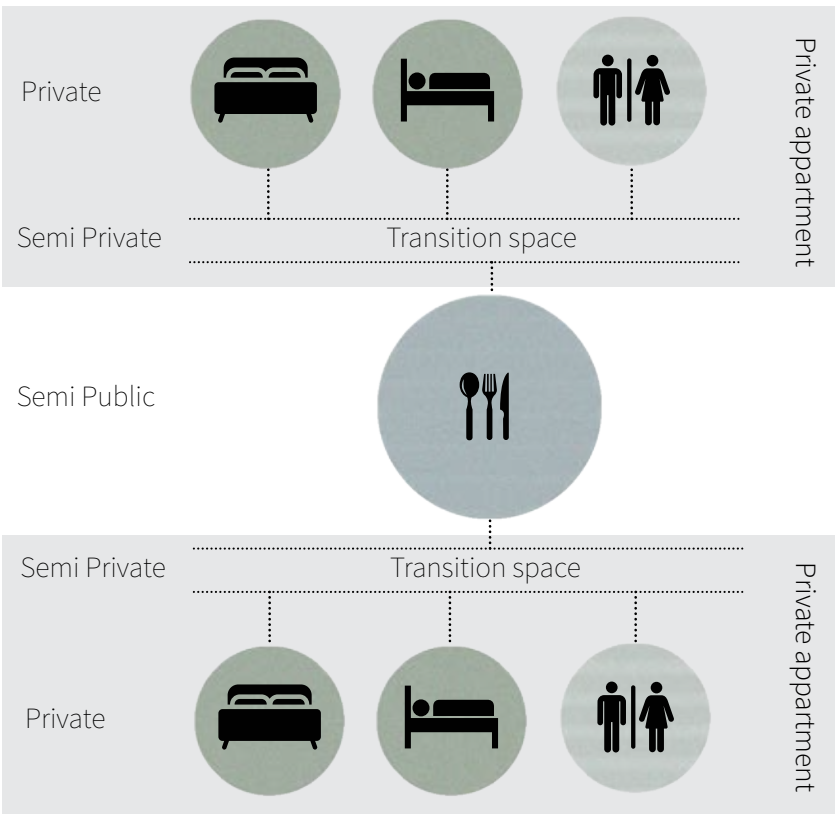


Fig: 24 - Adjoined family accomendation - Concept

The adjoined family accommodation shall be designed to provide two private apartments, sharing a single detached kitchen. The private apartments shall grant sleeping arrangements for a maximum of four individuals in two separate bedrooms with a private bathroom. Ensuring the disconnect between the apartment units and the kitchen ensures that the apartments maintain the sensation of privacy; ensuring the apartment is associated with familiar relations and a sense of control/safety.

The kitchen is shared between two groups of individuals with, presumably, have no preliminary social relations. Consideration of interpersonal distances and locomotive permeability is, therefore, essential when deciding the physical dimensions of the kitchen. In comparison with the large family accommodation, the adjoined family accommodation shall provide a large kitchen, with the purpose to reduce cortisol concentration and cultivate social engagement between the families sharing the kitchen; thus increasing the social relations associated kitchen, reducing an anxiety response and increasing the opportunity for social support.

Unaccompanied accommodation

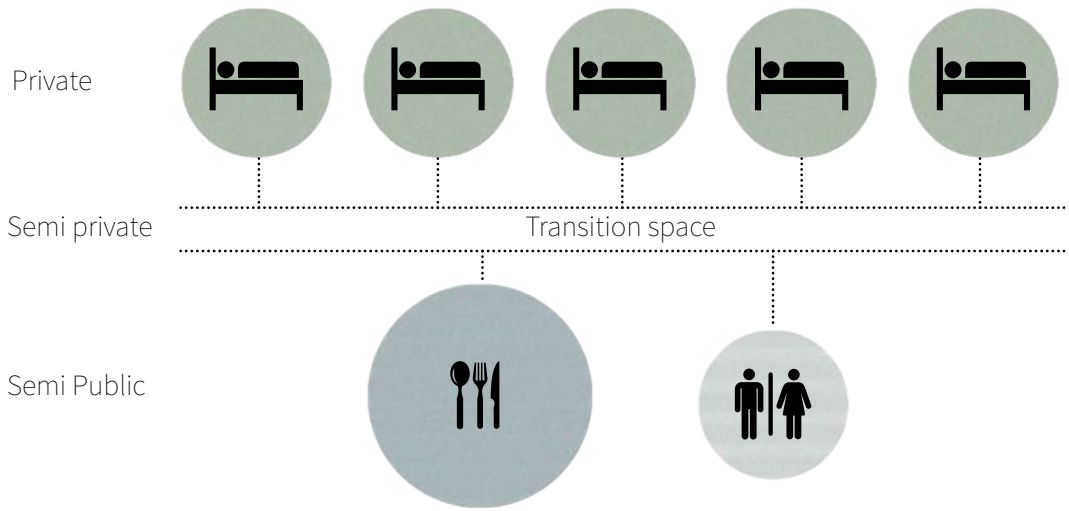


Fig: 25 - Unaccompanied accommodation - Concept

The accommodation unit conceptualized for housing unaccompanied asylum-seekers consist of five separate private bedrooms, each with a single bed, a shared bathroom and a common space with a kitchen. The individuals of accommodated in this unit are assumed to have no pre-existing social connections; this unit is, therefore, the most critical in regards to visual- and locomotive permeability; to ensure low anxiety response caused by the enviorment in the occupants of the space. The layout of this accommodation unit shall, therefore, be open and allow multidirectional locomotion within the units common space. An extent of privacy shall be aimed at being obtained for the private bedrooms; ensuring that the individuals have the opportunity to detach them self from others and also ensuring the owners of the bedrooms has a sense of control over their own private space.

Room program

The room program is constructed by in correspodance with guidelines provided by Rødekors (2019). As previously mentioned, the function of the asylsum centre can be divided into four distinct categories; residential units; administration; healthcare and activities. The majority of the floor area is devoted to accommodation. The architectural project will only focus on the design of the residential units and the healthcare facilities, square meters for the other functions will be included in the resolving architectural composition. The proposed composition of accommodation units resolves in a maximum capacity of 725 refugees, a capacity which will ensure the operation of the centre is cost-efficient.

Residental units & amenities	#	m^2 per. #	sum m^2
Family accommodation *Capacity: 4 - 8 persons*	50	90	4000
Joined family accommodation *Capacity: 6 - 8 persons*	25	90	2250
Unaccompanied accommodation *Capacity: 5 persons*	25	90	2250
Laundry facilities	5	30	150
Administration			
Office space *Capacity: 40 personal*			825
Interview rooms	7	25	165
Reception			40
Production Kitchen			60
Archive			150
Healthcare			
Medical threatment *8 treatment rooms, offices, storage and reception*			425
Psychotherapy *8 treatment rooms, offices, storage and reception*			425
Activities			
Workshops	3	75	225
Classrooms	4	65	260
Kindergarden			120
Communal spaces	5	50	250
Gym			120
Library			60

Distribution

Fig: 26 - Room program

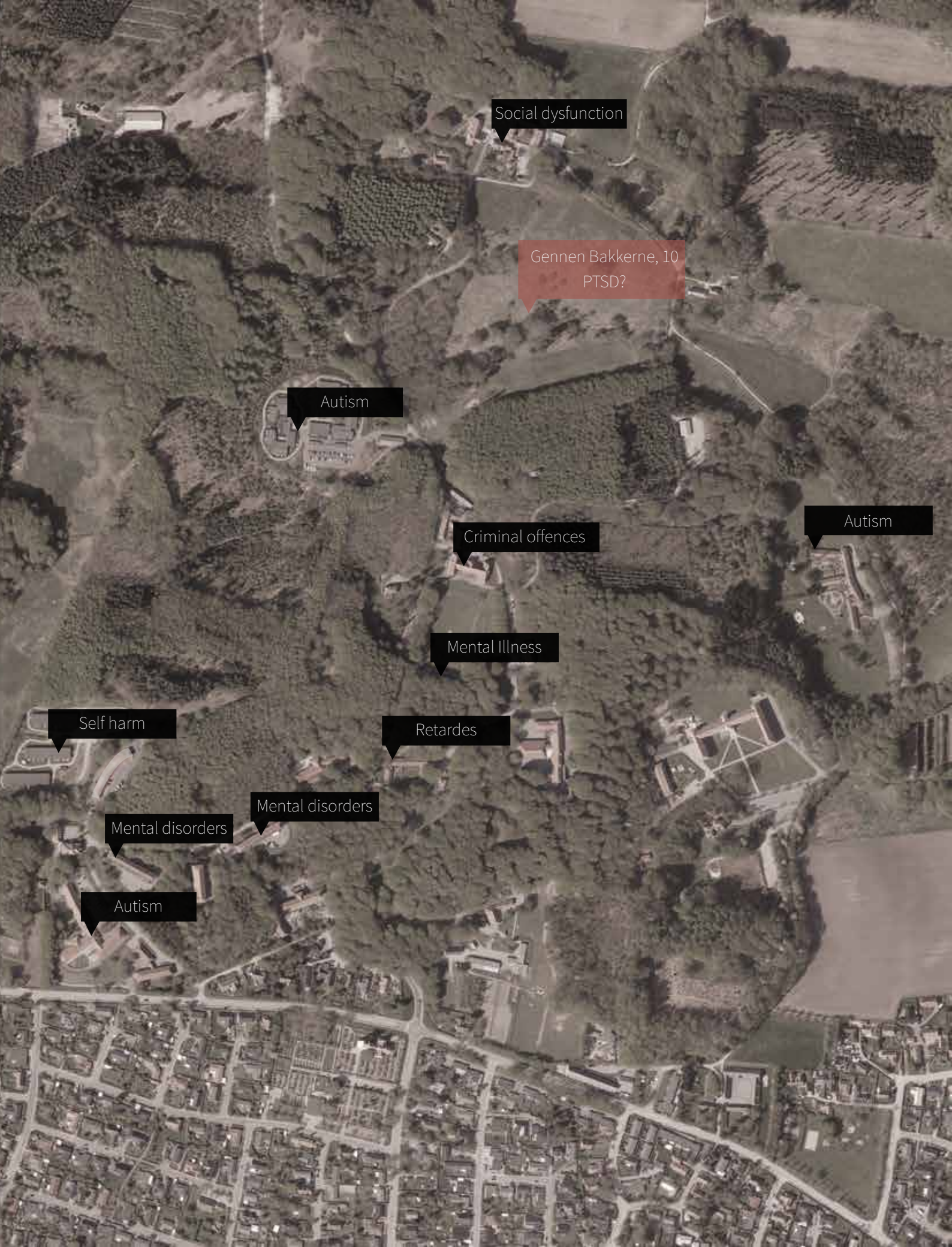
** The combined gross area represents the total constructed area excluding design depended variables such as, but not limited too; technical rooms and accessways.*

Location

'Insitutionbyen Hammer Bakker', located in the outskirts of Vodskov, North Jutland, was selected as an ideal location for the construction of an institution specialised in the treatment of refugee diagnosed with post-traumatic stress disorder. The area is well-known for its long history for treating various mental disorders. Currently, a broad range of institution is operating with this picturesque nature, treating various mental-disorders and illness. The combination of pre-existing social acceptance of people with cognitive issues; the symbiotic relationship between institutions and the existence of pristine nature, makes this area an ideal location for a new specialised asylum centre. Legislation currently protects a vast majority of the forestry, and as previously demonstrated; nature is a vital environmental component of healthcare architecture, therefore, should the architecture be designed with preservation of the natural qualities of 'Hammer Bakker' in mind. 'Gennen Bakkerne 10, 9310 Vodskov' is currently used as pasture land for grazing horses, cows and goats.

The site provides an exciting architectural challenge, due to its complex terrain; making planning and construction more difficult. The site was not selected purely to make the project more architecturally enjoyable, but due to its natural embedded spatial qualities. Variation in terrain height and steepness grants the site unique qualities in regards to spatial- and locomotive permeability; elevated sites grants more visual permeability (prospect) and potentially grants some privacy (refuge); while steep terrain reduces locomotive permeability (refuge). Analyse of the site spatial properties in regards to visual- and locomotive permeability is, therefore, a vital task of the program phase, to ensure an ideal interplay between the desired healing properties of the architecture and the inherent spatial properties of the site.

The site is 46.000 square meters and has no enforced local plan. With inspiration from neighbouring construction; an allowed maximum building percentage of 30% must be assumed to be approved. Resolving in a total allowed gross area of 13.600 square meters, a size which corresponds with the spatial requirement with red cross asylum centres (Larsen, Whyte and Olwing, 2015; Rødekors, 2019).


Social dysfunction
Gennen Bakkerne, 10
PTSD?
Autism
Autism
Criminal offences
Mental Illness
Self harm
Retardes
Mental disorders
Mental disorders
Autism

Site elevation

The site varies drastically in elevation, ranging from 22 MASL as it lowest, to 51,5 MASL at its highest. The difference in elevation both affects, as previously mentioned, the sites visual permeability and locomotive permeability. As depicted in fig xx.xx ;the elevation of the site decrease from the west towards the east, and rises towards the sites highest point on top of the hill on the sites northern portion. The peak in the sites northern portion indicates that the area offers high amounts of prospect; overlooking the majority of the site; neighbouring forestry and open landscapes. Similarly, the drop in elevation towards the east allows the majority of the southern portion of the site to have a supreme view over the open landscape towards the east. The curvature also indicates what areas are suitable for construction; the southern portion of the site has a lower average slope, compared to the northern portion. Less complex terrain ensures that the foundation of the buildings is cost-efficient; reducing the combined cost of construction and also ensures that the buildings have an excellent opportunity for designing accessibility.

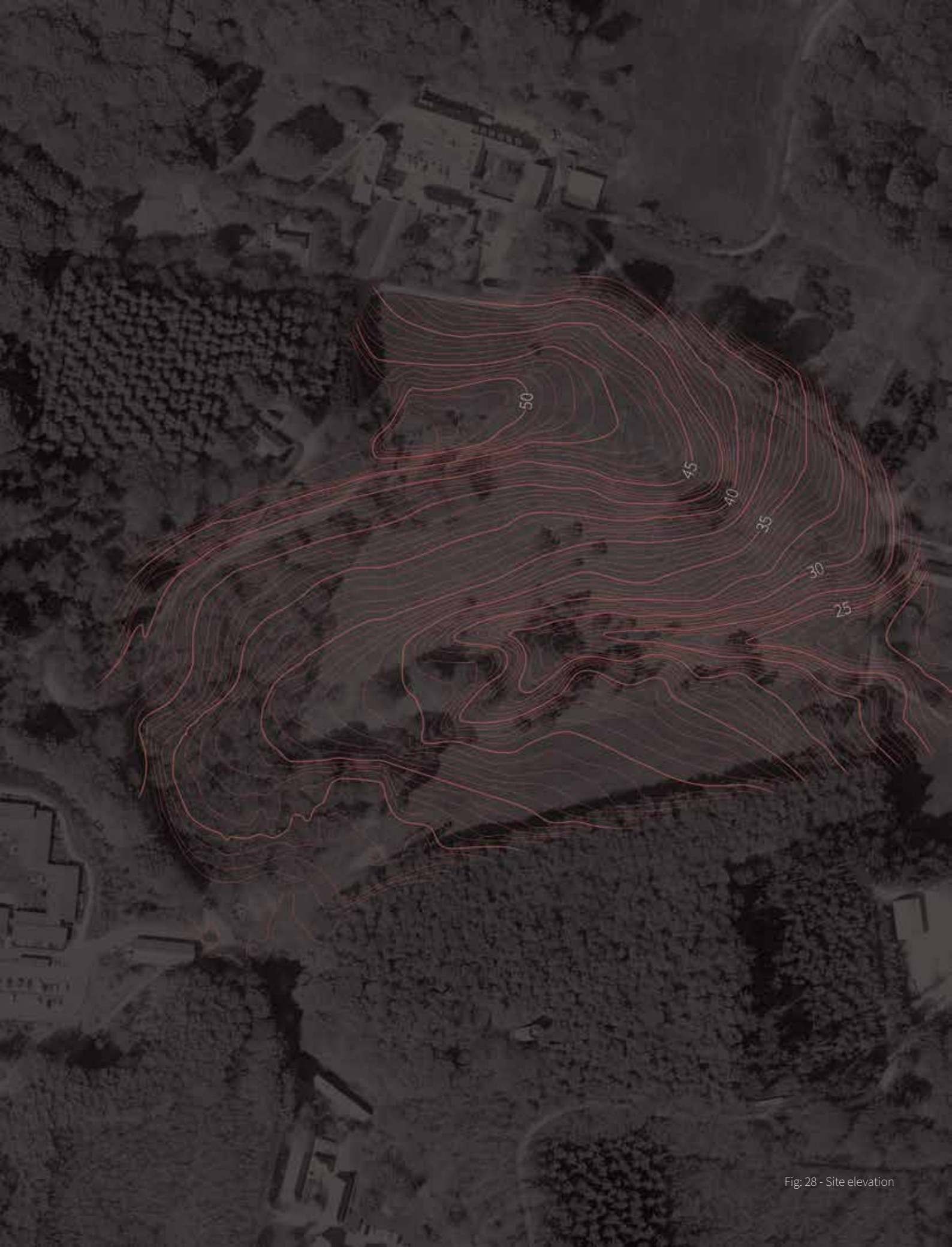


Fig: 28 - Site elevation

Site incline

The incline of the terrain of the site is depicted in fig. xx.xx. The incline is averaged out within a homogenous area. As displayed in the diagram, the vast majority of the relatively flat area is located in the west-south corner, the middle of the southern portion and on top of the northern hill; these areas the most suitable for construction, similarily also the most accessible areas. The diagram also displays that accessway between the northern- and southern portion should be located along the west, where the incline is reduced in comparison to with its counterpart of the eastern edge of the site.

Fig: 29 - Site Incline

Image study of site

To increase the understanding of the sites spatial properties, and how the inclination is experienced. Five key points on the site were selected; A;B;C;D and E. Location A is the sites natural entrance. Location B is the point were the site open ups towards the north. Location C is placed on the southern relatively flat terrain. Location D is the area connecting the northern and southern portion of the site. Location E is on top of the hillside.

Each point was used to photograph the 360-degree field of view surrounding said point. The resulting photographs were used to analyse the spatial properties of the given location, in regards to visual- and locomotive permeability, refuge and mystery. The result of this study improves the understanding of the site, in regards to what directions views from windows and urban spaces should be orientated and gives an impression of the scale of the environment; both in regards to the scale of the typology and greeny on and surrounding the site.

Fig: 30 - Site study

Location A

Location A is positioned at the sites instinctive entrance; a relatively flat area with a direct connection to the main road (img. 5A). In comparison with the remaining site; this subdivision grants the visitor a sense of enclosure, constructed by the dense forestry (img. 1A;3A;4A;6A). A slim opening (img. 2A) grants the visitor a glance between the neighbouring treelines; overlooking the vast majority of the sites open pastureland and the adjacent field towards the east. Towards the south (img. 4A), underneath the tree crowns, three local paths intersect and disappear beneath the forestry; constructing a sensation of mystery and indicating of potential routes for locomotion along with the sheltering forestry towards the south and along the main road. The typology of the location grants excellent opportunity for the construction- and design of efficient parking facilities, recycling stations and other required exterior amenities; which requires access by various dimensions of motorized vehicles. The natural atmosphere of this location signals enclosure, while still providing the occupant's various opportunities for moving towards and away from the location. The most significant and protect worthy environmental feature is the natural opening between the forest lines (Img. A2). This feature would grant the occupant a broad vista overlooking the open landscape; an environmental feature highly correlated with preference and corresponding positive emotional response. Architectural interventions in this location should, therefore, enforce and preserve this environmental quality; empowering the architectural experience and perpetuate the site natural qualities

Img. A1

Img. A2

Img. A3

Img. A4

Img. A5

Img. A6

Location B

Moving from location A, through the opening in between the forest lines (Img. A2), the occupant would reach location B. Contrasting the prior location; location B offers the occupant an extensive view towards the east; overlooking the downwards sloping pasture land and the adjacent field (Img. B2), while still being in close contact with the more encapsulated atmosphere of location A (Img. B5;B6). In correspondence, with the previous location, the dense and tall forestry of evergreens towards the south continues to provide a sheltering wall, hardly penetrable by vision (Img. B3;B4;B5). Less visual obstruction occurs as a result of vegetation towards the north, where the foliage of few trees hinders the full view of the hillside of the sites northern portion (Img. B1;B2).

The natural atmosphere of this location is spaciousness with some mystery granted by the visually obstructing foliage towards the north, and with a sensation of refuge granted by the forest towards the south. In combination with the still relatively even terrain, this location makes it ideal for the construction of homes, administrative- or healthcare facilities, due to the possibility of granting the occupants of the spaces excellent views of the open field. One problematic issue arises as a result evergreen forestry to the south, the heigh and density of the forest affects possible location for buildings, as the forest hinders access to an essential component of sustainable architecture; passive solar heating. Careful considerations and analyses shall, therefore, to understand how the forestry affects the access to direct sunlight.

Img. B1

Img. B2

Img. B3

Img. B4

Img. B5

Img. B6

Location C

Moving further down the sloping terrain, one reaches location C. This atmosphere closely resembles that of the previous, but significantly enforced by the improved visibility of the sites northern hillside resulting in a strong impression of openness and grand vistas of the pristine nature of 'Hammer Bakker'(Img. C1;C6). Especially Img. C1 reveals an exciting local landmark; a single beautiful tree positioned on top of the northern hill – the highest walkable point on the site. Similar to the two aforementioned locations, the southern wall of forest prevails; providing refuge and hindering direct sunlight from reaching the southern portion of the site (Img. C3;C4;C5).

Location C closely resembles that of the previous location B and, therefore, subject of the same positive- and negative remarks. The main differences are the previously described alternation in typology, where the terrain at location C is more complicated compared with location B, increasing the difficulty of construction, especially when including the potential requirement of positioning building away from the forest, towards the south, in order to grant the building mass passive solar heating.

Img. C1

Img. C2

Img. C3

Img. C4

Img. C5

Img. C6

Location D

Location D is a natural connection point between northern- and southern portion of the site. This part is relatively flat and currently occupied by a few trees (the trees causing visual obstruction for the northern hillside at location B)(Img. D1;D2;D3;D6). The atmosphere of this location is relatively open, the few small trees (Img. D1;D2;D3;D4;D5;D6) surrounding the location only results in small visual obstruction of the view of the adjacent open field of both the southern pasture land, the small field at the edge of the northern hillside and the hillside itself. The area currently serves as the natural connection between the two portions, due to low inclination, compared to the remaining area along the two portions. Therefore, will this section become a vital component of the project; either if the desire is to construct building mass that joins the two portions of the site or if the natural forestry of location D should remain untouched and act as a walking path between the two-portion. Never the less: The spatial qualities of this location offer an excellent opportunity for both design strategies as the location offers a vast vista (especially for construction exceeding one story) and the natural trees of the location resemble a spatial structure of a more dense-packed savannah.

Img. D1

Img. D2

Img. D3

Img. D4

Img. D5

Img. D6

Location E

Location E is positioned in close proximity to the peak of the hillside. The increased elevation, in combination with low visual obstruction, grants the occupant excellent opportunity to surveil across vast distances; giving the location a sensation in close resembles of that of a watchtower (Img. E1;E2;E3;E5;E4;E6). This atmosphere is furthermore enhanced the steep downward sloping terrain; granting the location a sense of control as the occupant is granted prospect and speed of locomotion from potential threats, coming from various directions, is dramatically reduced, due to the hillsides steep inclination.

The natural atmosphere and typology of location E resemble that of an ideal location for a medieval fortress; great opportunity to surveil the environment and protection is granted by steep inclination. The natural characters of this location, therefore, offers an excellent opportunity for housing facilities assigned with an increased requirement for giving the patient a sense of comfort and control, such as psychotherapy. The complexity of the terrain of location E, and the path leading there is not suitable for largescale building construction, as this would require extensive foundation solution; enhancing the cost of construction per square meter. Considerations should, therefore, be made to restrict the construction of building at this location to a small scale typology, both to avoid overpowering the pristine nature and granting potential building a sensation remoteness; furthermore enhancing an atmosphere suitable for psychotherapy.

Img. E1

Img. E2

Img. E3

Img. E4

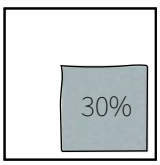
Img. E5

Img. E6

Local architecture

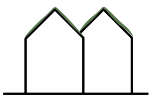
The morphology of "institutionsbyen Hammer Bakker" is characterized by relatively small institutions, scattered independently across the forest landscape. This composition ensures that an occupant of this portion of Hammer Bakker are only able to perceive one or two institutions at the time, ensuring the natural atmosphere of the forest is not overpowered by large and massive buildings. The preservation of the impression of being encapsulated in the pristine forestry is an essential design strategy for "institutionsbyen Hammer Bakker". Local zoning laws are, therefore, enforced, ensuring that new development within the area, follows the current morphology; restricting new construction to solely occur in existing glades, field or other areas not occupied by protected forestry (Aalborg-Kommune, 2014). The architecture of the area can be divided into three distinct categories; classicistic, traditional danish functionalism and contemporary nordic architecture. The eldest buildings are constructed prior to 1924 and designed in accordance with the design principles of classicism; with simplified forms and an extensive focus on symmetry and harmonic proportions. The five classicistic buildings are primarily built with red brick facades and corresponding roofing, the only exceptions from this commodity is a single building renovated with white plaster façade and another building erected with yellow bricks instead of red brick. The traditional Danish functionalism is the most common architectural style within the area, counting a total of seventeen buildings designed in correspondence with this style epoche. These buildings were erected in the period between 1925 and 1980 in the style of traditional Danish functionalism, maintaining the aesthetic tools of symmetry, order and harmonic proportion from the classicistic buildings in their redbrick facades but with less attention towards details, resulting in a more simplified expression. Since 1980, the design expression in of the recently constructed building more closely resembles contemporary nordic architecture, using various types of wooden cladding as the primary façade material; increased window dimension, and replaced the red brick roofing with more humble materials such as; fibre cement or roofing felt, and less attention towards symmetry and order, but still maintaining a humble and clean aesthetic expression, ensuring the architecture does not overpower the surrounding pristine nature. The dimension and composition of the various buildings vary independently from its aesthetic epoche, and its more significantly correlated with the individual buildings adjacent environment and the function of the specific building. Currently, no local area plan has been designated for the project site. Newly erected neighbouring constructs have been granted building permission granted upon project-specific local area plans. The only indication of potential building restriction is, therefore, the municipality plan, which regulation is summarized in fig. xx.xx in combination with conclusive design guidelines, based on this brief assessment of the existing local architecture.

Local Area plan 5-2-111



Plot ratio

A maximum of 30% plot ratio is tolerated for construction in this area, resulting in a maximum of 13.800 square meters.



Green roofs

The buildings shall have green roofs to maintain/improve biodiversity.

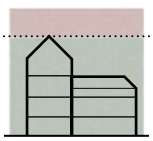
Colours

The colours of the buildings materials must be its natural colour or altered into black or earth colours.

Facade materials

The buildings façade must either be brick or wood cladding.

Municiplal plan 5.2.R1



Building height

A maximum of four stories is tolerated.

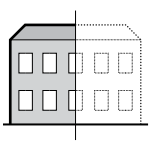
Forest preservation

The trees is protected under the legislation, the buildings should, therefore, be constructed with damage on the trees on the site.

Analyze results

Merge w/ nature

It is essential that the pristine atmosphere of 'Hammer Bakker' is perserved, the buildings should, therefore, be positioned and dimensioned in accordances with the natural dimensions of the site; ensuring the buildings does not overpower the nature.



Simple and orderly

The existing local architecture is orderly and simple in its expression. The design of the asylum centre, must mimic the existing architecture; ensuring the design is perceived coherent with the preexisting architecture.

Fig: 31 - Local architecture and zoning laws

Designing sustainable architecture

The term sustainability has since the '80s become a word of the common tongue. The increased adoption of the word in literature, business strategies and daily talk is a reflection of heightened awareness on the worlds limited resources and humans impact on the earth ecosystems; these considerations are environmental sustainability. Environmental sustainability only reflects a third of the considerations required when defining if a solution is sustainable. Evaluation upon if a solution is sustainable is only truly defined if consideration of the social- and economic impact are included; resolving in the trinity of sustainability - environmental-; social- and economic sustainability. The trinity of sustainability is essential assessment categories, to evaluate architectural design solutions, and incorporate into the design process; ensuring the final product addresses the current climate crisis and ensures high quality of life both at an affordable price point.

The following chapter is subdivided into three specialised subchapters; construction and materials, indoor climate and social. The purpose of these subdivisions is to construct inquiry on the respective focus area and extract design strategies that correlate with the trinity of sustainability, thus, ensuring sustainable consideration are incorporated in the early design phase. The subchapters will be highly focused on social- and environmental sustainability, as these are the main focal point of the project.

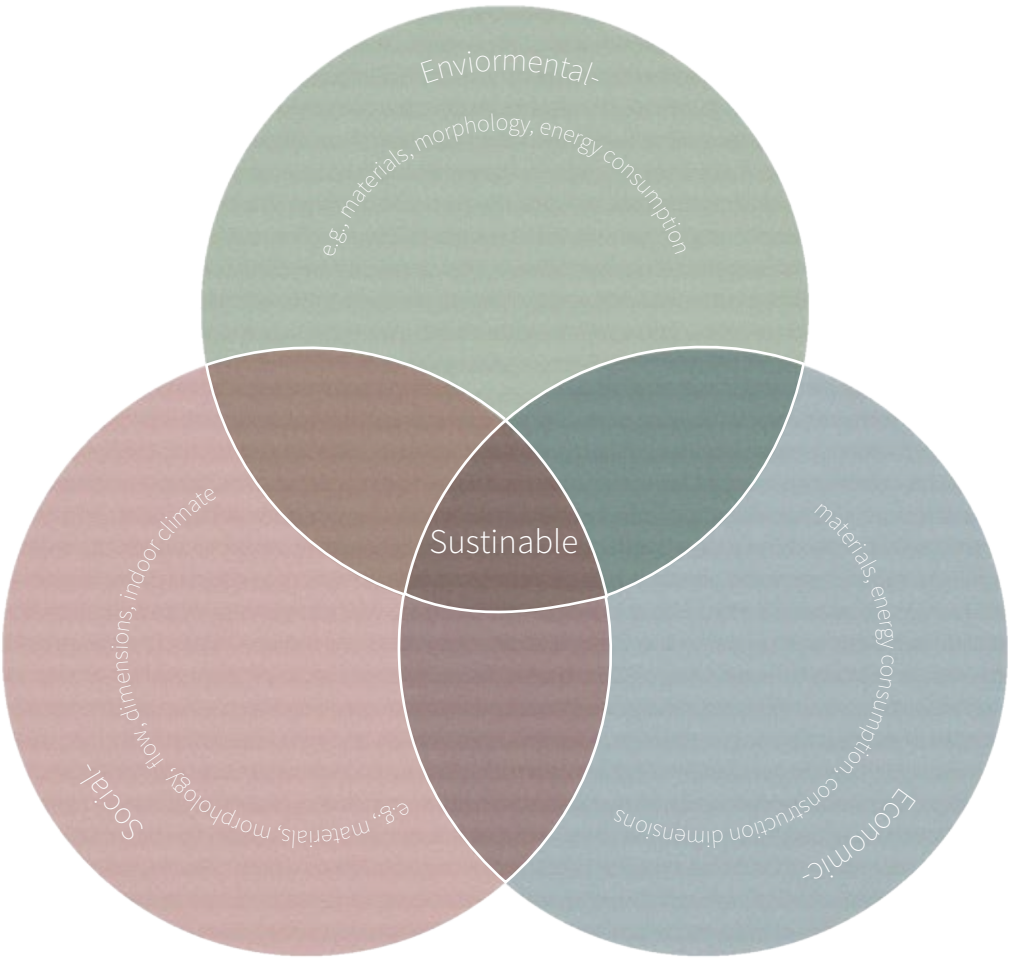


Fig: 32 - Designing sustainable architecture

Construction and materials

The production of building materials is one of the main sources of global warming, approximately 20% of the combined emission of greenhouse gasses is associated with the production of building materials and the construction of buildings (JCSS, 2018). In the Danish context, approximately 59-72% of a buildings combined emission of carbon dioxide equivalent is associated with the selection of materials. The remaining portion is associated with emission associated with the energy production for maintenance of the desired indoor climate (Birgisdóttir and Madsen, 2017b). Material usage, therefore, has a substantial impact on the current global warming crisis, and, thus, an essential consideration when design architecture.

As indicated by IEA EBC Annex 57; increased usage of biobased materials in architectural design is an essential design decision to reduce the buildings resulting climate impact. The study revealed 27 – 77% reduction of carbon dioxide equivalent emission can be achieved by substitution to biobased materials (Birgisdottir et al., 2017). Usage of biobased materials is, therefore, essential strategies to minimize the buildings carbon footprint. This conclusion is also reflected in Skullestad, Bohne and Lohne (2016) study which compared emission of carbon dioxide equivalent from reinforced concrete structures and timber construction (glulam and CLT). Their study displayed 56 – 84% reduction from three-storey buildings when constructing in timber instead of reinforced concrete. The variation in reduction is depended on methodological assumptions. The system boundaries for these assessments, in correlation with EN 15804:2012, were A1-A3. Expansion of the system boundaries to included module D: reuse-, recovery-, recycling potential, displayed an increased reduction of carbon dioxide equivalent emission, resolving in a potential reduction of 193 – 234%, by building in timber instead of reinforced concrete. Reduction above 100% indicates that timber construction has a negative climate change impact, this is achieved by exploiting the chemical energy in biobased materials, at the end of its lifecycle, to substitute fossil fuels for energy production. Although the calculation methodology of module D has been questioned (Birgisdóttir and Madsen, 2017b), the carbon mitigation strategy of applying biobased materials for energy production, by incineration, has displayed to be an essential component of bioenergy with carbon capture and storage strategies (BECCS); one of the essential strategies to ensure global temperature is kept below the tipping point (Minx et al., 2018). Despite the current lack of well-integrated BECCS-solution, the project will adopt the assumption that biobased materials in the construction will be incinerated at the end of the material lifecycle, as incineration, even without energy capture or carbon storage, has reduced global warming potential, compared to decomposing in landfills (Börjesson and Gustavsson, 2000). As illustrated by the previous empirical findings, substantial carbon mitigation can be achieved by using wood-based products, and other biobased materials, as the primary materials; when applicable. Reduction of carbon dioxide equivalents is an essential goal of environmental sustainability, but the emission of carbon dioxide equivalents is only an eleventh of the assessment categories included in life cycle assessment. As demonstrated by

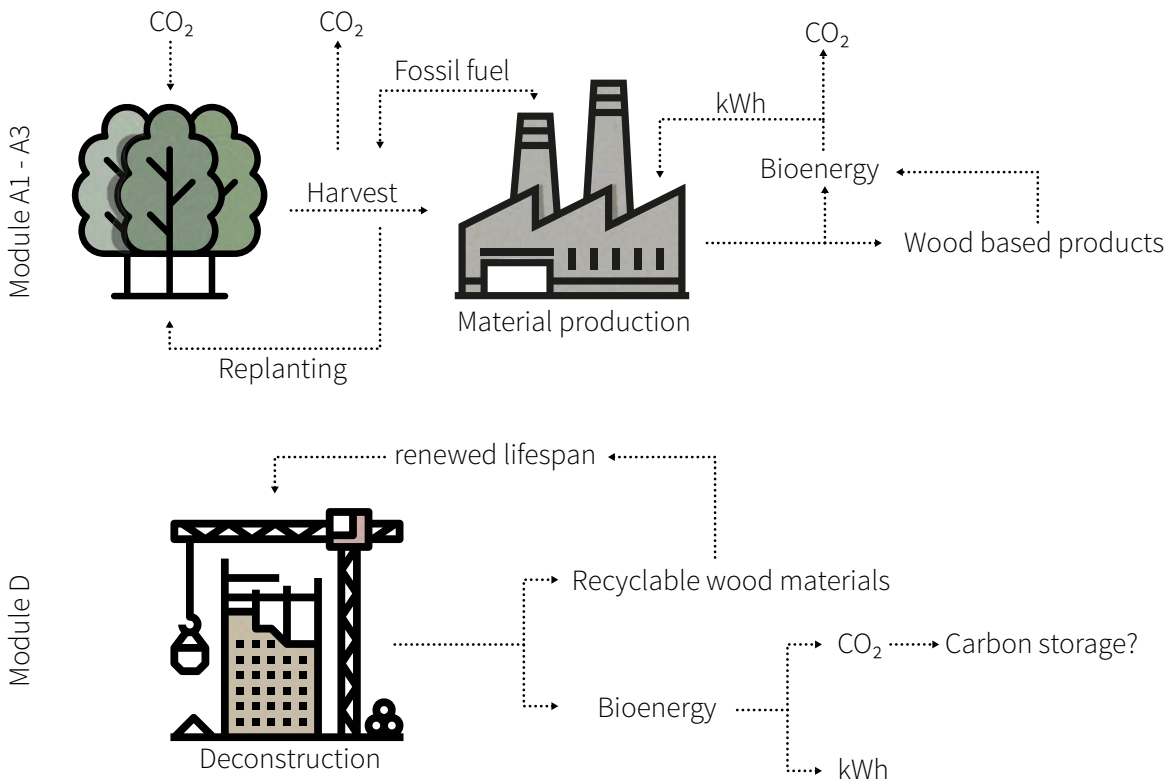


Fig: 33 - Wood life cycle (A1 -A3 + D)

Robertson (2011) cross-laminated timber performed significantly better, compared with concrete structure, in ten out of the eleven assessment categories: global warming potential; acidification potential; eutrophication potential; water intake; ecological toxicity effects; air pollutants; carcinogenic and non-carcinogenic effects; ozone depletion; smog formation potential and embodied energy. The only category concrete outperformed cross-laminated timber were fossil fuel depletion, were the concrete solution performed 6% better. Cross-laminated timber fossil fuel depletion originates in natural gas consumption, an essential resource for the production of adhesives and other bonding agents. The bonding agents ensure that timber construction is cost-efficient by reducing the required growth time prior to harvest.

Construction

As illustrated by the brief preliminary review on materials environmental impact, timber construction is far superior compared concrete as the main material for the structural system when the environmental impact is the main criteria. The project will, therefore, be designed with timber as the primary materials for construction of the buildings structural system. This environmental consideration resolves in structural restrictions, which are essential to be taken into account when designing the asylum centre. Multiple construction systems have been developed for timber construction; log-; frame-; platform-; panel-; frame- and solid timber construction. As suggested by the preliminary theoretical review of environments correlation with the emotional system, visual- and locomotive permeability in the horizontal plane strong predictors of cortisol concentration. A point-supported structural system is, therefore, the most applicable construction principle for the design, as this will ensure large architectural freedom for designing open spaces in the interior and wide window spans in the exterior façade. Frame construction is, therefore, most suitable for this project, compared structural systems depending linear load distribution. The choice of construction systems, depending on point support is associated with other benefits such as; increasing adaptability by reducing the dependency on loadbearing walls; allowing future remodelling of the interior spaces – improving the lifespan of the building. Furthermore, a point-loaded construction system also allows the usage of helical pier foundation; removable and recyclable stell foundation, ensuring that the pristine nature of the site can easily be restored post demolition.

Designing efficient frame construction requires the design correspond with a uniform grid system, ensuring that structural members are of similar dimensions; reducing the building cost and increases the construction time. The spacing of the columns will dictate the dimensions of the other structural members; the large the grid, the cheaper the structure will become, due to reduced load transferring joints. It is, therefore, essential that selection of grid size corresponds with the functional requires of the resulting space; minimizing the number of joints and ensuring that the dimensions of the structural members correspond with the desires architectural impression (Kolb, 2008).

The primary structure of frame construction is only designed to distribute vertical loads into the soil, ensuring that the structure is stable three-dimensionally, the secondary structure shall, besides distributing the horizontal loads into the primary structure also brace the structure for horizontal forces, such as; wind. Ensuring the three-dimensional stability can be done by multiple accounts, including wood-based boards or diagonal steel branching. Solutions ensuring three-dimensional stability should correspond with the architectural vision and be combined with other usages and, such as elevator shaft, noise reduction and stairway support to ensure efficient usage of material (Kolb, 2008).

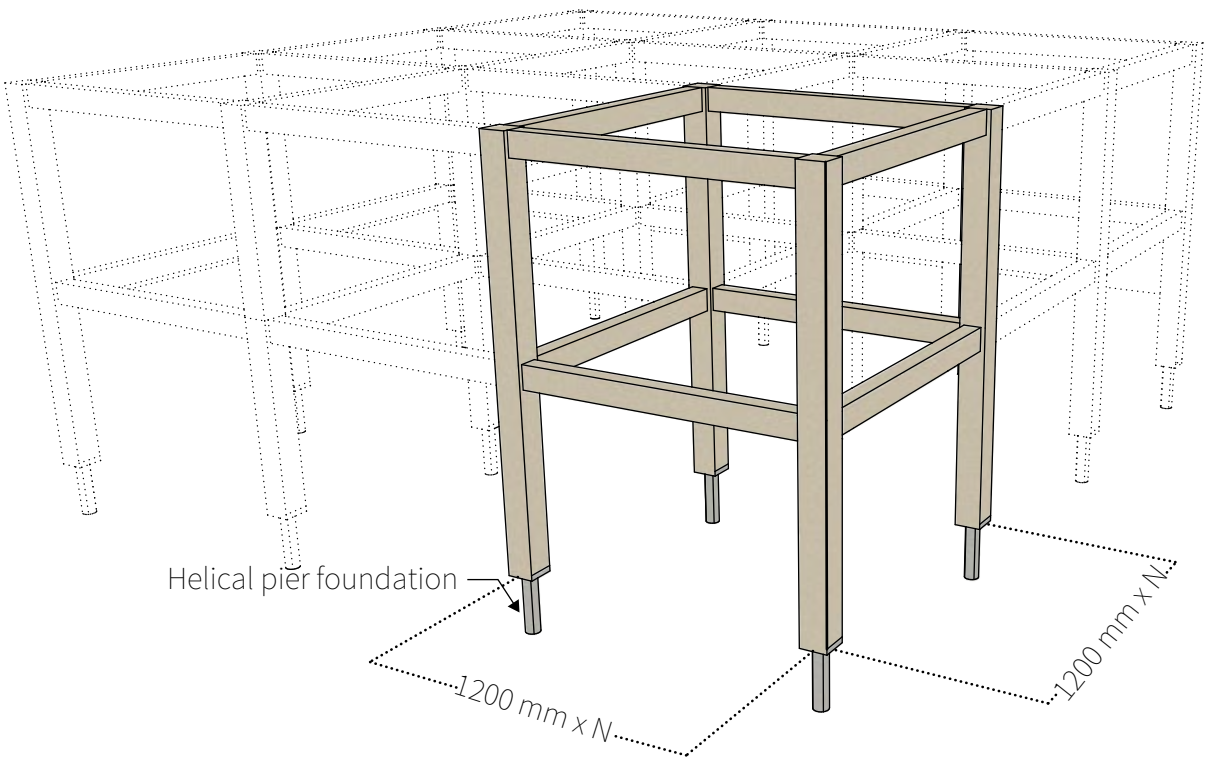


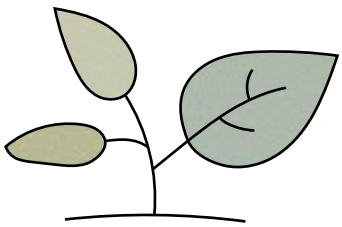
Fig: 34 - Primary structure - conceptural diagram

Interior materials

The usage of biobased materials has displayed to be essential if the architectural intention is to reduce the buildings carbon footprint. Interestingly the usage of wood interior cladding has also been associated with a reduction of blood pressure and heart rate (Zhang, Lian and Wu, 2017). Their study displays an interesting addition to the preliminary theory on environments influence on emotional modulation; that the materiality of architecture also interferes with the homeostasis balance. The inclusion of wood-based products in the interior space; therefore, both provides an environmental- and social benefit and correlates with the desire to design environments that reduce the occupant's cortisol concentration. Uncertainty prevails regarding what properties of wooden interior cladding that result in the positive physiological effects. The effect can be argued to be a result of increased visual complexity (Berlyne, 1971; Kaplan and Kaplan, 1989); that it is a natural material (Ulrich, 2008); that the material gives the room more layers of depth (Arthur E. Stamps, 2006); altered thermal conductivity and radiation or altered degassing. The physiological effects can, therefore, be derived by multiple causes. Without sufficient clarity regarding each variable and the corresponding effect, no clear indication of the origin of the positive effect can thus be made.

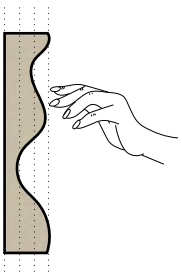
The project will assume that the inclusion of wood materials in the interior space is associated with both environmental- and physiological benefits. The interior space, and the corresponding usage of materials, shall ensure high levels of illumination (Stamps, 2007, 2012), achieve modest amounts of complexity and be coherent (Berlyne, 1970, 1971; Kaplan and Kaplan, 1989; Jagt et al., 2014); grant an impression of depth (Arthur E. Stamps, 2006) and ensure the materials are warm and soft when touched. The materials used, should be biobased to ensure that the environmental impact is low, and ensure that the positive physiological effects as demonstrated by Zhang, Lian and Wu (2017) are included in the project, ensuring a holistic approach towards healing architecture.

Biobased materials



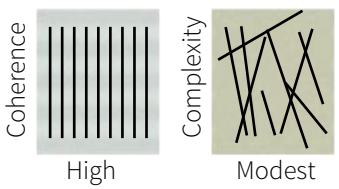
- Reduced enviormental impact (CO_2-eq)
- Potential postive effect on health and well-being

Increased sensation of depth



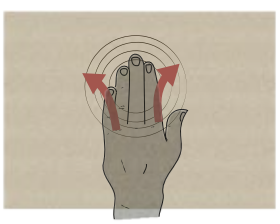
- Potential postive effect on health and well-being
- Increased preference

Coherence and complexity



- Potential postive effect on health and well-being
- Increased preference

Soft and low thermal conductivity materials

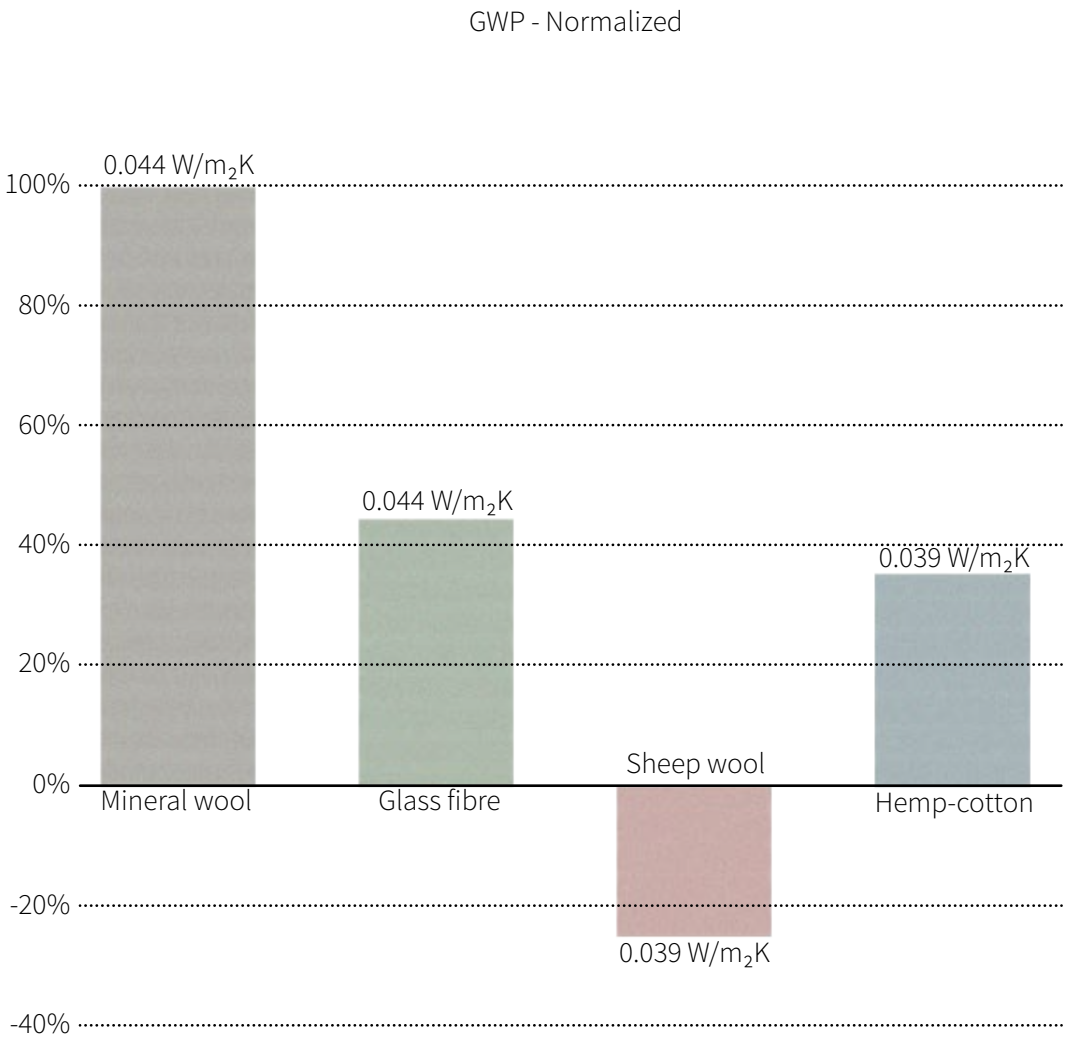


- Increased thermal comfort
- Increased somatic comfort

Fig: 35 - Criterias for interior materials

Insulation materials

The requirement for energy efficiency of the European building mass has been under substantial regulation over the past fifty years, resulting in insulation materials accounting for a consequential large amount of the combined material consumption. The most commonly used insulation materials, above floor level, is mineral wool, but as previously indicated by IEA EBC Annex 57 increased usage of biobased materials reduces the building environmental impact, indicating potential enviormental benefits from using biobased insulation. Various alternatives for mineral wool currently exist on the market. In order to evaluate the potential environmental befit of the using biobased alternatives, the project will rely on a study conducted by Norton and Alexander (2008) their study took offset in four insulation materials, two conventional; mineral wool insulation and glass fibre insulation, and two insulation materials based on natural fibre; sheep wool insulation and a hemp-cotton insulation. Common for all the materials is their thermal conductivity (see fig 36). Other bio-based insulation materials, currently exist on the market. The researches choose, these two biobased materials, as these already had a large share of the market and experienced substantial demand and corresponding growth in production. As illustrated by the findings, based on module A1-A3, cf. EN 15804:2012, sheep wool insulation results as in negative GWP100, indicating that the material composition migrates more CO2-eq, than released during manufacturing. Sheep wool insulation is an upcycled waste product from the production of lamb meat. The greasy wool used for manufacturing is of extremely low economic value, due to the price associated with the regulated disposal (Williams, Audsley and Sandars, 2006). These findings only illustrate a brief selection of the available biobased insulation materials, currently under development. The project will assume sheep wool insulation will be available, and be an affordable solution, compared to its counterparts. Interestingly, sheep wool insulation has been associated with the ability to purify the interior air. The quality derives from amido- and amino groups in the wool to react with formaldehyde and other volatile organic compounds (Maskell et al., 2015). The selection of sheep wool insulation, therefore, also potentially counteract the emission of formaldehyde from the composite wood product (EPA, 2019). The amount of sheep wool in the construction is governed by the recommendation proposed by DK-GBC (2016), with the desire to minimize transmission loss; the project will follow the higest scoring quality in regards of building envelope performance.



(Norton and Alexander, 2008)

Fig: 36 - LCA Insulation materials

Exterior materials

Biobased materials have displayed to be an environmental- and physiological, therefore and essential material to be incorporated into the architectural design of the asylum centre. In accordance with the governing municipality plan, the exterior materials shall be wood or brick, and be contained within a natural colour scheme; the natural colours of the materials, earth colours or black (Aalborg-Kommune, 2014). The biodegradability of biobased materials grants this material type disadvantages for exterior usage. Life cycle assessment will, therefore, be performed on a selection of materials applicable to the exterior cladding, within the municipality plan. The selected materials are; untreated exterior pine cladding; surface treated wood cladding; regular-sized masonry bricks; cladding bricks and slates. The LCA calculation will be based on generic environmental product declarations (EPD) available in LCAbyg 3,2 due to current lack in the development of product-specific EPD's. The calculation will assume a building lifespan of 100 years.

As indicated by the LCA comparison between the aforementioned exterior façade solution (fig. 38); untreated wood is the solution resulting in the lowest emission of greenhouse gasses, followed by slates. Interestingly, untreated wood outperformed wood threated in regards to the emission of carbon dioxide equivalents. The reasoning behind this is revealed in the detailed LCA analyses, where the expansion of the wood lifetime, every tenth year, with treatment resulted in increased emission, compared to replacement of the untreated wood façade every forty years. As continuous treatment of the wood is a cost-efficient measure, the usage of untreated wood will, therefore, become a more expensive solution, compared to continuous treatment. Comparison of the material price of slates and untreated wood revealed that a slate facade is roughly 2,5 times the price of an untreated wood façade (Coates, 2013; Saxo, 2019). The slates lifetime (>100 years), therefore equals out the cost of material, due to untreated woods relatively short lifespan (40 years). This simplified LCC-assessments excludes complex labour-cost assessment. Inclusion of this parameter would favour the usages of slates, due to the increased lifespan and corresponding reduced requirement of labour during the building's lifespan. Unfortunately, this assessment is conducted on genetic, environmental product declarations, comparison between various engineered wood solution are, therefore, not achievable. This restriction excludes the potential to evaluate the environmental impact of façade solution such as heatwood developed by Frøslev. Heatwood has received the Nordic Swan Ecolabel for its durability and corresponding environmental impact. Heatwood is heat-treated ash-, abodo- and/or pine wood, three relatively inexpensive wood materials. The production process involves gradually heating the wood to 212 Celcius, in order to vaporize the woods sugar content and alter the cell structure of the wood, without the addition of chemical, thus significantly increasing the lifespan of the final product and removes the requirement of treatment during the material lifecycle (Frøslev, 2019). The project will, therefore, assume with confidence that Heatwood and slates are both applicable materials for the product due to the products its economical-, environmental sustainability.

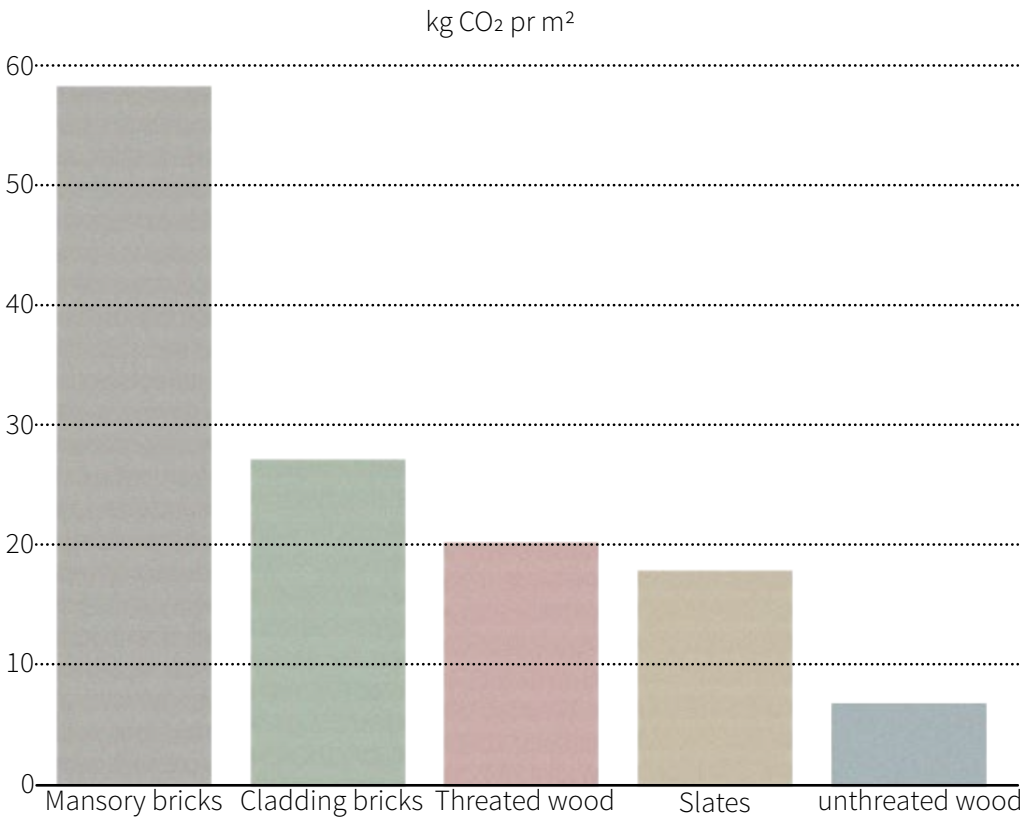


Fig: 38 - LCA Facade materials

Image examples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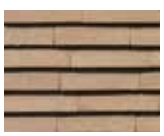
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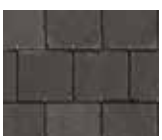
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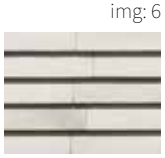
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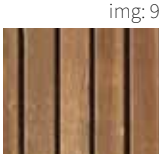
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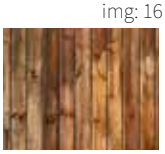
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The previous assessment of materials has been based on environmental- and economic considerations; essential consideration for material selection, but as illustrated by Zhang, Lian and Wu (2017) and a few findings included in the preliminary theoretical review on architectures correlation with the emotional system, materials and corresponding architectural impression are influential on the well-being its occupants. The architectural possibilities and aesthetic qualities of the selected shall, therefore, be assessed to ensure that they are suitable for the project.

Slates is composed of clay or/and volcanic ashes; slates are mounted on the façade or roofing as overlapping shingles. The colour of slates ranges in the dark end of the grey spectrum and can either processed to obtain a smooth surface or be installed with material natural rough- and texture-rich surface. The variation in texture and colour are only perceivable at close proximity, and at a distance, the slates will be perceived as a homogenous black surface. Over time, the appearance of slates will not be sustainably altered during the building lifespan, as long as potential biological growth is removed.

Heatwood is currently produced from either ash-, abodo- or pine wood. Each of the materials contains a different colour schema and complexity. The pinewood is light brown in colour with contrasting dark knots and visible growth rings. In contradiction abodo and ash contains no knots, and the only colour variations are the result of the growth rings. Ash is slightly darker than pinewood and more homogenous in appearance. The same is true for abodo, but the natural colour of the wood is significantly darker than ash, with a colour scheme in the deep brown-red spectrum. Over time, all the wood species will fade into grey, due to UV-radiation and water. This alteration in colour can be prevented by architectural design, protecting the façade from solar radiation and water or threating the wood with a protective coating.

As uncertainty still prevails in the scientific community regarding materials influence human physiological, no concrete conclusion can be drawn at this moment on which tree species are most suitable for the project. As indicated by Zhang, Lian and Wu (2017), wooden materials have positive effects on human health; wood materials should, therefore, be heavily included in façade, with the assumption that the positive effects from interior use also are applicable for exterior usage. The usage of slates, ash, abodo and pinewood will, therefore, later be decided in correlation with the building morphology, façade design and other design factors, to ensure the usage of the material is coherent with the design intentions.

Indoor climate and energy frame

Humans spend approximately 90% of their life indoors (Klepeis et al., 2001). Energy-efficient maintenance of a suitable indoor climate is, therefore, essential to ensure the building are social-, economic- and environmentally sustainable. The quality of indoor climate is measured in regards to thermal-; atmospheric-, acoustic- and visual comfort. All of these criteria are regulated by the Danish building regulations; in addition, European standards have been developed to construct a framework to access the quality; in this project, the following standards will be followed: DS/EN 7730; DS 447; EN15251. Fulfilment of these criteria shall be met within the buildings respective energy frame regulated by the Danish building regulations.

The project will restrict itself to a detailed evaluation of the indoor climate and corresponding calculation of energy consumption of the housing units. The remaining architecture will follow the design principle of the housing units to ensuring the whole building/ complex are energy efficient and is designed in correspondence with the regulation.

In correlation with BR20 § 474; housing units are allowed to consume 20 kWh/m2 per. year for heating, ventilation, cooling and hot water usage. The building design shall address this requirement through passive- and active solutions, such as; passive solar gain, insulation, thermal mass, natural ventilation and mechanical ventilation, to ensure minimum energy consumption is achieved. It is important to note that extensive measures should not be made to reduce the resulting energy consumption significantly below the BR20's requirement as this could resolve in an economically unprofitable solution (Birgisdóttir and Madsen, 2017). Similarly, the project will aim at obtaining the requirement, without the implementation of energy-production systems, such as photovoltaic cells or solar cells. The reasoning is that the building already has access to energy-efficient district heating (Aalborg-Kommune, 2014) and that photovoltaic cells are not recommended in the Danish context (Huld and Amillo, 2015). Reliance on a secondary solution to ensure energy efficiency will, therefore, be counterproductive in correlation with the desire to construct environmental- and economically sustainable. The following subchapter will construct inquiry upon the requirement for good indoor climate, to survey the energy expenses required to ensure the building is socially sustainable, and what passive means solutions can be implemented to reduce the energy consumption.

Thermal comfort

Thermal comfort is associated with a diverse range of measurements; indoor air temperature, heat radiation and draft speed and temperature. The majority of these assessments categories can be summarized as operative temperature. The hybrid ventilation system shall be designed without occupant dissatisfaction originating from draft speed and -temperature. This project will be focus purely on operative temperatures. The comfortable range of operative temperatures a subdivided into the heating season and the cooling season. The project will follow category 2 cf. DS/EN 15251; resolving in the following thresholds of operating temperatures:

i) Heating season

Minimum operative temperatures of 20,5 C^0 (DK-GBC, 2016), in accordance with clothing level, assumed activity level and quality level of category B cf. DS/EN 7730. The resulting operative temperature interval for the heating season is between 20,5 C^0 and 23 C^0.

ii) Cooling season

Operative temperatures ≤ 26 C^0 of which a maximum 100 hours above 26 C0, and maximum 50 hours above 27 C^0 (DK-GBC, 2016). In accordance with clothing level, assumed activity level and quality level of category B cf. DS/EN 7730. The resulting operational temperature interval for the cooling season is between 23 C^0 and 26 C^0.

Thermal comfort shall be maintained, in the heating season, by the HVAC system, with room-specific heaters, ensuring the temperature can be adjusted at room level. In the cooling season, the indoor thermal climate shall be regulated by natural ventilation, through manually operated window openings. Hybrid ventilation system reduces the energy consumption, by eliminating the energy consumption required to ventilate the building when heat-recovery is unnecessary. The building shall be designed so fast regulation of the indoor temperature can occur, as it essential when designing for occupants prone to elicit a stress response, that temperature can be adjusted in correspondence with the alteration of metabolism. Alteration of metabolism occurs as a result of increased cortisol concentration; increasing core temperature and decreasing skin temperature (Herborn et al., 2015).

Atmospheric comfort

The perceived air quality depends on the concentration of various components in the air; including carbon dioxide, moisture and various airborne molecules emitted from the buildings interior, exterior air and the occupants of the space. Atmospheric comfort is not directly regulated in the Danish building regulation. The regulation only ensures that housing is ventilated with a minimum of 0,3 l/s pr. m^2 cf. §443 BR18. The projects allocated square meters per persons does not represent the average value; therefore, could ventilation and corresponding energy consumption dimensioned in accordance with §443 BR18, render an insufficient air quality and misguiding energy consumption. Combatting this issue; the project will investigate the guidelines of DS 447 annexe C, to ensure the air quality is satisfying. In accordance with category 2, 7 l/s pr. person (n) is required for 80% satisfaction with the atmospheric comfort, and 0,7 l/s pr. m^2 (A) is sufficient to provide sufficient indoor air quality as a result of the emission of chemicals from the interior materials (e.g., VOC's). In accordance with the room program, the resulting ventilation rate for a 70 m2 apartment occupying six individuals will have approximately ventilation rate of 433% higher, following DS 447, compared with §443 BR18. As indicated by the comparison; a large difference in ventilation rate is recommended; depending on the selected restriction/methodology, suggesting that §443 BR18 are insufficient to ensure atmospheric comfort for this design.

The recommendation of DS 447 is based on assumptions on human activity and degassing from materials. Carbon dioxide concentration is believed to be the deciding factors for dimensioning ventilation rates based on human activity; if sufficient carbon dioxide concentration is achieved moisture- and olfaction discomfort is managed (Persily, 1997). The concentration of carbon dioxide in the interior air is essential to manage, as high concentration of carbon dioxide has been correlated with reduced cognitive function (Myhrovold, Olsen and Lauridsen, 1996; Madureira et al., 2009; Satish, Mendell and Shekhar, 2012; Twardella, Matzen and Lahrz, 2012) and correlated with negative mental well-being (Tsai, Lin and Chan, 2012). A high concentration of carbon dioxide, thus potentially counteract the design intentions for the spatial configuration of the architecture to assist the treatment of post-traumatic stress disorder. As indicated by Vehviläinen et al., (2016) the physiological and psychological effects are correlated with concentration exceeding 1400 ppm. Calculating the required ventilation rate per person for ensuring a maximum concentration of 1400 ppm, resolves in 6 l/s per person cf. EN15251. Following DS 447 ventilation requirement per person (7 l/s) resolves in a static concentration of 1150 ppm cf. EN15251. As indicated by the empirical findings, 6 l/s should be sufficient

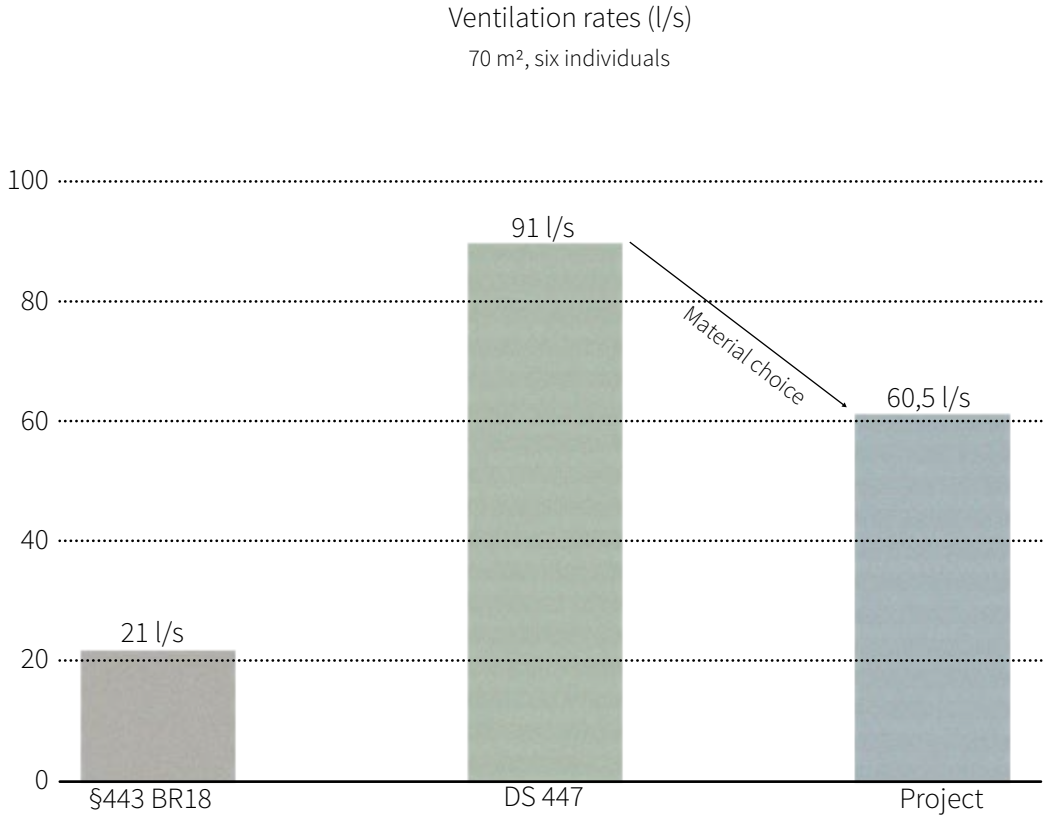


Fig: 39- Comparison of ventilation rates

for ventilation rate to achieve atmospheric comfort in regards to human activity but does not address discomfort and health risk associated with degassing for building materials; the second component of DS 447 annexe C. In the aforementioned calculation example in correlation with DS 447, 54 % increase in ventilation rate were required to ensure chemicals emitted from interior materials were dispersed, for a building design of seventy square meters occupying six individuals. The chemical composition of the interior materials, thus, pose great influence on the buildings energy consumption and dimensions of the ventilation system. The selection of interior materials with a low concentration of formaldehyde and other volatile organic compounds; such as restricted to the use of materials label with the Nordic Swan Ecolabel; recycled materials or let the buildings materials degas before occupancy, are therefore passive design solution to reduce the required ventilation rate; reducing the required consumption of electricity, heat, reduces noise pollution and reduces discomfort as a result of draft. Furthermore, reduced ventilation rate also reduces the cost of installation of the ventilationsystem; reducing the dimension of the mechanical ventilation system, thus, also reduces the embedded emission of carbon dioxide equivalents (Birgisdóttir and Madsen, 2017). Based on passive solution of conscious material selection and the corresponding usage of sheep-wool insulation, the project will assume, that 0,35 l/s per. m2 + 6 l/s per person should be sufficient to ventilate the interior spaces, and provide atmospheric comfort that ensures health and well-being. Resulting in a static carbon dioxide concentration of 942 ppm.

Visual comfort

Architectures modulation of emotional response has previously been associated with visual permeability, both within the interior and through the building envelope, the dimensions and placements of the windows are, therefore, an essential design parameter to ensure the environment supports the treatment of post-traumatic stress disorder. Besides the allowance of visual permeability, windows also provide light and heat for the interior spaces. In accordance with BR18 § 379, the daylight levels of 50% of the interior space shall reach a minimum of 300 lux. This requirement is normally ensured by having a window area that is a minimum of 10% of the interior floor area. As demonstrated by Stamps (2007;2010) increasing the daylight levels from 300 lux to 600 lux were significantly correlated with an increased sensation of spacious, thus a theoretical reduction of cortisol concentration. The project should, therefore, aim at providing increased daylight levels. The room layout and window design shall ensure daylight is evenly distributed, without dark areas (Stamps, 2012). Daylight levels are orientation independent, but the colour of the sky and direct sunlight is not, these are depended on the pathway of the sun. The quality of the light plays an essential role in the regulation of the circadian rhythm, especially natural light as it contains the ideal configuration for stimulation (amount, spectrum, distribution, timing and duration). The circadian rhythm regulates sleep, activity-rest behaviour, alertness, mood, performance and body temperature, therefore, tightly correlated with health and well-being. Figueiro and Rea (2016) conducted a study to test this interesting correlation, in an office setting and found that subjects exposed to increased amounts of circadian light had significantly increased sleep quality and work efficiency. Improvement of sleep quality has been associated with increased allocentric navigation performance (Samanta, 2018); indicating that sleep supports the construction of verbally accessible memories, thereby supporting the treatment of post-traumatic stress disorder and ensures the construction of emotional associations with spatial memory. Interestingly, east orientated windows have displayed to be more beneficial for the treatment of depression, compared with western orientated windows. (Beauchemin and Hays, 1996; Benedetti et al., 2001)

As evident by the empirical finding, the composition of natural lights affects health and well-being, the interior spaces, shall, therefore, have daylight access, primarily towards the east and south, as these directions are more strongly associated with circadian light compositions. In correlation with access to circadian light and window orientation; access to direct sunlight is an essential passive solution to ensure the building is energy efficient.

Passive solar gain

The previous passage on daylights psychological- and physiological influence suggested that the resulting design solution should consist of large window spans (approximately 20% of floor area) where the majority of the glazing orientated in an east – south direction. Windows are an essential passive strategy to improve the indoor climate, both in regards to daylight, but also, more importantly, the indoor thermal climate and corresponding energy consumption. The transmission loss of windows is approximately ten times greater than that of an exterior wall (DK-GBC, 2016). The usage of large window panes, therefore, drastically increases the buildings transmission loss; an increased energy consumption which shall be counteracted with passive solar heat-gain, to ensure the resulting design solution is energy efficient. To improve the understanding of the accommodation units energy requirements, in regards to heating; a BSim model of a large family accommodation was constructed for simulation intentions. The accommodation united were designed as a unit, on the highest floor, and three exterior walls exposed to the outside climate – to depict the worst-case scenario. The materials chosen were based on the aforementioned selection of wooden as the primary material for the structural system. The amount of insulation was decided in correlation with the highest score achievable in DK-GBC (2016) in regards to the quality of the building envelope. The housing unit was fitted with a glazing area, corresponding to 20% of the floor area. The physical properties of the glazing were manipulated, and the G-value of the glazing was set to 0, in order to construct a detailed depiction of the units energy consumption when passive solar radiation is excluded. The unit was fitted with hybrid ventilation in correspondence with the aforementioned criteria for atmospheric- and thermal comfort.

The first figure plotted from the data is fig 40. The red curve on the graph represents the weekly heat requirement for the unit. As indicated by the graph; solar radiation is desired in the period between, roughly, 21/9 to 7/5. The blue curve represents the solar altitude at solar noon, on a respective day. Combination of these datasets gives a good indication upon what solar altitudes the windows of the project-specific accommodation units, shall be exposed to, in order to minimize the buildings energy consumption, and what solar altitude shall be blocked in order to reduce overtemperature in the interior space. Solar radiation is sparce in the winter month, the spring and autumn are, therefore, of stronger interest, as designing after these solar altitudes would resolve in an energy-efficient building without overengineering the buildings with the desire at receiving a sparse passive solar gain in the winter months. Based on this assumption; access to a 24-degree solar altitude at solar noon should result in an energy-efficient building.

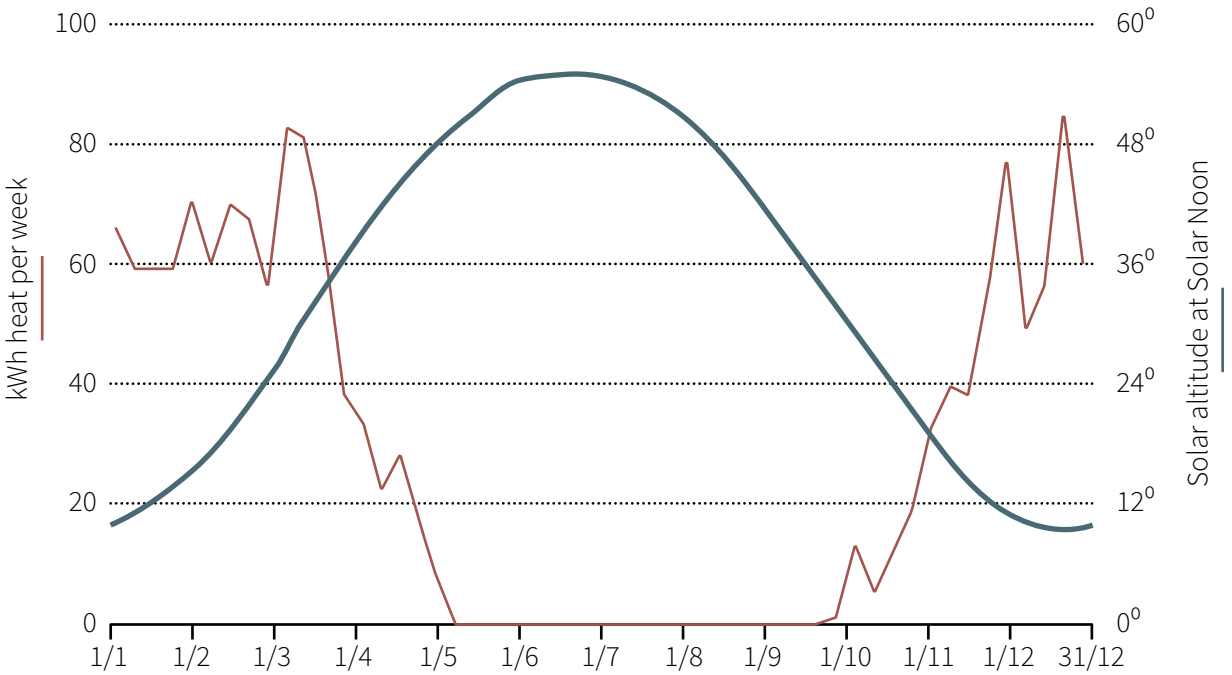


Fig: 40 - Energy requirments and solar altitude

One of the critical byproducts of selecting biobased materials as the primary building material for construction and interior materials is the corresponding drastically reduced low thermal mass, in comparison with concrete. The choice of material, therefore, resolves in the thermal comfort and corresponding energy consumption being more vulnerable to fluctuations in internal heat gains, passive solar radiation and alteration outside temperature. In order to combat wood construction reduced thermal capacity, a second dataset was exstracted from the BSim analyse. As depicted in fig 41; three critical months were selected for detailed analyses; January; March and November. The red shape in each diagram is a depiction of the energy consumption and variation of required heating per hour in the time span between six in the morning and ten in the evening. The blue curve is the solar direction at the corresponding time of the day. As illustrated by the graph; solar exposure from the east - south is the most efficient direction in order to capture passive solar radiation — especially the south direction, as this will have an increased solar altitude, compared to east direction. The study on passive solar radiation, therefore, construct an additional argumentation, in combination with the passage on daylight access, for an east-south orientation.

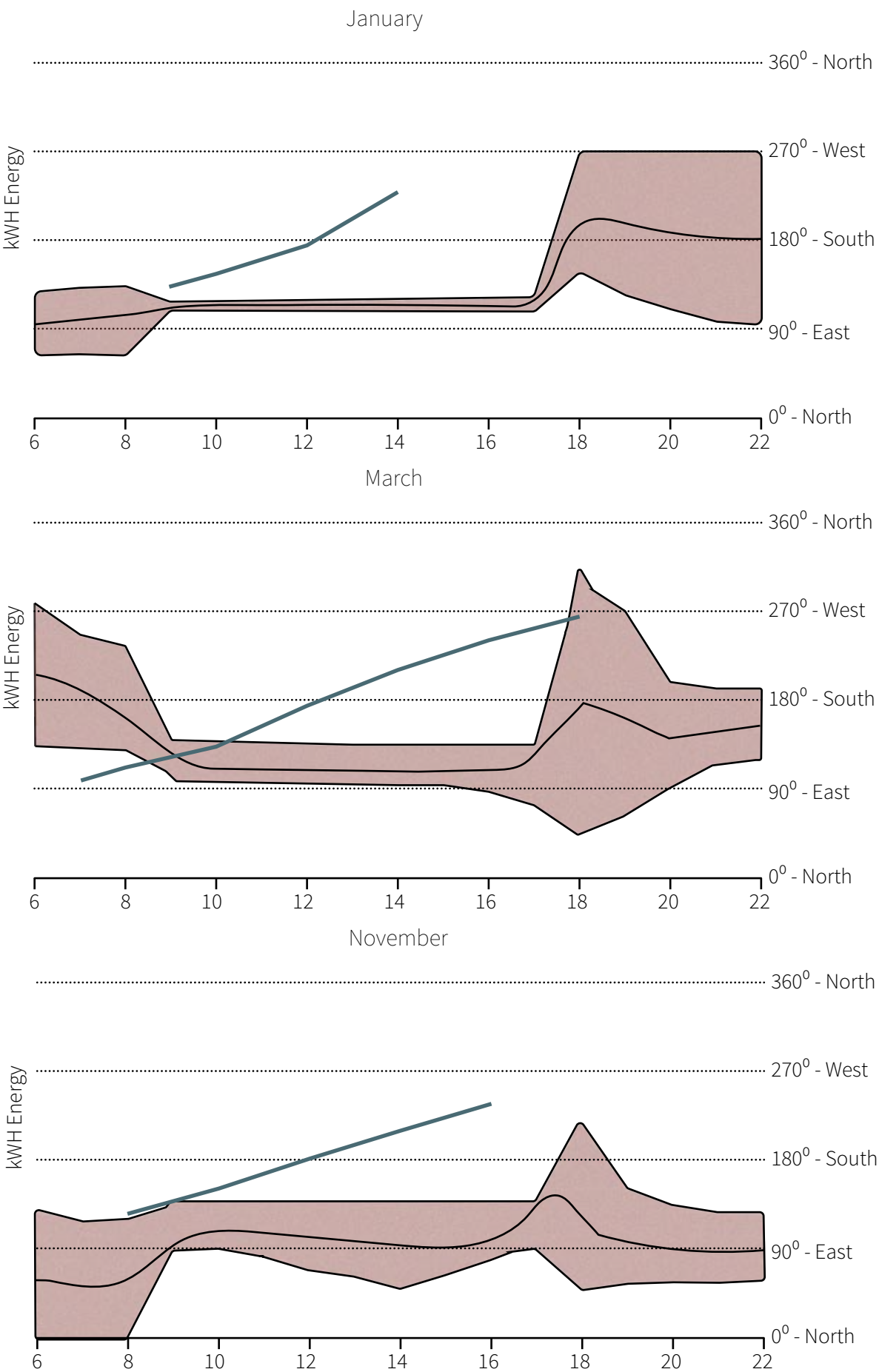


Fig: 41 - Energy requirments and solar direction

Social

As indicated by the preliminary theoretical assessment of environments correlation with the emotional- and memory system, social connections to environments influence emotional modulation and thus alters behaviour. Similarly, social support has been correlated as an essential component of the treatment of post-traumatic stress disorder (Conway, 2009; Fegert et al., 2018). When the refugees arrive at the asylum centre, they will have few, or none, social connections to the other inhabitants. It is, therefore, essential that the architecture facilitates proper social interaction, both to ensure social connections are constructed and corresponding, ensuring that the spaces of the centre are associated with interactions associated with a positive emotional response.

As previously mentioned, the active usage of space during social interaction is called interpersonal distances. The active usage of space is a reflection of the trust associated with the individual; how much reaction time is required to avoid danger and how much information regarding their psychological- and physiological state does the individuals desire to exchange with each other. In correlation with the works of Edward T. Hall (1969), interpersonal distances can be subdivided into four categories; intimate; personal; social consultive and public. Environments failing to facilitate sufficient interpersonal distance, render increased cortisol concentration and resolves individuals to perform coping behaviours to account for the lack of sufficient interpersonal distance (Maslow, 1943); thus resolving in a negative emotional modulation, resolving in negative spatial associations and unsuccessful social interaction. The spatial dimensions of the building shall, therefore, correspond with the social connection between the individuals actively using the space. As indicated by the empirical findings, PTSD patients required enlarged interpersonal distances, compared to healthy individuals (Allekian, 1973; Bullock-Loughran, 1982). There is no clear indication of how enlarged the requirement of interpersonal distance is due to a post-traumatic stress disorder, and if the alteration is present at all types of social relations. The project will assume a 20% increase in distance requirement for social consultive and public interactions, excluding the enlargement of interpersonal distance requirement for intimate and personal is based on the assumption that these interactions are more significantly associated strong social connections,thus less likely to be associated with a strong anxiety response, as these interactions are not associated with unpredictably (Fig. xx.xx)

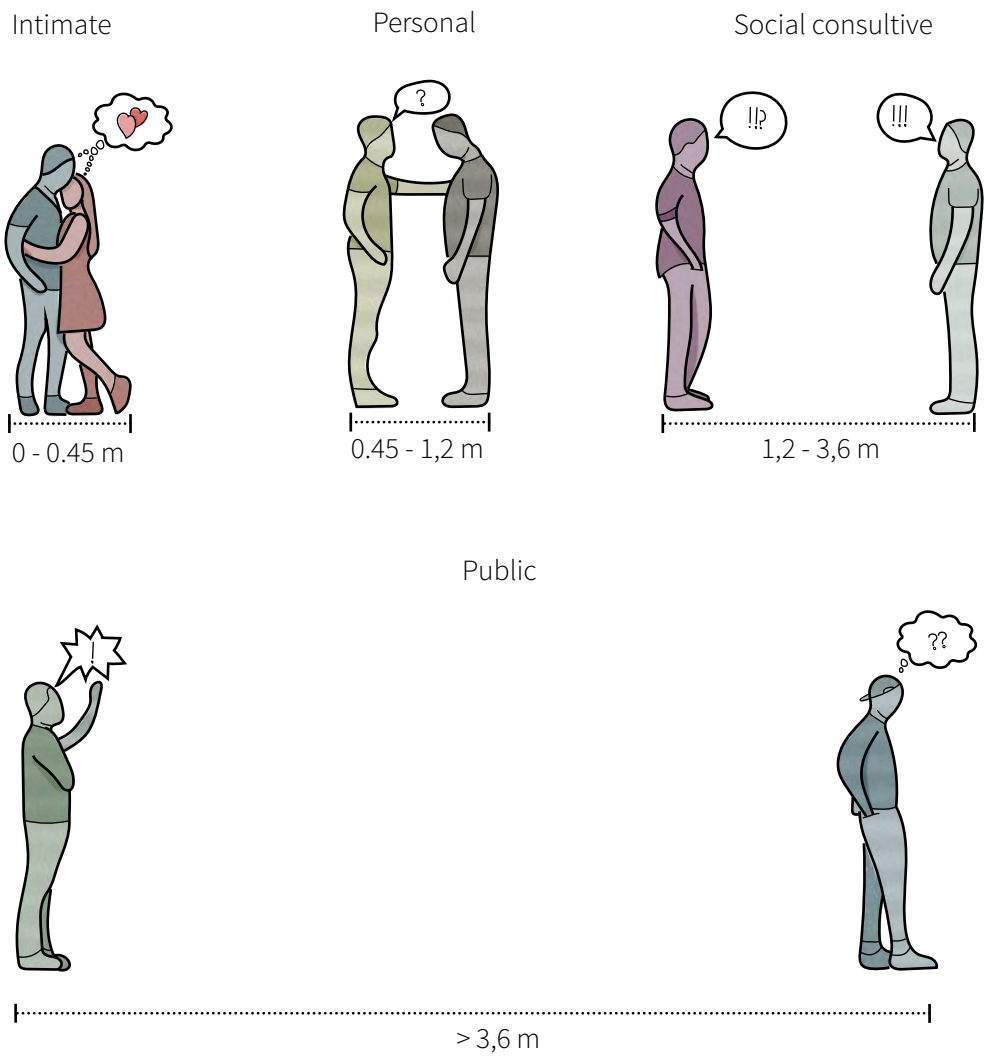


Fig: 42 - Interpersonal distance PTSD

Social structure

The organisation of social connections is often described as a network; an interwoven set of connections tying individuals together and illustrating the social relations between the involved. In architectural terms, the concept of private, semi-private, semi-public and public is often brought forward to illustrate the ownership/accessibility to a given space. This simple concept is highly applicable for this context; just as individuals organize their social connections into various interpersonal distances, the same can be argued to correlated with concepts of private and public spaces. The private is controlled, regulated and known – low anxiety response. The public is, uncontrolled, unregulated and unknown. The asylum centre shall be carefully designed, in regards to these concepts to cultivate social interaction and reduce cortisol concentration. The underpinning concept is roughly illustrated in fig. xx.xx. The transition between private and public is subdivided into sections, sections expanding in the number of individuals with a connection to the space, as they progress towards a public status. By subdividing the environments, it limits the people associated with regularly visiting the space, thereby construction social association to the subdivided environment, improving the sense of control of the people who access the place. The first subdivision of the transition, from private to public, is the semi-private space. This environment should be shared by a small cluster of different accommodation types. The purpose of this subdivision is to construct a neutral gathering point for interaction; a space with limited people associated with it, thereby creating a sensation of community with the other individuals who use it; increasing the sensation of control and assigning a social connection to the space. The semi-private space grants access to the semi-public subdivision, an area associated with an increased number of users, thus lower sensation of control.

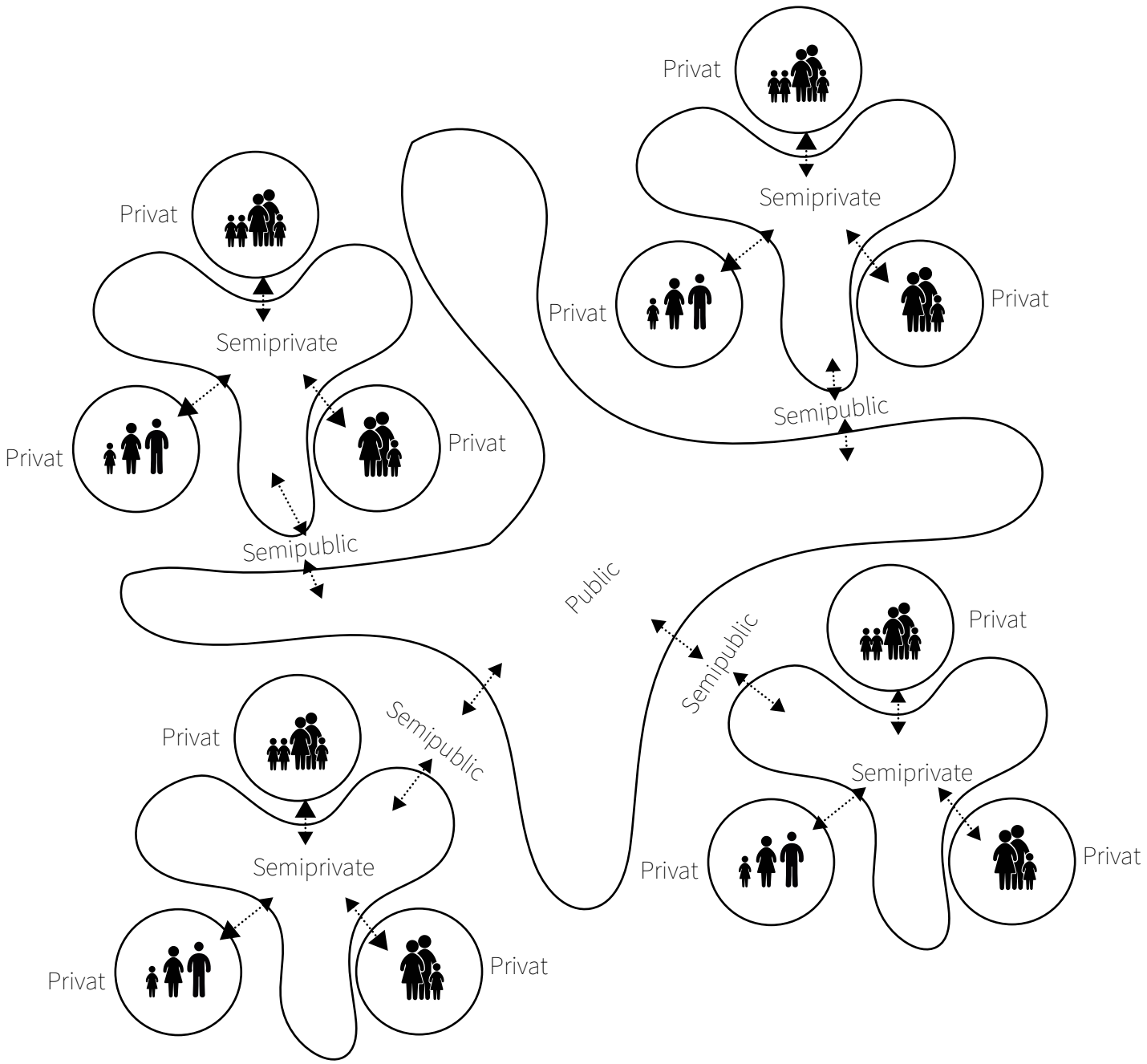


Fig: 43 - Social structure - concept

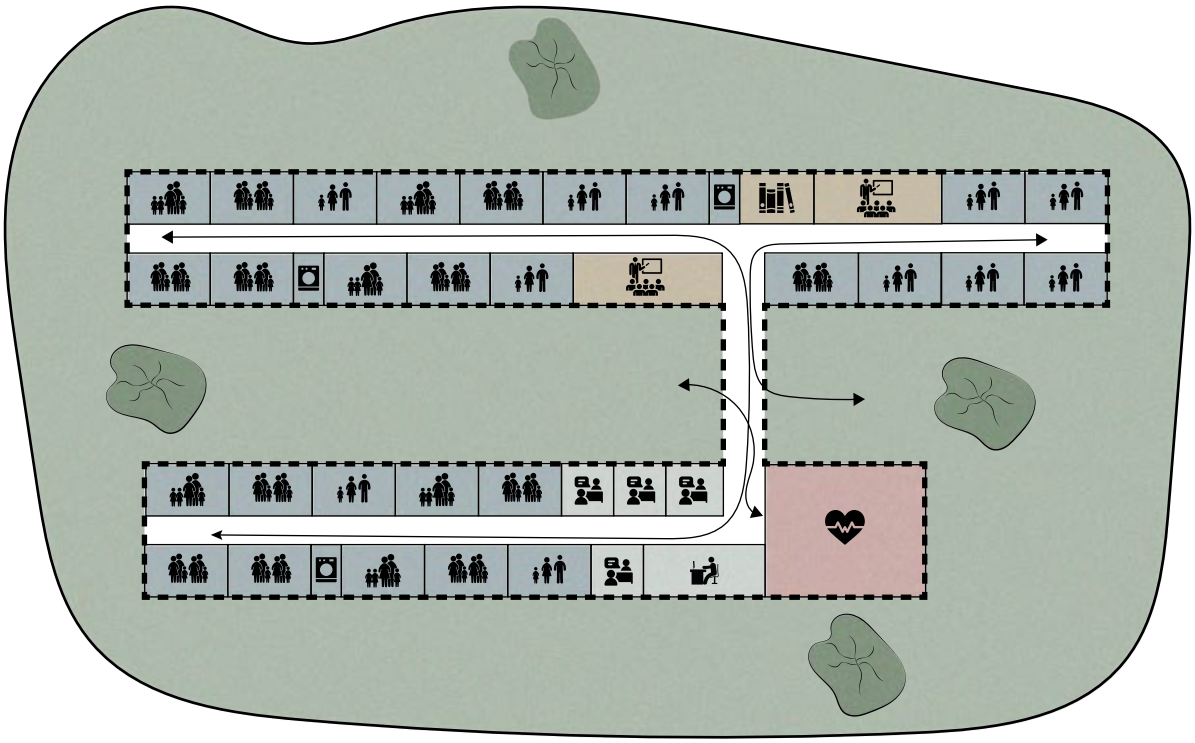
Morphology

The morphology of the asylum centre will influence the behaviour of the occupants, by alternating how they interact with the site and its buildings; what routes they have to take to complete daily errands and what environments do they interact with others in. Health-care buildings, and other institutions a classically designed as largescale interconnected buildings with central hallways, contradicting the village-style urban structure commonly found in the asylum centres operated by the Red Cross.

One of the primary tasks of an asylum centre is the rehabilitation of the refugees into normal everyday life; the urban structure shall, therefore, support this intention. The village-style urban composition, more closely mimics the everyday life of regular citizens, compared to the institutional morphology. In the village-style composition, the various functions of the asylum centre are scattered across the site, within separate building envelopes. Separation ensures a clear distinction between the various functions associated with the building; what is home?; what is educational?; what is treatment?. Compared to the institutional morphology; were all functions are comprised of a single or few buildings, typically interconnected.

As illustrated in fig. 44 by applying the village-style urban structure, the occupants are required to interact with the nature of the site, in order to get to a certain destination. As indicated by the literature nature is generally more preferred, compared to build environments and has been associated with corresponding psychological- and physiological benefits . Increasing the refugee's interaction with nature will, therefore, improve the treatment of the occupants. Furthermore, in the village-style composition, the majority of social interaction with a public domain is conducted in nature, therefore, larger spaces compared to an interior setting; thereby ensuring the requirements for visual- and locomotive permeability is addressed without the requirement to construct large interior spaces.

Composition of institution



Composition of village

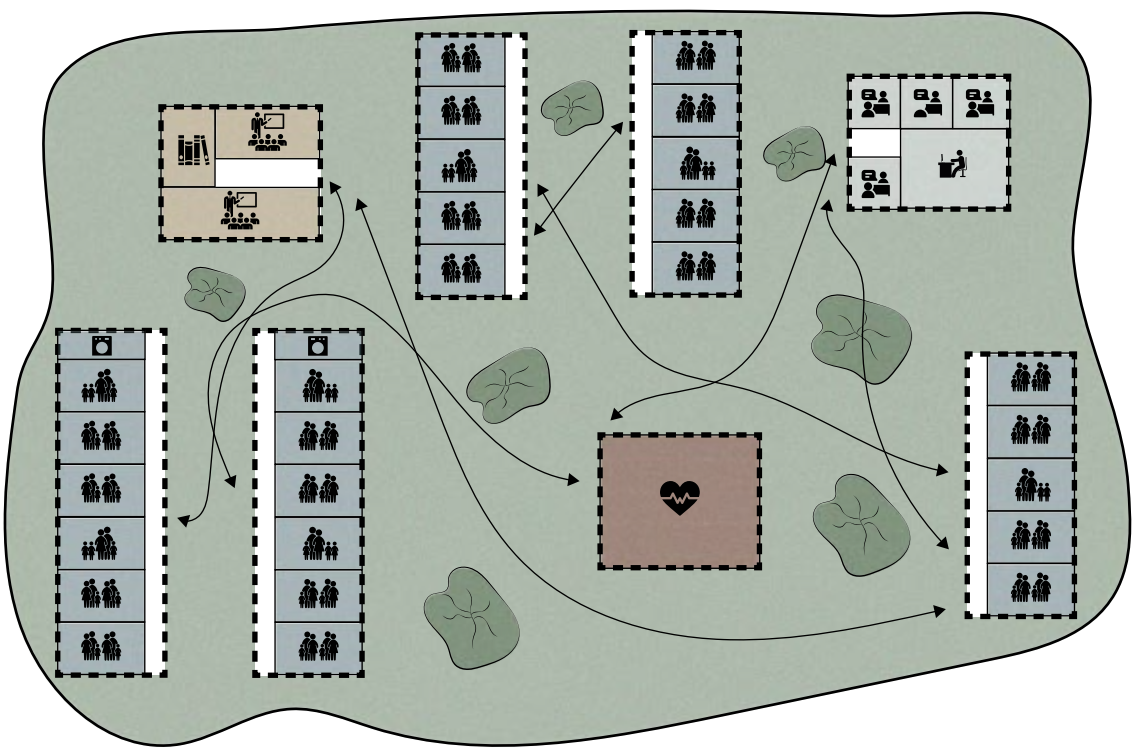


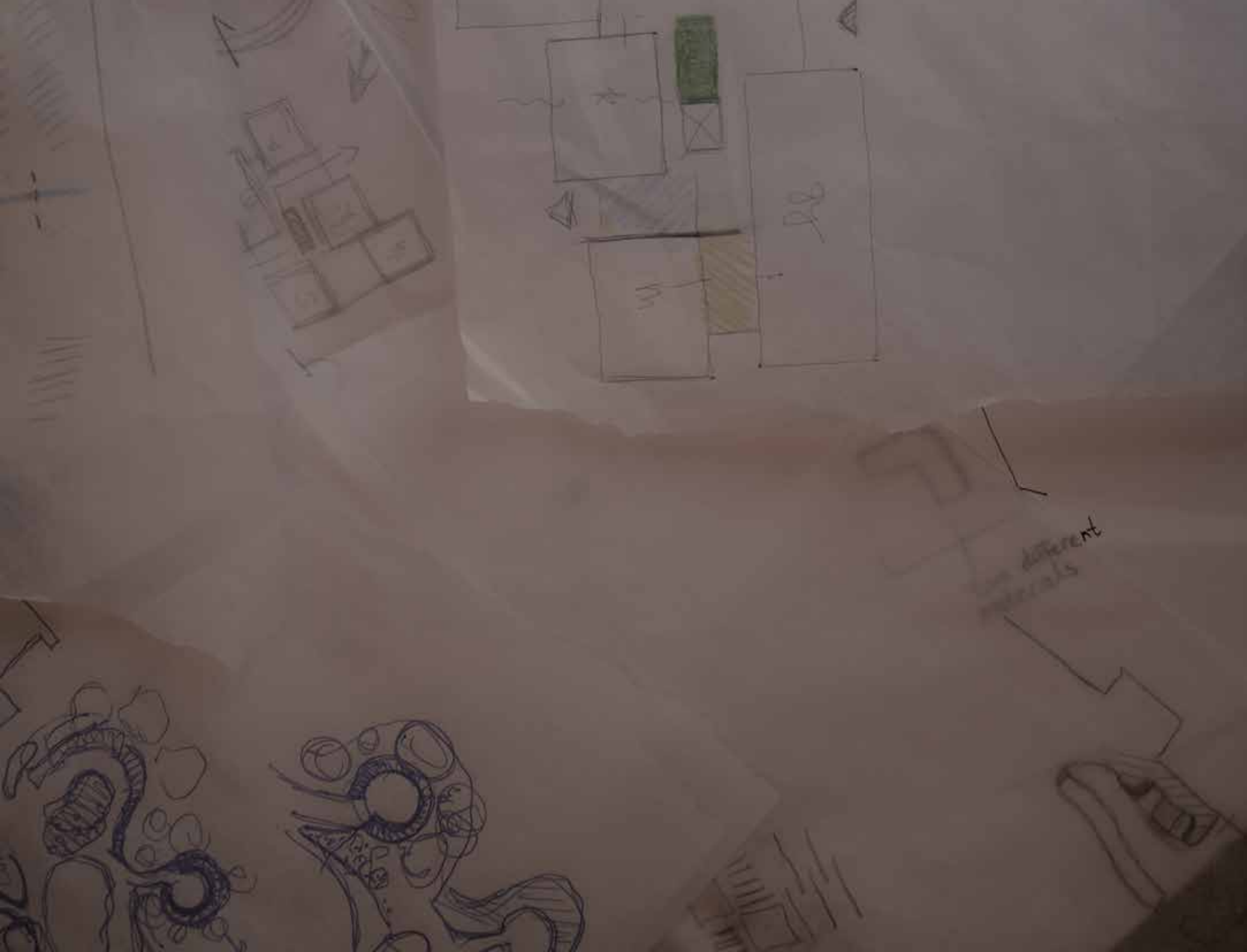
Fig: 44 - Institution versus village-styled

Conclussion

In accordance with the vision to design an environmental friendly asylum centre supporting the treatment of post-traumatic stress disorder, a project-specific inquiry was constructed in the design program to extract design guidelines for the following design process. As indicated by the duration of the asylum process; the asylum centre has the potential to have a substantial effect on the life of the asylum-seekers due to the long duration of their stay. Investment into improving the accommodation facilities for refugees can, therefore, be worth the increased expenses if the resulting effect is an improvement of the individual's ability to integrate into the host society. The selected site for the project, correspond with the desire to create an environment for the treatment of a mental disorder, as individuals suffering from psychological disorders is already associated with the local area, and the site is surrounded with pristine views of nature. The zoning regulation and the size of the site facilities the construction of a cost-efficient asylum centre housing a maximum of 725 individuals and provide the necessary amenities; healthcare facilities, administration building and spaces for various activities. Studies of the spatial qualities of the site have indicated specific placement for the various function, and illustrated what areas of the site is most suitable for construction; primarily the southern portion of the site. The architectural composition of the asylum centre shall consist of various scattered buildings, a composition that correlates with the zoning regulation and ensures that pristine nature is not overpowered by large construction. The design of the buildings and urban plan shall correspond with the desire to construct a good transition between private and public spaces, to promote social interaction and reduce the environment's influence on cortisol concentration.

Inquiry on material selection and environmental impact indicated that timber construction is the most sustainable solution for the project, and that frame construction is most applicable for the design of open spaces with large window spans. Furthermore, wood based materials for the interior and exterior cladding were also associated with reduced environmental impact and psychological- and physiological benefits. The applied wooden materials for the interior- and exterior cladding shall be threated without chemicals, in order to reduce the environmental impact, reduce energy consumption and ensure atmospheric comfort. Similarly, sheep wool insulation was selected as the most ideal insulation materials due to its low environmental impact and air cleansing properties.

The included and conducted studies on window orientation influence of the psychological benefits and the energy balance of the accommodation units, indicates that the building shall have a primary glazing orientation in an east-south direction. This direction conflicts with the southern portion of the site being the most suitable area for construction, as the large treeline towards the south has a negative effect on the buildings access to daylight and direct sunlight; detailed analyses of the forestry influence on accessibility to sunlight should, therefore, be made during the design process.


different

03

Design process

The design process

The following chapter examines a selection of the analyses which were incorporated into the design-process, in order to produce the final design proposal. The following representation of the design process is not a full account of the design process underpinning the final design, as displayed in the presentation chapter. The vast majority of the studies displayed are focused on the increasing the energy performance of the accommodation buildings. Considerations on social- and economical sustainability were included into evaluation of the findings of the technical, ensuring a holistic integrated design process.

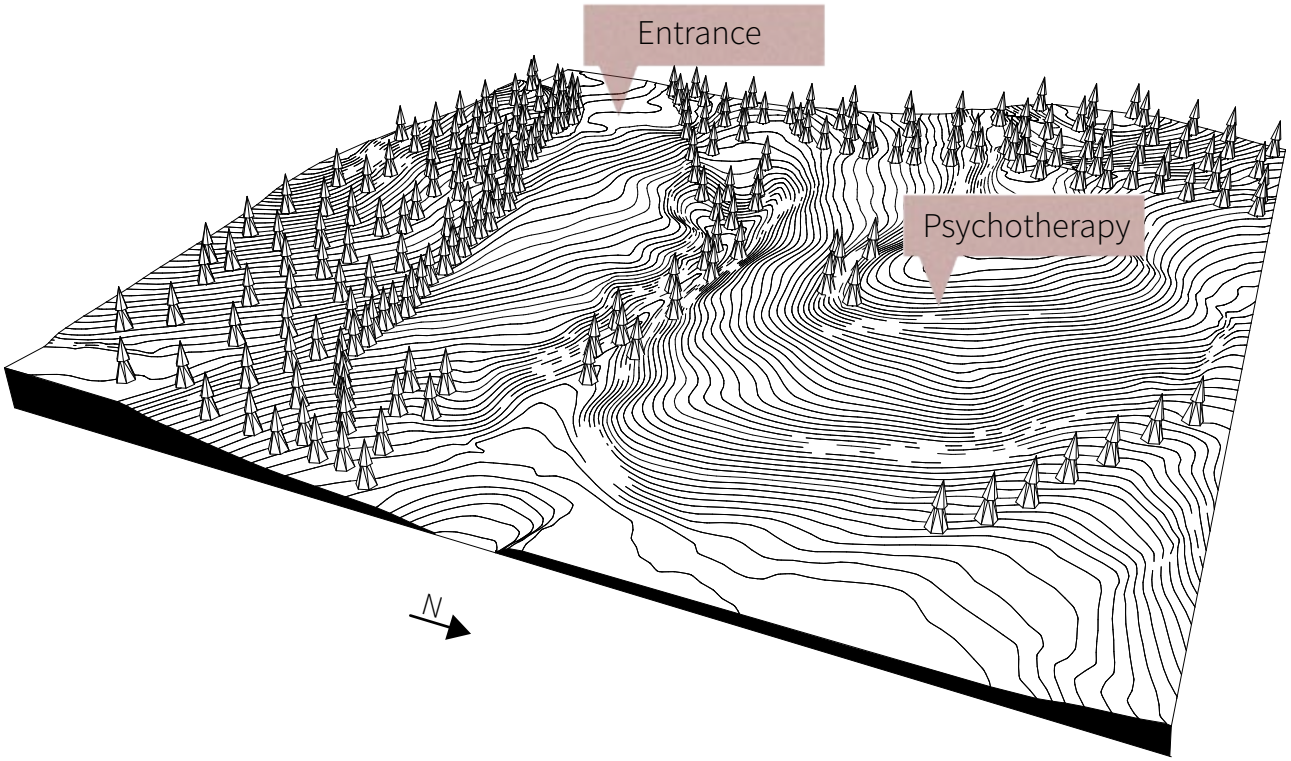


Fig: 45 - Key functions - Design process

Mapping key functions

Based on the site study analysis, two major functions; the entrance area and psychotherapy are mapped on the site. The placement of the entrance area is intuitive; access to the main road and positioned on a flat area that facilitates the construction exterior amenities, such as; parking, waste management. The psychotherapy is positioned at the location where the site offers the largest amount of visual permeability and is positioned where the surrounding typology restricts locomotive behaviour of potential threats. These properties are associated with reduced stress response; therefore, essential that psychotherapy is granted this position, as therapy is strongly associated with elevated cortisol concentration and is function/space that the refugees rarely associates with a positive emotional response, therefore, crucial that the egocentric impression of the environment introduces the minimal amount of stress response. The location of the psychotherapy is this location will thus, theoretically, improve the efficiency of the treatment and increase the health and well-being of the refugees.

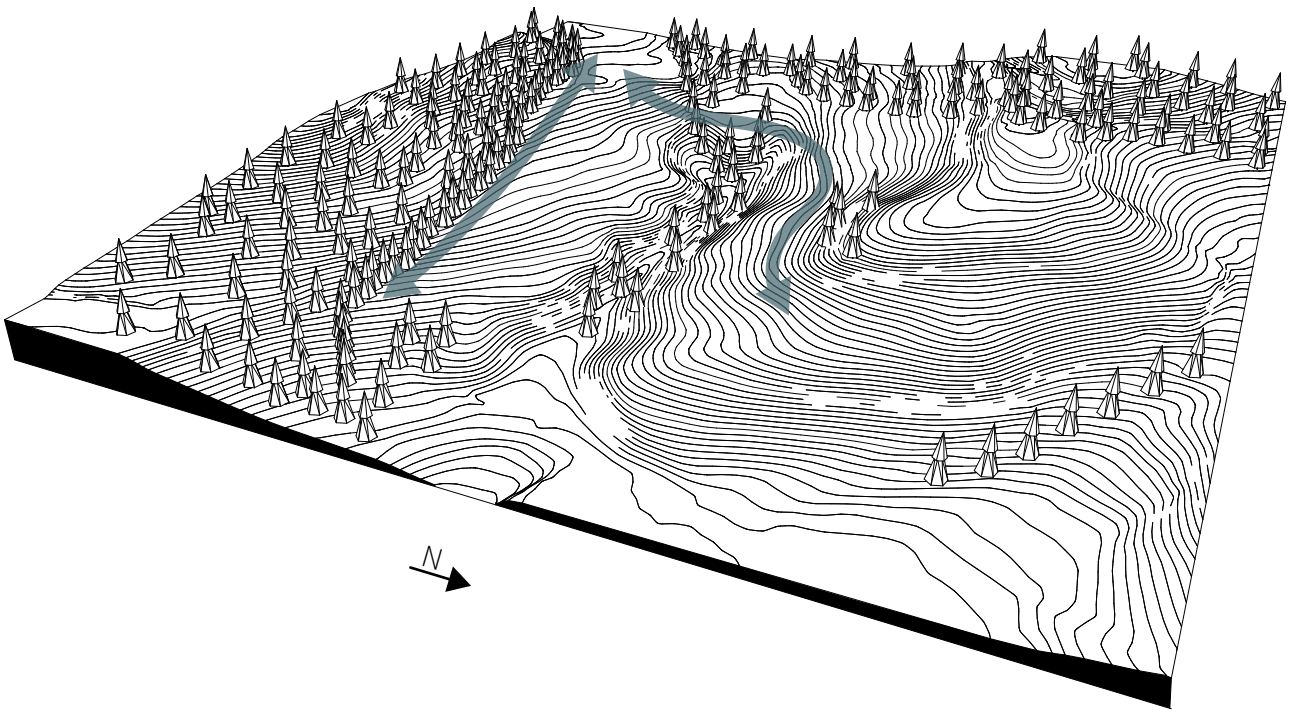


Fig: 46 - Accessways - Design process

Accessways

As previously illustrated by the typology study, the site curvature and alteration in elevation relatively complex, and only one potential natural pathway connect the northern- and southern portions of the site. Accessway is, thus, plotted on the site to guide the developed along these axes, to ensure that the building is accessible with motorized vehicles. The axis along the southern forest line is an already existing path, expansion and asphalting of this path resolves in a road suitable for driving for various sizes of vehicles. The accessways plotted from the entrance area to the Northen hillside is following the natural curvature of site, ensuring that the road is effortless drive- and walkable.

Urban strucuture

The morphology of the buildings and its corresponding usage of space is strongly correlated with the requirement to grant accessibility to solar radiation, ensuring both the required interior illumination and ensuring passive solar heat gain. Furthermore, the complexity of the typology of the site also influences the possibility of design. The following sketching study is conducted with the, aim at investigating the possibilities of using the southern portion of the site as the area to facilitate accommodation, administration and house activities (marked in the colour blue in diagram fig 47). To conduct the study two perpendicular axis were drawn on the site (see fig 47). The direction of the A-B axis correlates with the pre-established building orientation, designed to ensure the buildings have greate access to circadian light and passive solar heat gain. The direction of the A-B axis is also parallel with the direction of decline in elevation of the southern portion, the complexity of the typology will, therefore, also be included in the sketching phase; ensuring the resulting architecture is correlated with the typology of the site. The C-D axis is drawn perpendicular to the A-B axis, resolving in the 2D plane for the A-B axis displaying the façades of the building along the respective axis, and the 2D plane of the C-D axis displays a section cut through the buildings.

The primary focus of the following analyses is to construct inquiry upon how the morphology of the building can be designed when consideration of access to solar radiation, social structure and dimensions of public spaces are taken into account. In accordance with the preliminary analyses of the heat consumption of the housing units, the project will assume that granting 50% of the southern facade access to passive solar heat gain a solar angle above 24 degrees, due to decentralized ventilation, should be sufficient to ensure the buildings energy consumption is within regulation. The chosen solar height correspond desire to provide solar radiation to reduce the energy consumption of the housing units from late February to late September. This interval does not cover the full extent of the period with a heating requirement but is the interval is selected, as this solar angle is realistic in correspondence with the desire to construct a village-style morphology. The consideration of solar access is the primary design parameter of the sketches on the C-D axis, were the aforementioned assumption governs the distance between the building. The resulting space between the buildings are then measured and subdivided into its corresponding functions; public and semi-private. The sketching phase on the C-D axis resolved into three different morphologies, differing in building height, building percentages and corresponding distances between the buildings. The sketching phase on the A-B axis included two considerations; the building interaction with the typology of the site, accessibility to the entrance and the distance between the buildings along the respective axis. Consideration of the design resolved into four different solutions, varying depending on the distance between buildings and the building length.

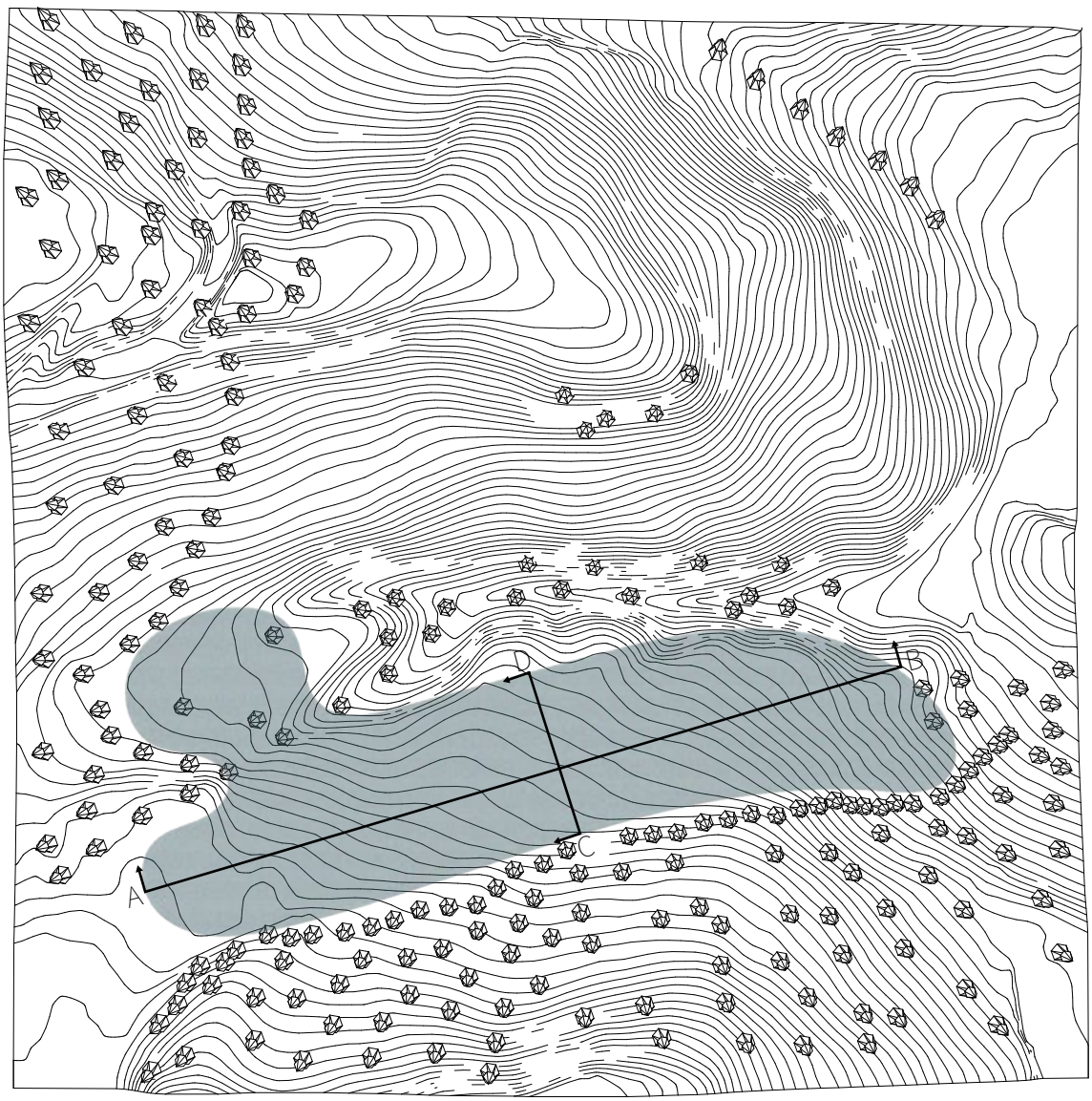
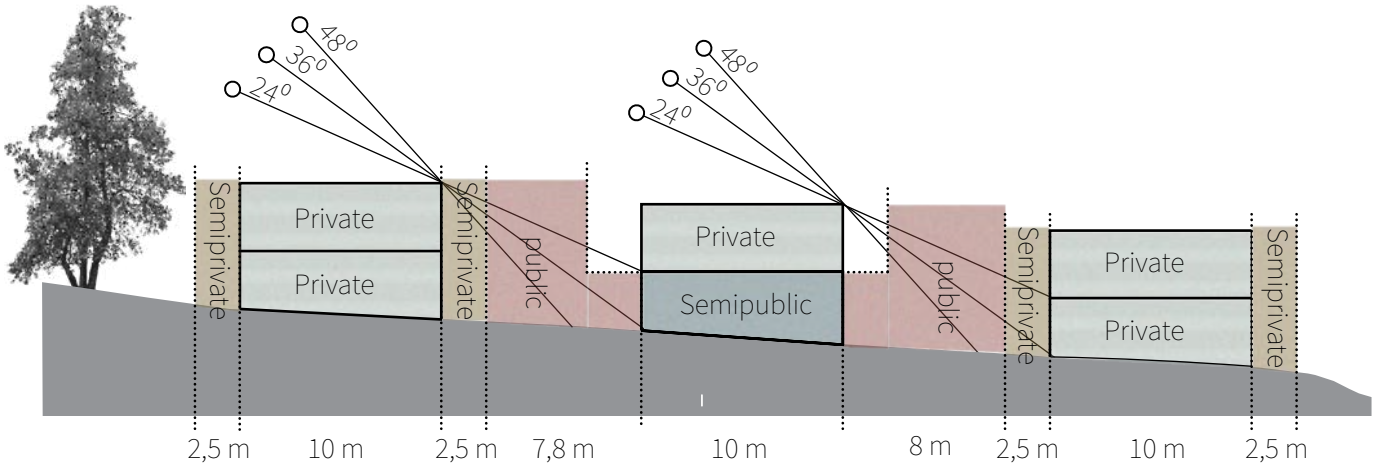
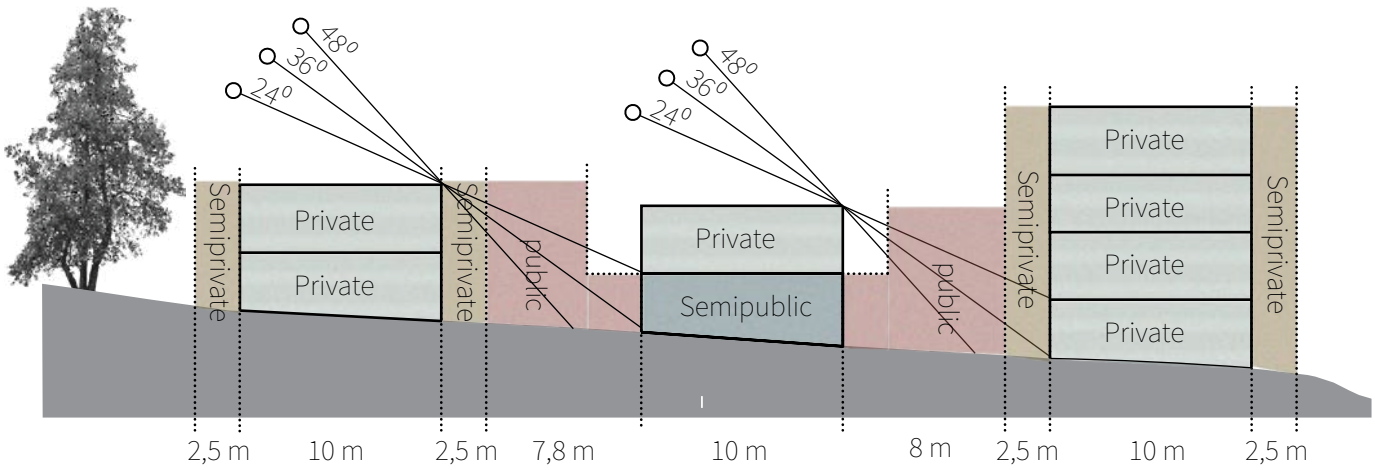


Fig: 47 - Typology study and construction area



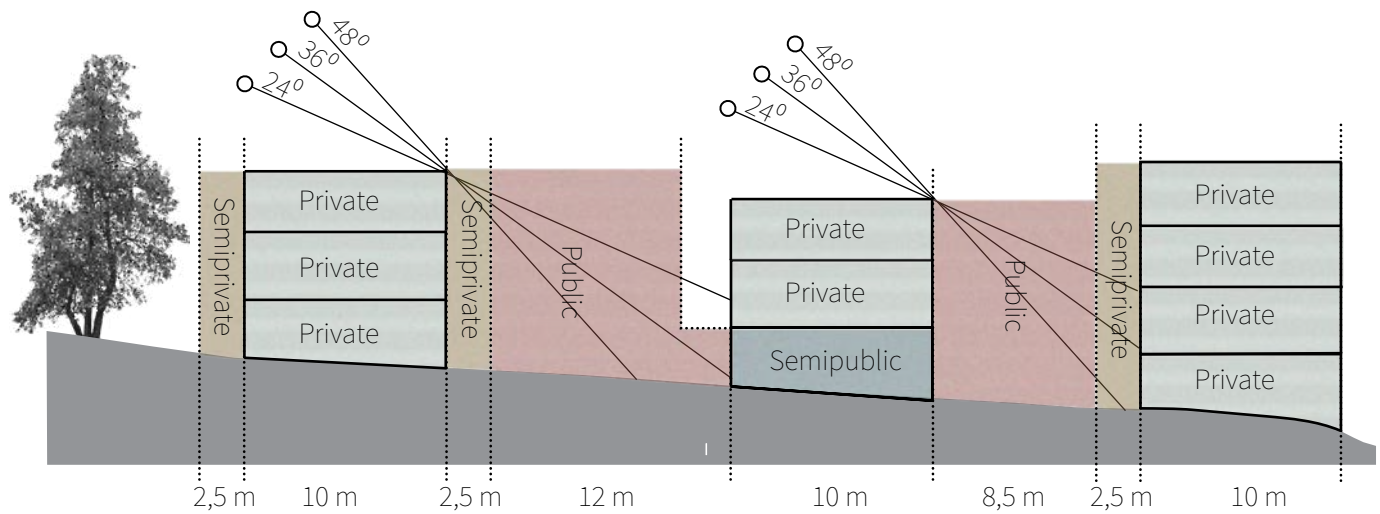
Effective area usage = 95%

Fig: 48 - C-D section - 1: Two storey



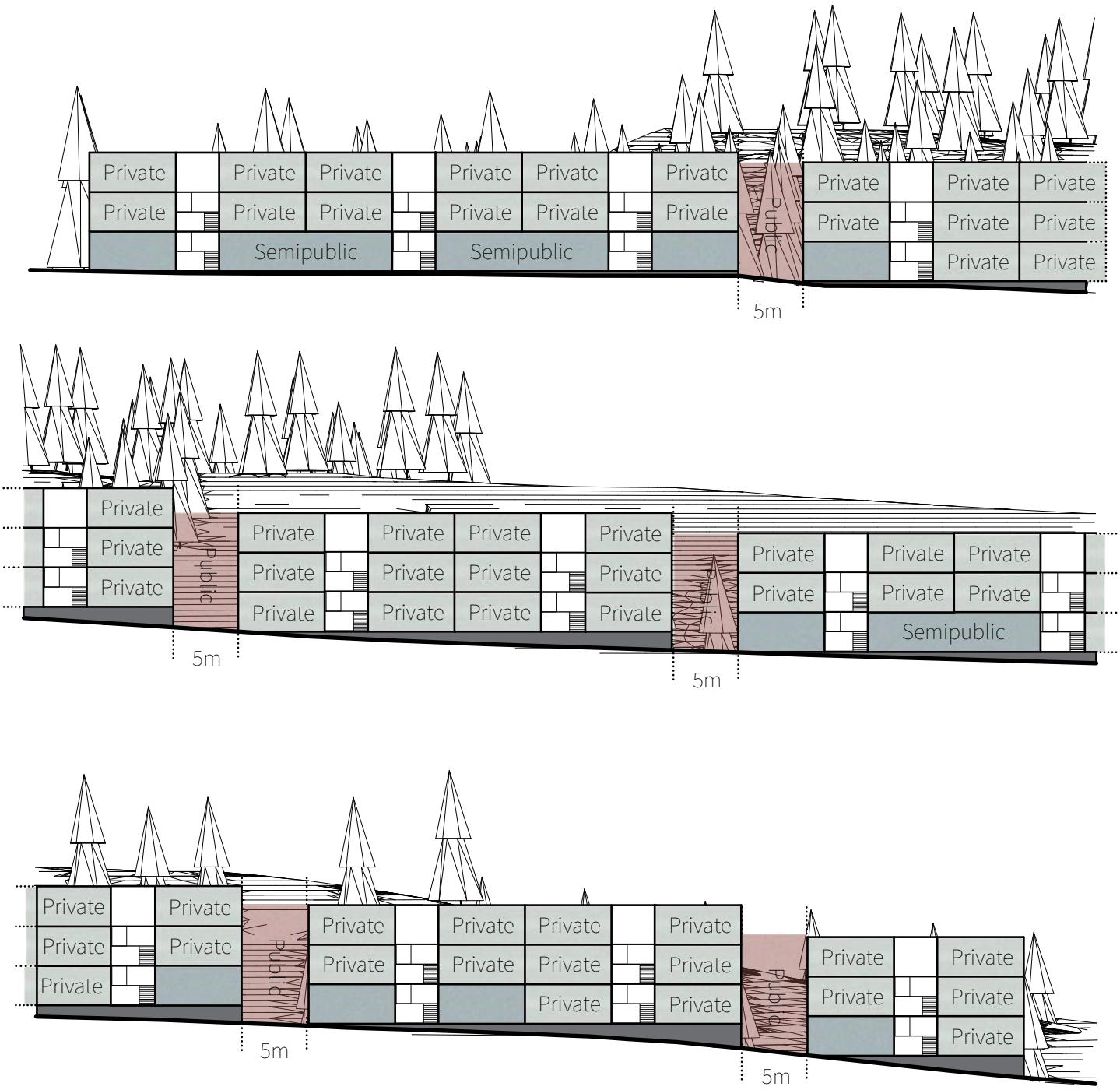
Effective area usage = 126%

Fig: 49 - C-D section - 2: Two-, two, three storey



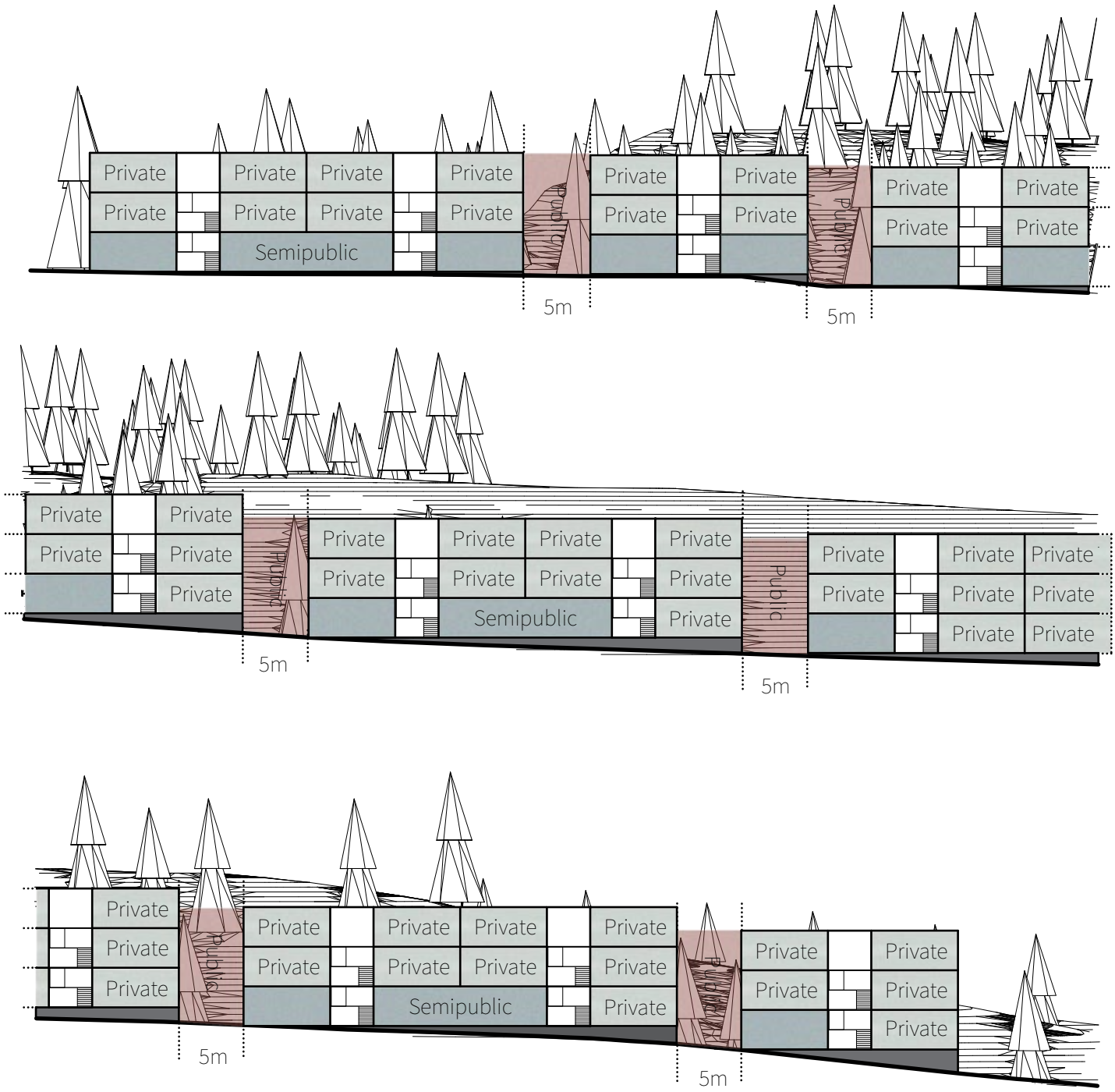
Effective area usage = 158%

Fig: 50 - C-D section - 3: three-, three, four storey



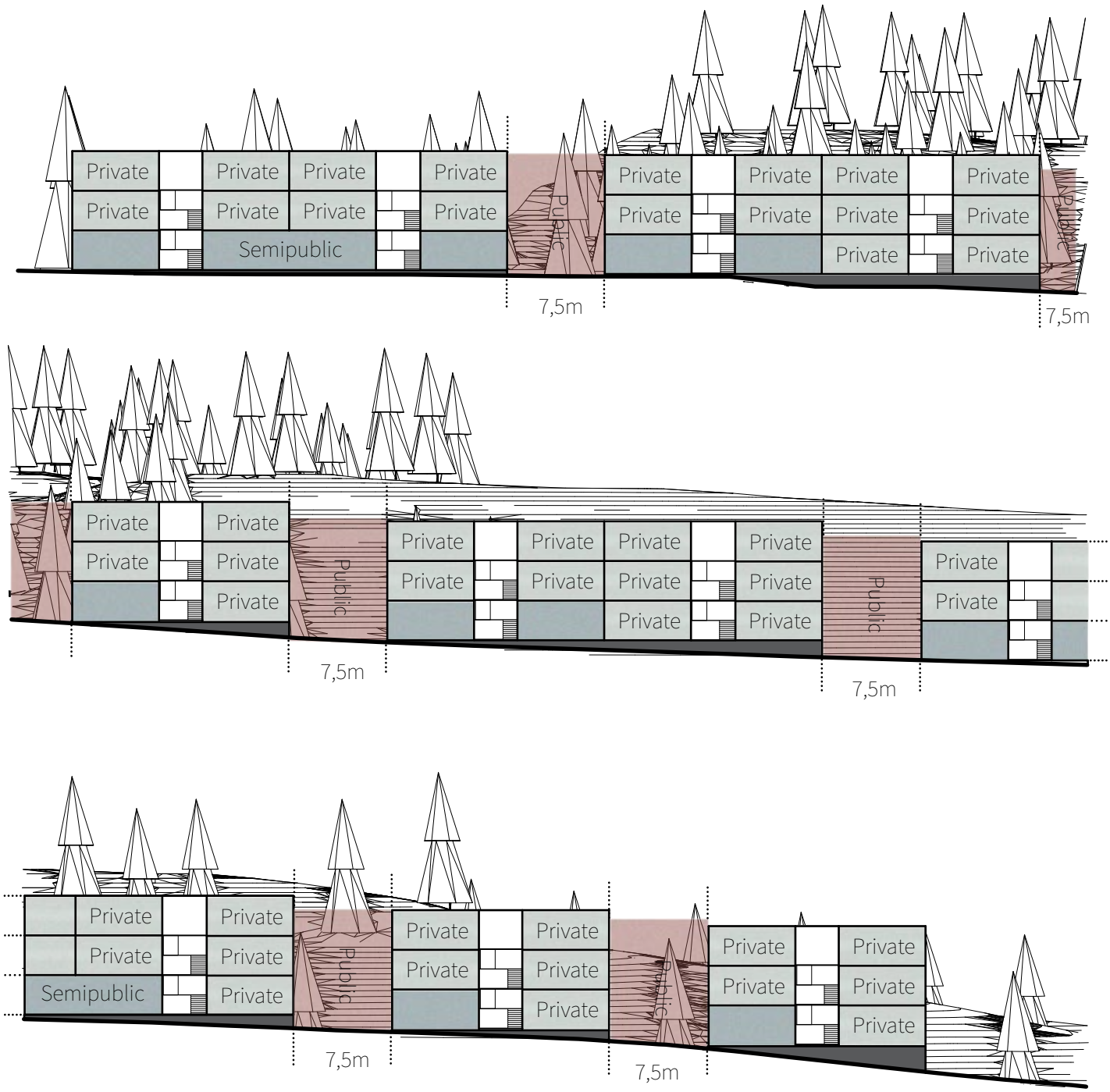
Effective area usage = 267%

Fig: 51 - A-B section 1 - No restrictions on building size



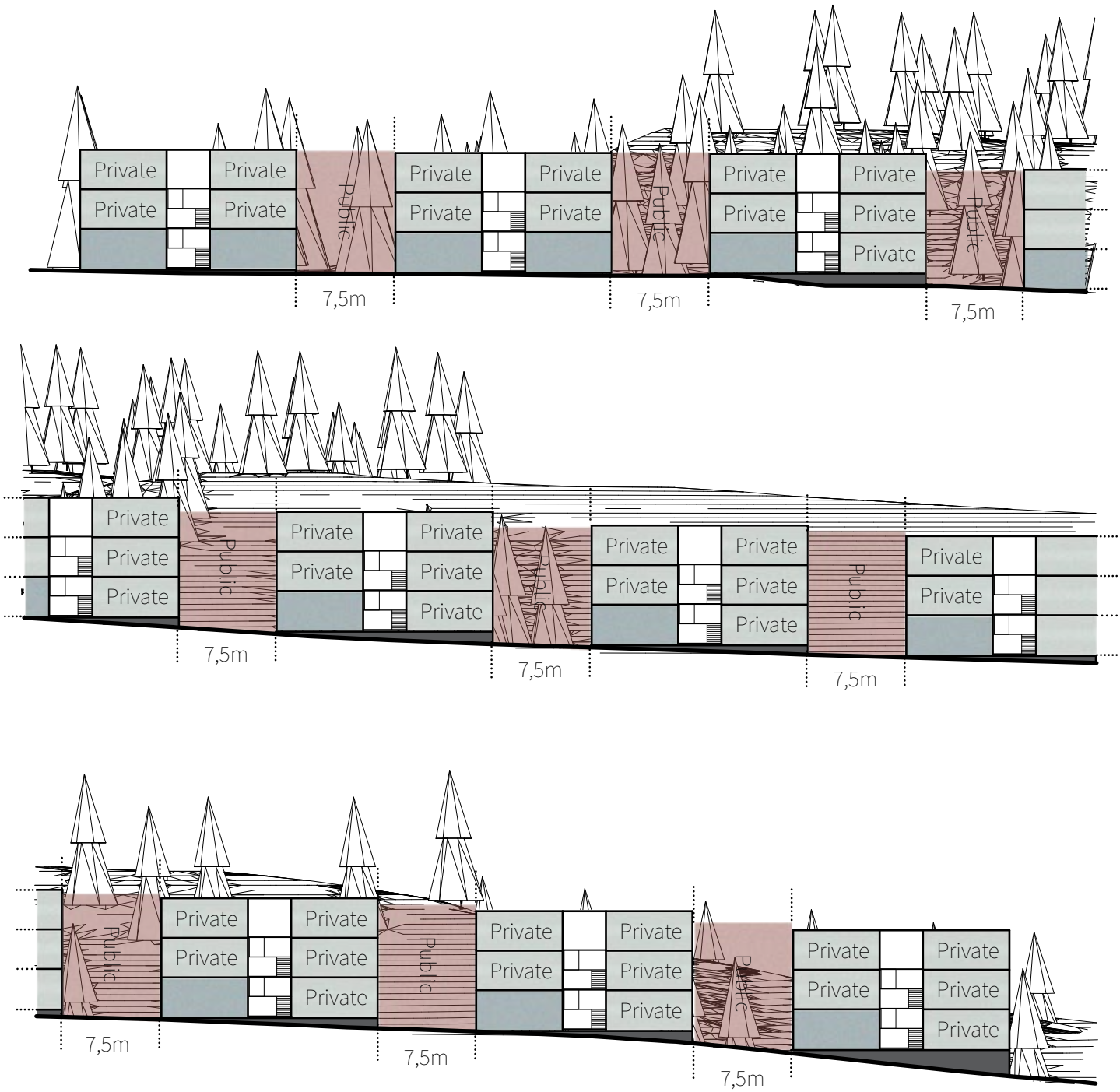
Effective area usage = 246%

Fig: 52 - A-B section 2 - Restrictioning building lenght



Effective area usage = 226%

Fig: 53 - A-B section 3 - Restrictioning building lenght and increased width of urban space



Effective area usage = 204%

Fig: 54 - A-B section 4 - Only small buildings and increased width of urban space

To assess the viability of the various design proposals, the resulting floor area is preliminary required to be calculated for all the possible combinations. In correlation with the room program, 10.925 square meters are required to be constructed to house accommodation, administration and the activities. The results of the calculation are displayed in fig 55; the results are shown in percentages reflecting how much floor area the respective solution provides in correlation with the aforementioned requirement. As indicated by the findings, section 1 in the C-D plane is not viable for the project. Similarly, section 2 in the C-D plane is only applicable with section 1;2 and 3 on the A-B plane. Section 3 in the C-D plane computes with all proposed sections on the A-B plane, even with the most restricted proposal in the A-B plane (section 4) while still maintaining a 53% surplus of square meters. The surplus of square meters in Section 3 in the C-D is achieved by using three and four-storey buildings. As indicated by Stamps (2011), building height reduces the perception of spaciousness, therefore, potentially effecting emotional modulation. On the contrary, increasing the building height, as displayed Section 3 in the C-D in combination with the proposals on the A-B plane, allows increased visual- and locomotive permeability in the horizontal plane and as demonstrated by Stamps (2005) spaciousness is more significantly correlated visual permeability in the horizontal plane. Increasing the building height, to increase visual- and locomotive permeability on the ground level might, therefore, be the most applicable solution. The increase in building height, also ensures more housing units can be positioned above ground level; providing an increased sensation of privacy and refuge. Of the 10.925 square meters required to be constructed approximately 14 % of the required square meters are intended for public and semipublic usage (activities and administration); functions which do not demand the same degree of privacy as these the accommodation units, these functions are therefore suitable for a position on the ground level. In a four-storey construction, parameters reserved for housing activities and administration are not sufficient enough to fully fill the square meters on the ground floor, accommodation units are, therefore, required to be placed

	%	Section C - D: 1 95%	Section C - D: 2 126%	Section C - D: 3 158%
Section A - B: 1	267%	72%	128%	201%
Section A - B: 2	246%	67%	118%	185%
Section A - B: 3	226%	61%	108%	170%
Section A - B: 4	204%	55%	98%	153%

Fig: 55 - Typologies and area requirments

on the ground level. As indicated by the sketches of the sections in the A-B plane, the natural typology of the site in combination with building length results in accommodation units raised significantly above the ground floor, therefore increases the perception of privacy. This strategy, as displayed in Section 1, 2, 3 on plane A-B are, therefore, applicable as a design strategy to increase privacy for accommodation units positioned on the buildings ground floor. Extension of the building length increases the elongation of the spaces in front of and behind the building. Currently, no evidence suggests that elongation influences emotional modulation as long as sufficient horizontal area is provided to conduct multi-directional locomotion in the horizontal plane in correspondence with the interpersonal distances the respective environment is associated with.

As indicated by the previous discussion, three and four-storey buildings are most suitable for the project (section 3 in the C-D plane). The resulting immense surplus of square meters allows the opportunity to remove a significant amount of the building mass depicted in the sketches, such as removing the middle row of buildings on the C-D plane; expanding the public space between the building, and granting the opportunity to offset the building, towards the south, further away from the forest line; improving the buildings access to solar radiation.

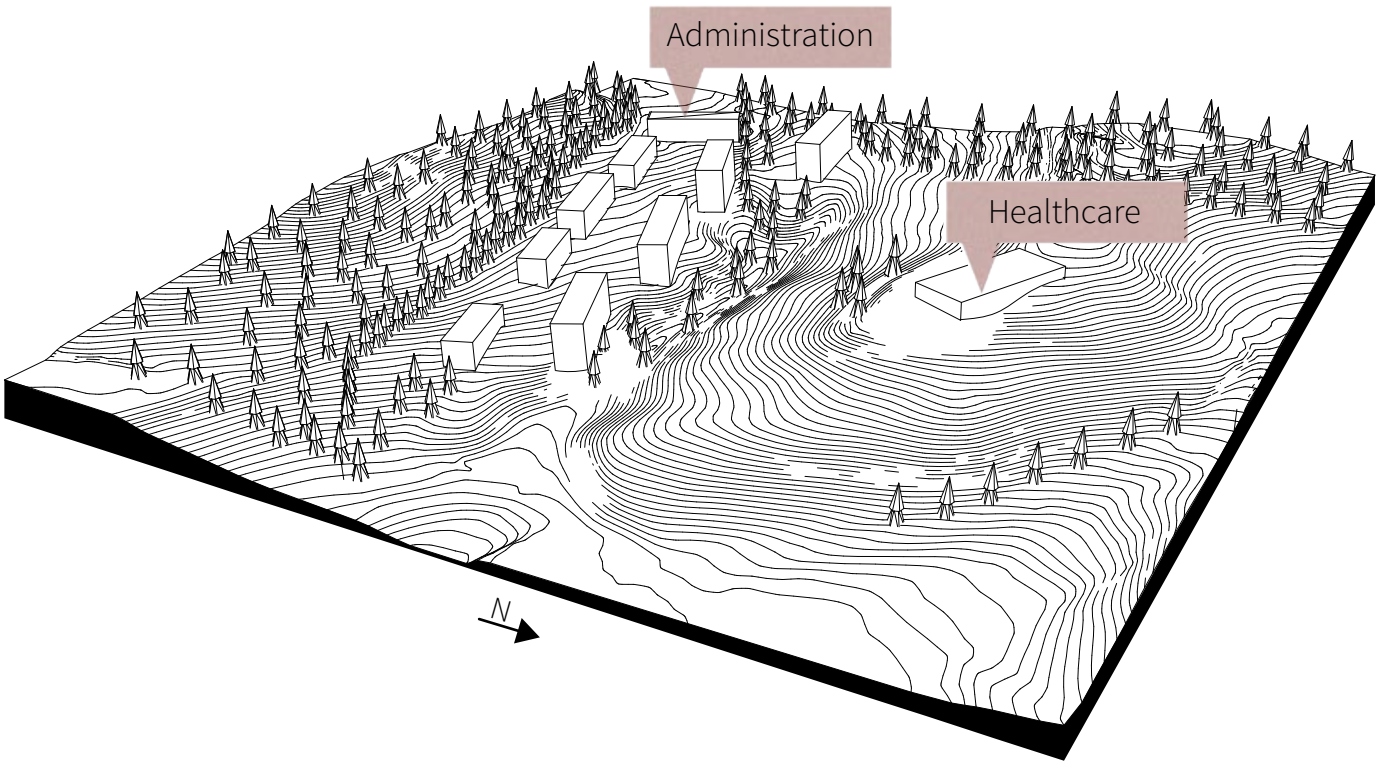


Fig: 56 - Composition #1

Composition # 1

Based on findings from the prior study, a composition for the structure was sketched as depicted in fig. xx.xx. The new structure consists of only two rows of buildings. The buildings towards the south are of three storeys, and buildings towards the north are of four storeys. Furthermore, a separate building has been positioned to house the administrative functions, and the two healthcare functions have been combined into a single building, positioned on the northern hilltop. The composition takes offset in the 2-dimensional and simplified considerations on access to passive solar gain and daylight from the previous study. Further optimation of the composition is, therefore, possible and required to be made.

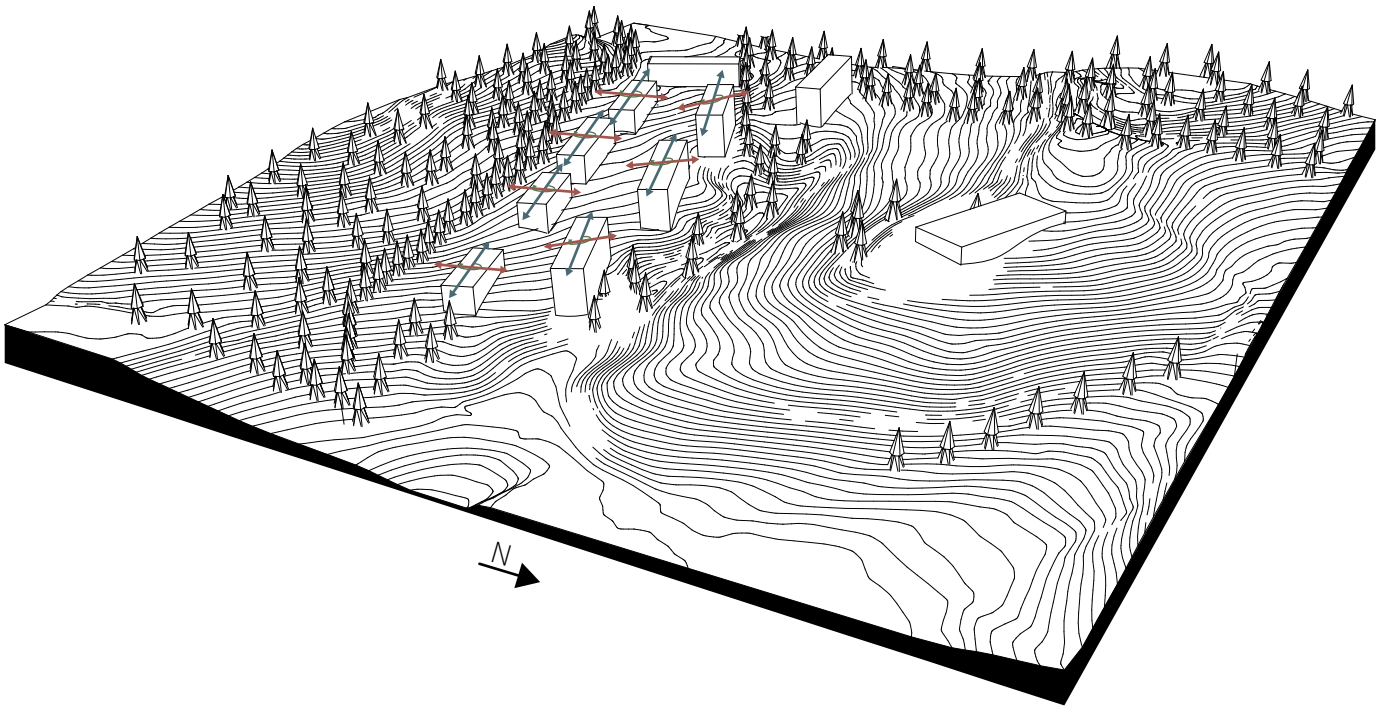


Fig: 57 - Composition #1 - optimisation of solar access

Optimizing solar access

The buildings access to solar radiation, both in regards to diffuse and direct solar light is crucial for achieving the desired level of daylight and ensuring the building is energy efficient. The prior considerations on solar exposure have been based on elementary assumptions, resolving the existence of the possibility to optimize the buildings access to sunlight by assessing the solar radiation three dimensional, and corresponding alternating the composition.

A script in grasshopper was developed to calculate and optimize the composition. The script applied the calculation engine of ladybug to compute solar radiation gain. The engine of ladybug was combined with the native grasshopper component - Galapagos. Galapagos is an evolutionary solver, which through adjustment of the selected variables, isolates the best configuration to achieve the desired goal. The goal of the Galapagos component was to either maximise the amount of diffuse light on the south and north façade of the building or maximising the amount of direct sunlight hitting the south façade during the heating season. Galapagos optimized solar exposure by adjusting the position and rotation of the buildings. The analyse were performed with the correct terrain of the site and corresponding vegetation.

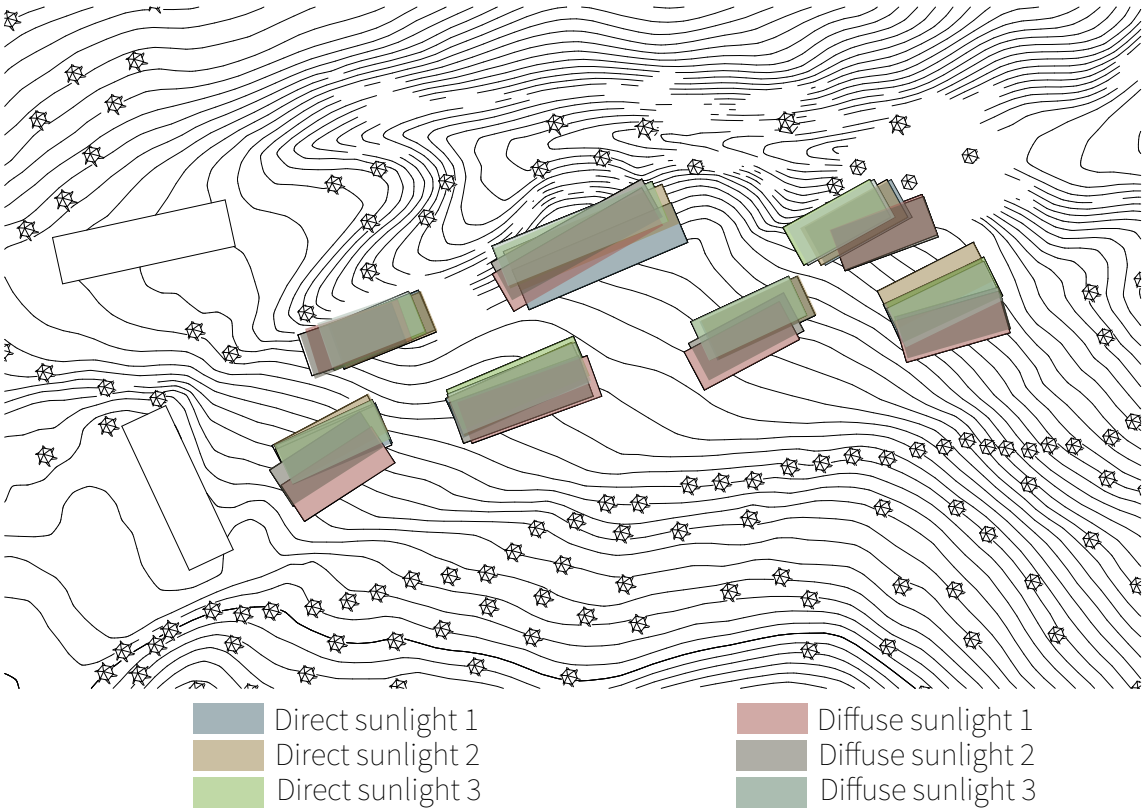


Fig: 58 - Results - Optimisation of solar access -

Three computations were conducted for both direct solar exposure and diffuse solar exposure, the reasoning for running multiple computation is ensure Galapagos seeks optimisation of different genomes, resulting in a variation in placement and corresponding performance. The resulting compositions are displayed in fig xx.xx. To evaluate the performance of the resulting compositions, calculation of diffuse solar exposure for the configuration optimized for direct solar exposure, and the vice versa was also conducted to compare the solutions; the respective findings for direct solar exposure and diffuse solar exposure were normalized, and the individual score for each type of solar radiation was added together to rank and compare the individual solutions. Direct sunlight 3 displayed the best overall performance with a combined score of 199,74; similar performance was displayed by solution Diffuse sunlight 3 with a resulting score of 199,72. These solutions were closely followed by the results of direct sunlight 2, with a score of 199,5. The other solutions performed around 5% worse. As indicated by the close resembles of the scores, another means of comparison should be applied to evaluate which solutions are most suitable for the project. Visual permeability is an ideal candidate for further examination of the solution's performance, as the increased accessibility to direct- and diffused sunlight is derived from the alteration of the placement of the buildings and rotation of the buildings, thus strongly affecting the visual permeability of urban space between the buildings.

The compositions affordance of visual permeability is evaluated by plotting twenty-three reference points divided along an assumed walking path. The walking path is aimed at presenting the path of motion an occupant of the space would travel by. A VGA analysis with a radius of twenty-meter is computed for each reference point. The VGA analysis indicates the amount of visual permeability the occupant is granted at the specific reference point. The resulting values are plotted in fig 61. Two consideration should be made when evaluating the findings; the amount of visual permeability at a reference point and the curvature of the graph – especially the curvature of the graph are essential as it is correlated with the concept of mystery. In correlation with previous accounts on PTSD influence on emotional modulation from environments, then the curve of visual permeability across the reference point should be relatively steady to avoid potential anxiety response from a sudden increased or decreased in visual permeability. As indicated by the findings; Direct sunlight 2 is the best solution by providing the highest amount of visual permeability across the majority of the reference points, and is correlated with the smallest drop in visual permeability between reference point 12 and 17. It is important to note that the composition of Direct sunlight 2 is not ideal as the small distance between the corners of the buildings in the east, resolves in the presumed walking path is around the southside of one building, instead of along the central street between the buildings; resulting in the drop in visual permeability. The findings of this study are, therefore, applicable but further optimation of the urban layout shall be performed to reduce the sudden decrease in visual permeability and ensure the walking path is between the buildings. A central linear walking path ensures the area is easily navigatable by egocentric strategies.

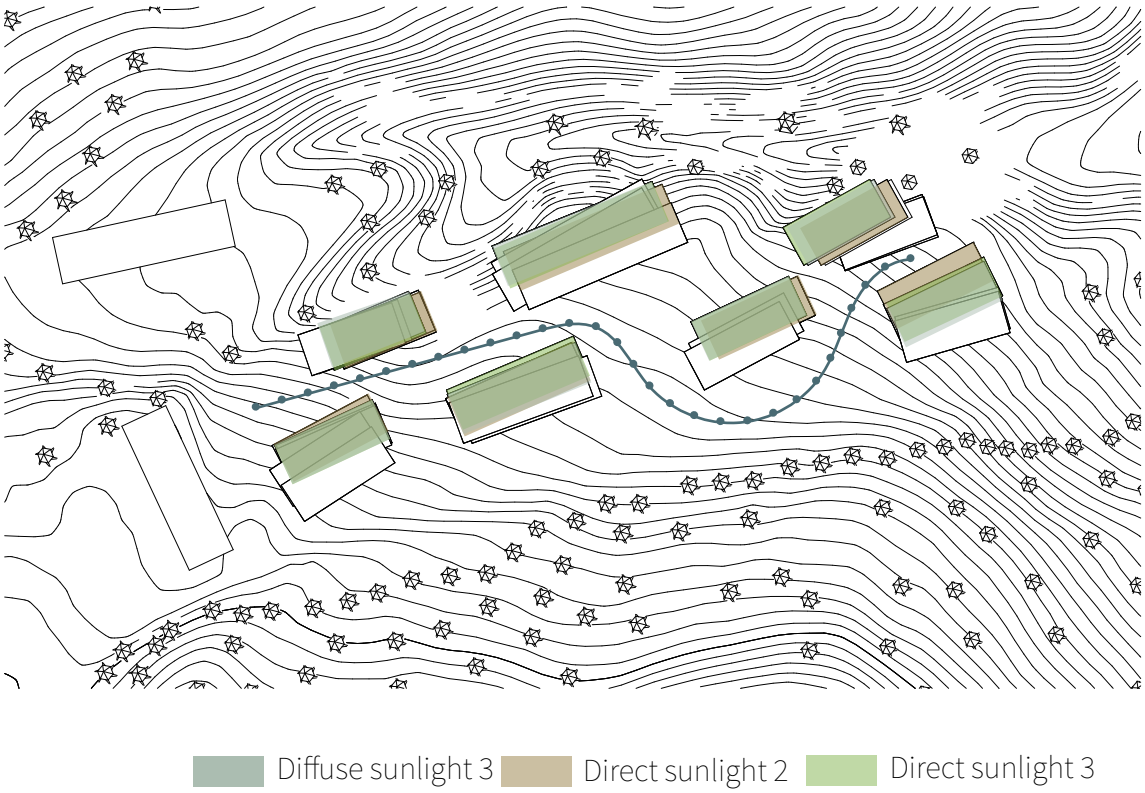


Fig: 60 - Analyse of visual permeability along route

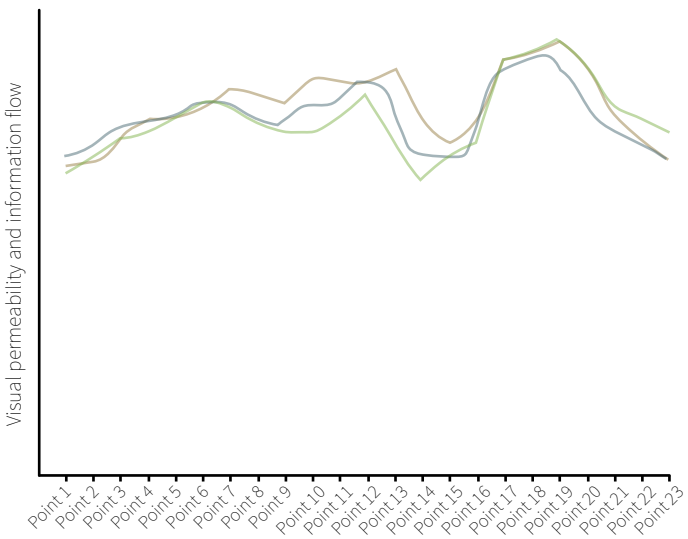


Fig: 61 - Results from Analyse of visual permeability along route

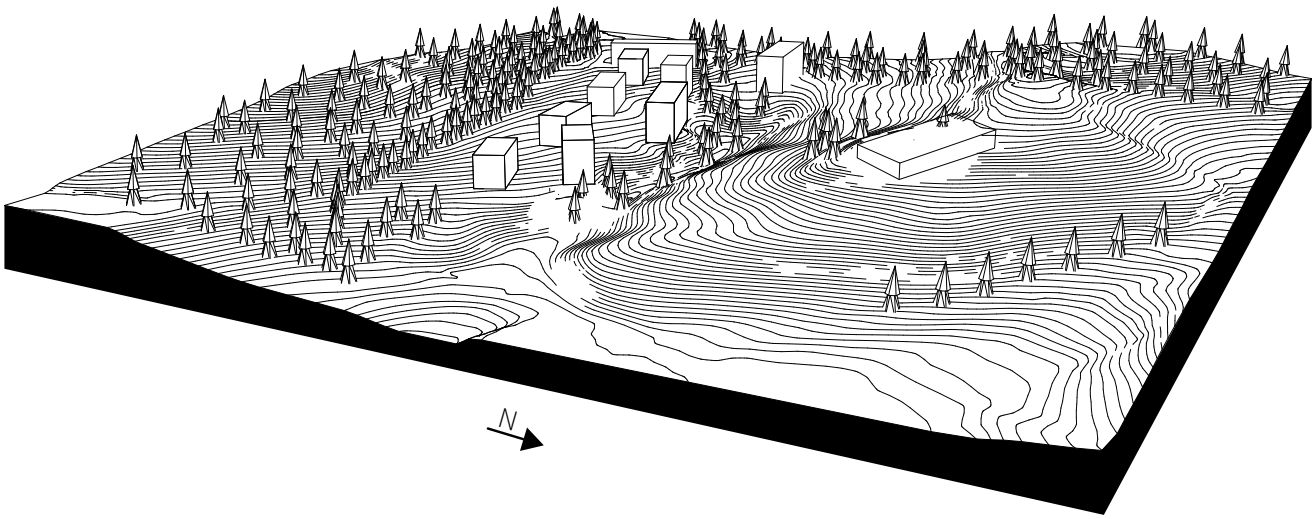


Fig: 62 - Designing final composition

Designing the final composition

To combat the issues of the composition named direct sunlight 2, a manipulated version was designed (fig xx.xx). The new composition restores the central street by performing a slight adjustment on a majority of the building, and a large displacement of the previously troublesome building. Calculation of this compositions access to direct- and diffuse sunlight was performed, to compare the solution with its optimized counterparts. The new composition scores a combined normalized score of 198,9, resulting in slightly reduced access to daylight and passive solar gain, but the difference is minuscule compared to its benefits in regards to visual permeability; where the new composition performs significantly better at the vast majority of the reference points. And as indicated by the curvature of the graph , this composition is presumably less correlated with negative emotional modulation, as the sudden drops in visual permeability are reduced, and replaced will steady alteration (fig. 64). It will be assumed that this composition is more suitable for the project.

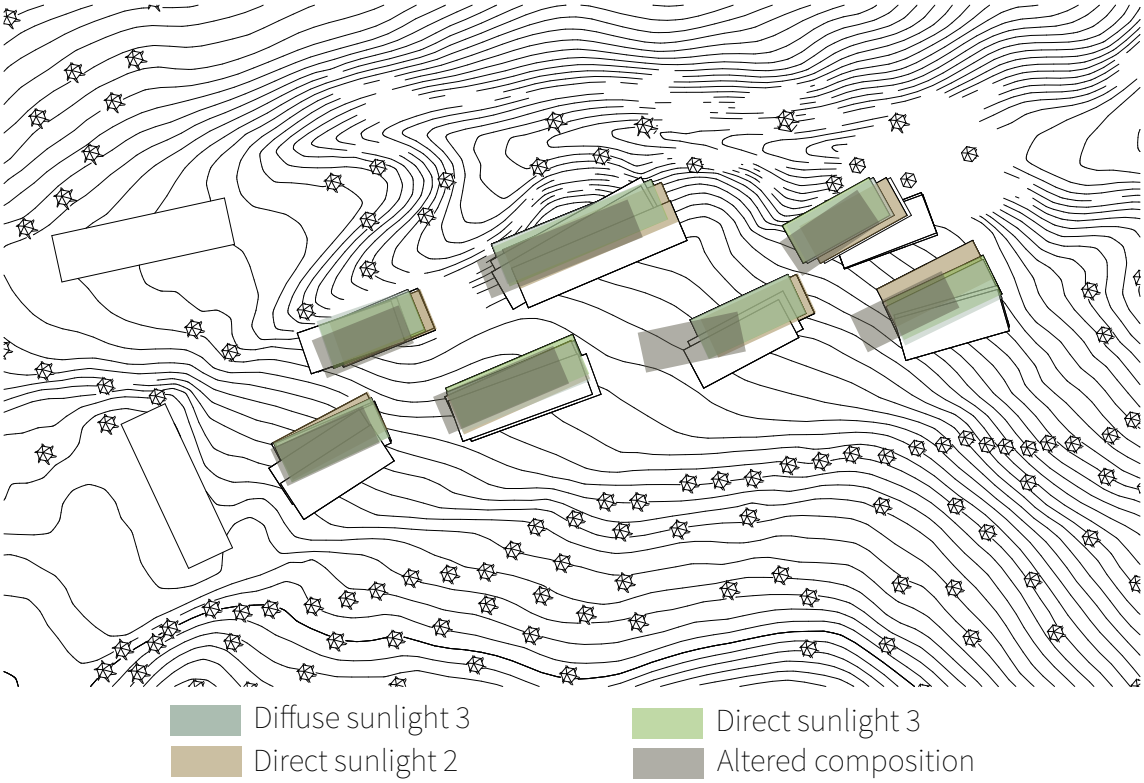


Fig: 63 - Altered composition

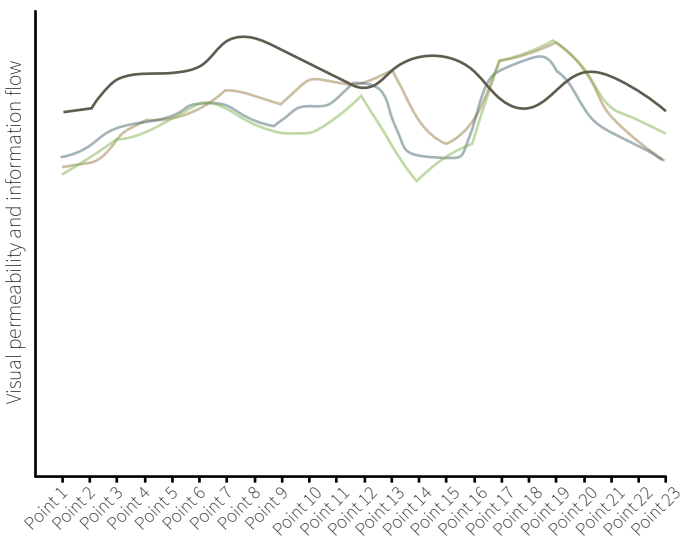


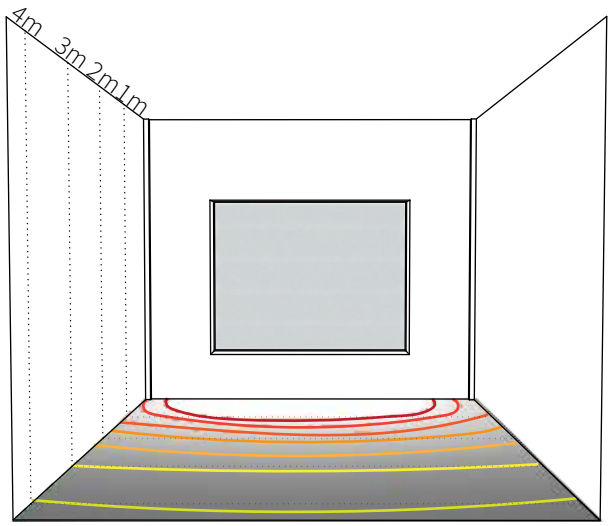
Fig: 64 - Results from Analyse of visual permeability along route

Window design

The primary purpose of the previous design process was to increase the amount of direct and diffused light reaching the building envelope. The next logical step, following the preliminary design process, is to investigate the correlation between window area, window design, daylight levels, energy consumption and thermal comfort. The first step in this process is investigating window design and daylight levels. Twelve different window compositions were sketched to conduct an inquiry on this correlation. The twelve compositions are based on three different designs (Design 1; Design 2; Design 3). The difference in the design of the window is their height, width, distance from walls and floor, and if the glazing area incorporates a door or not. Each design has been designed with dimensions corresponding to 20% of floor area, 25% of floor area, 30% of the floor and 35% of the floor area. Analyses in Velux daylight visualizer has been conducted to evaluate the window design influence on daylight. The distribution of daylight has been depicted in the corresponding diagrams. The assessment is conducted on a space with similar dimensions as the span between the columns in the accommodation units.

Design 1

8 % 7 % 6 % 5 % 4 % 3 % 2 % 1 %



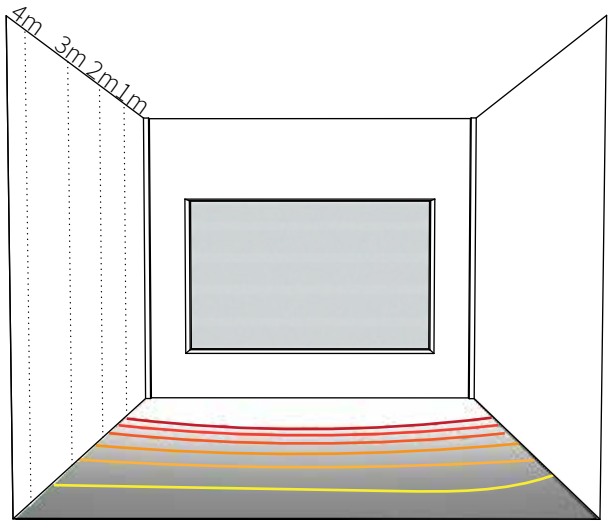
Window area/floor area
20%

Daylight levels first half
5,4%

Daylight levels second half
2,2%

Daylight media
3,5%

Fig: 65 - Window Design 1 - 20%



Window area/floor area
25%

Daylight levels first half
6,9%

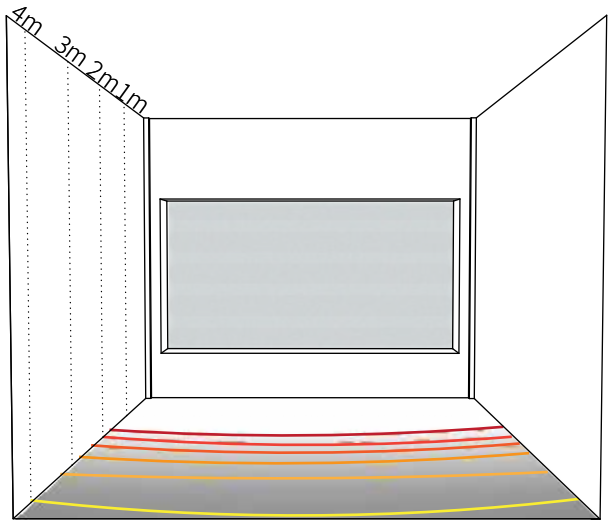
Daylight levels second half
2,8%

Daylight media
4,38%

Fig: 66 - Window Design 1 - 25%

Design 1

8 % 7 % 6 % 5 % 4 % 3 % 2 % 1 %



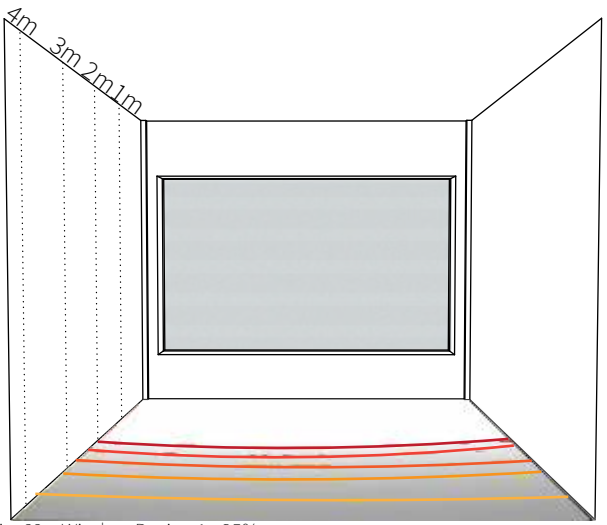
Window area/floor area
30%

Daylight levels first half
8,3%

Daylight levels second half
3,3%

Daylight median
5,19%

Fig: 67- Window Design 1 - 30%



Window area/floor area
35%

Daylight levels first half
9,7%

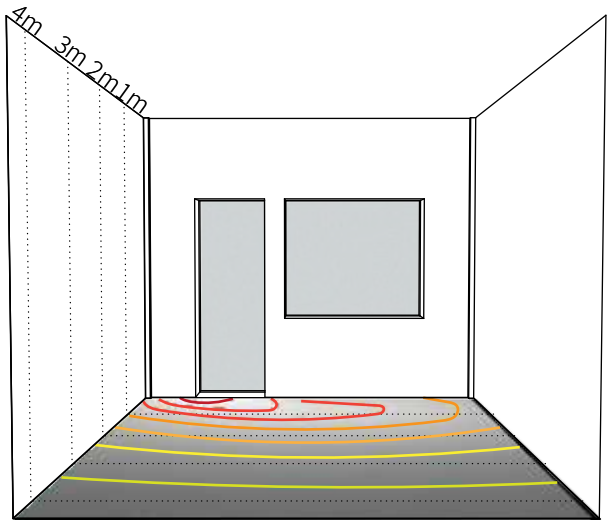
Daylight levels second half
4,1%

Daylight median
6,35%

Fig: 68 - Window Design 1 - 35%

Design 2

8 % 7 % 6 % 5 % 4 % 3 % 2 % 1 %



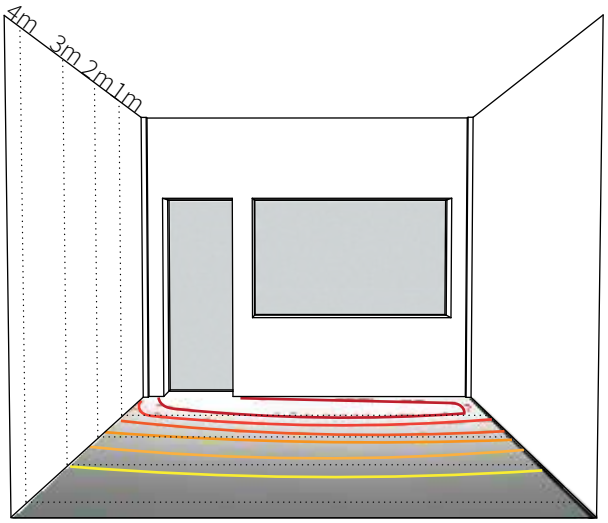
Window area/floor area
20%

Daylight levels first half
4,2%

Daylight levels second half
1,7%

Daylight median
2,42%

Fig: 69 - Window Design 2 - 20%



Window area/floor area
25%

Daylight levels first half
5,9%

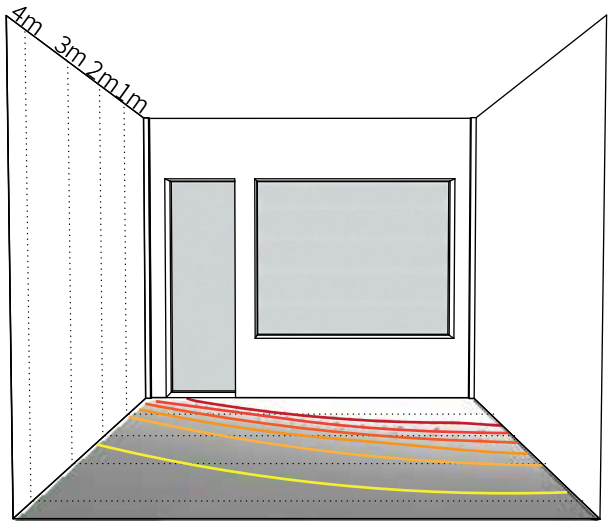
Daylight levels second half
2,4%

Daylight median
3,74%

Fig: 70 - Window Design 2 - 25%

Design 2

8 % 7 % 6 % 5 % 4 % 3 % 2 % 1 %



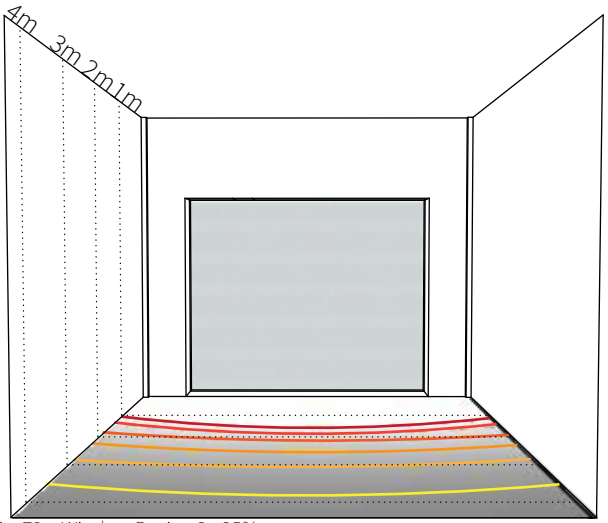
Window area/floor area
30%

Daylight levels first half
6,8%

Daylight levels second half
2,9%

Daylight median
4,01%

Fig: 71 - Window Design 2 - 30%



Window area/floor area
35%

Daylight levels first half
9,2%

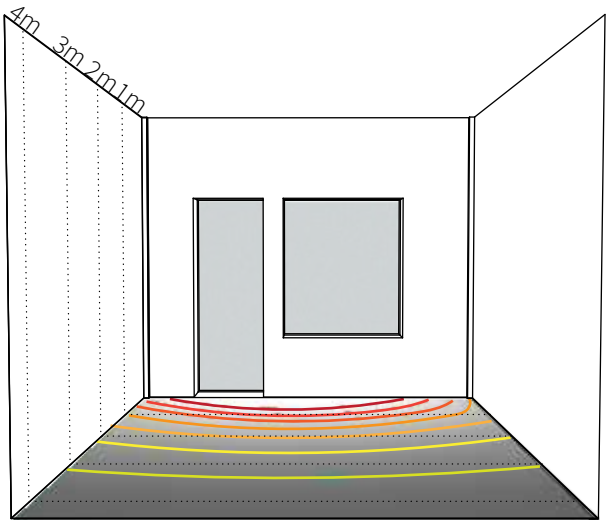
Daylight levels second half
2,9%

Daylight median
4,25%

Fig: 72 - Window Design 2 - 35%

Design 3

8 % 7 % 6 % 5 % 4 % 3 % 2 % 1 %



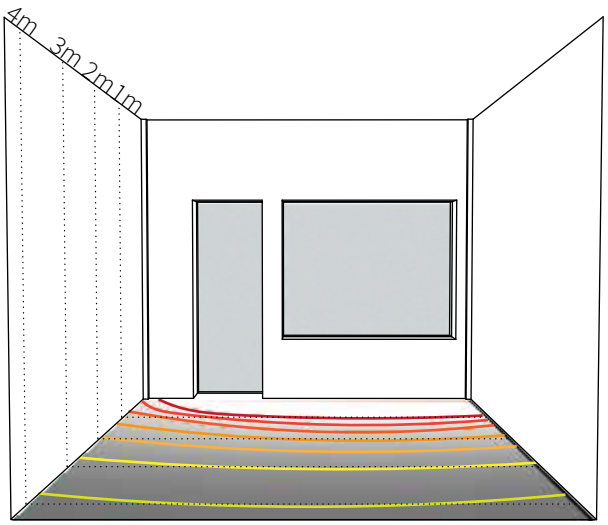
Window area/floor area
20%

Daylight levels first half
4,5%

Daylight levels second half
1,6%

Daylight median
3,18%

Fig: 73 - Window Design 3 - 20%



Window area/floor area
25%

Daylight levels first half
6%

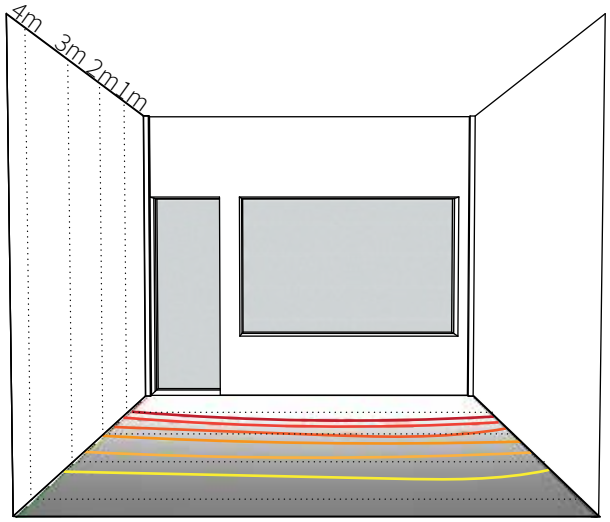
Daylight levels second half
2,1%

Daylight median
4,2%

Fig: 74 - Window Design 3 - 25%

Design 3

8 % 7 % 6 % 5 % 4 % 3 % 2 % 1 %



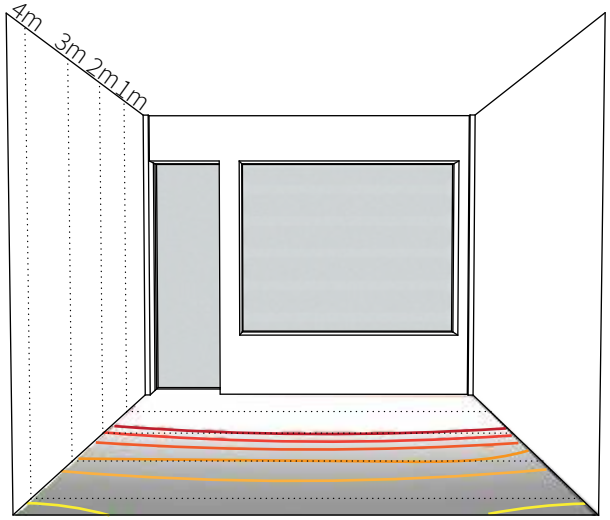
Window area/floor area
30%

Daylight levels first half
7%

Daylight levels second half
2,5%

Daylight median
5%

Fig: 75- Window Design 3 - 30%



Window area/floor area
35%

Daylight levels first half
8,9%

Daylight levels second half
3,5%

Daylight median
6,4 %

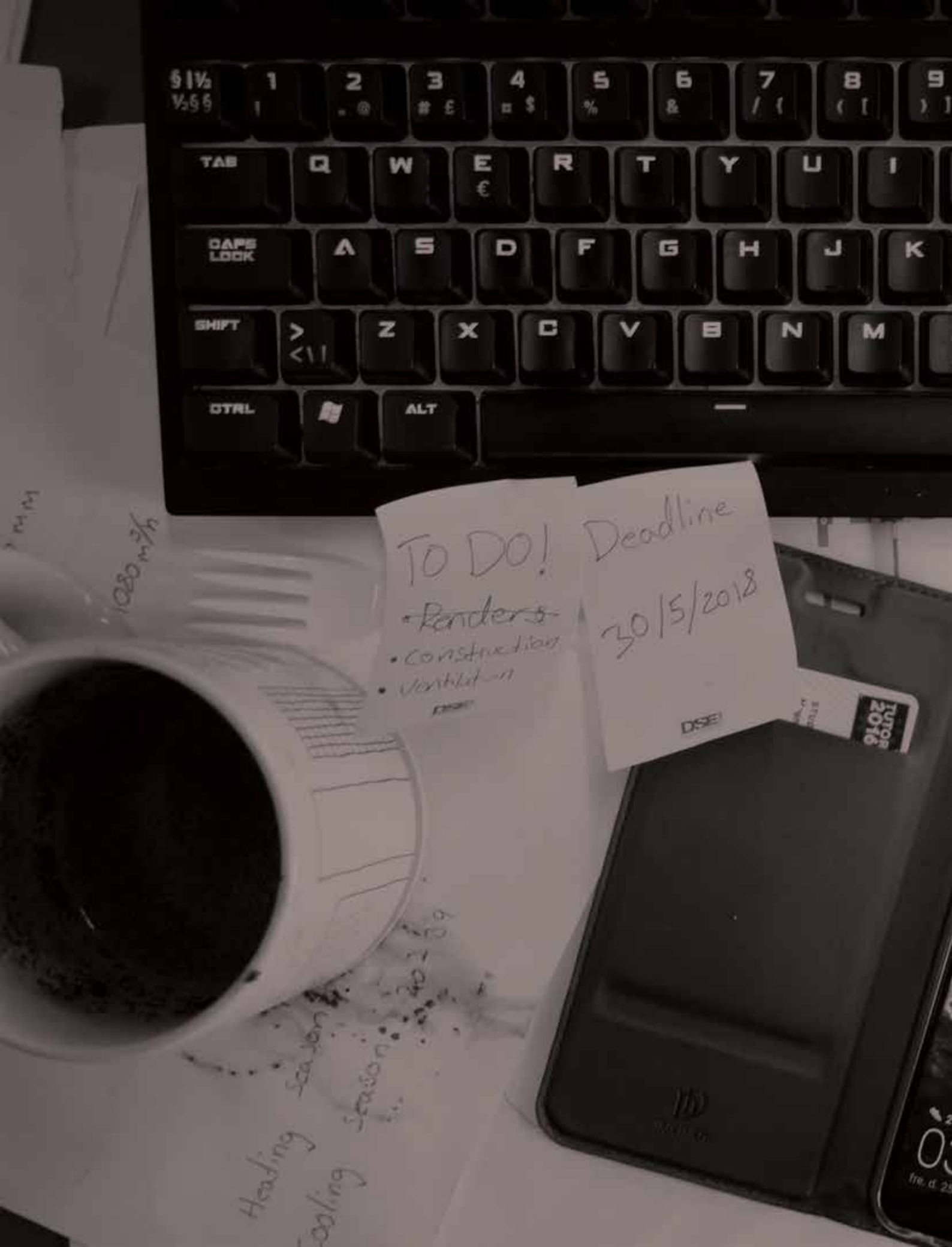
Fig: 76 - Window Design 3 - 35%

Generally, all of the solutions are applicable solutions as all the design proposals provide the required amount of daylight. As indicated by daylight simulations, design solution 1 is the most efficient solution; granting the interior space the most daylight per square meters of glazing. The two solutions including a door, displayed a significant reduction in daylight levels per square meters of glazing as a result of the tall and slender glass doors. This is the resulting effect despite the fact that the difference in daylight levels between design solution 2 and 3 suggested a benefit from a taller window, compared to increased with width. Furthermore, the findings also suggested a benefit by integrating the door into the glazing area, thus removing the section of wall between the windows, thus improving daylight levels. Design solution 1 is chosen as the window proportions most suited for the project, as the increased width of the window increases the amount of visual permeability in the horizontal plane through the building envelope; provide uniform light distribution and provides above 2% daylight factor in the second half of the space at only 20% window-/floor area.

As previously mentioned, the dimensions of the windows are required to be governed by more factors than considerations on daylight. Energy consumption is an essential consideration, when dimensioning glazing. BR18 calculation is conducted to construct inquiry on the correlation between glazing ratio and the corresponding energy consumption. The building selected for calculation of energy consumption is the building which received the lowest amount of direct solar radiation in the preliminary study on composition and solar access. Selecting this building for calculation ensures that all the building are energy efficient and proves that the preliminary calculation resulted in energy-efficient buildings. The BR18 calculation were modelled based on four glazing ratios; 20%;25%;30% and 35%. The findings of the study displayed that only the 20 % ratio and the 25 % solutions achieve a energy consumption below the governing energy frame of 20 kWh per. m2 per year. The energy consumption was respectively; 13,8 kWh per. m2 per year and 17,9 kWh per. m2 per year. These findings indicates that a maximum of approximately 25% glazing area is required to ensure that this specific building is energy-efficient. This assessment only addressed the energy consumption, without consideration of the resulting indoor climate. A BSim model of the accommodation unit receiving the highest amount of solar radiation was constructed, to evaluate the glazing rations influence on thermal comfort. The model was designed with exterior blinds for shading. The findings from this assessment displayed that 20% window area resolved in 46 hours above 26 degrees Celcius, and 2 hours above 27 degress. 25% window area increased the hours above 26 degrees Celcius to 54, and 4 hours above 27 degrees. No significant increase in mean or maximum ventional rate was associated with the increase of the glazing area. The thermal mass of the interior space was increased to experiment with this as a means to reduce thermal discomfort as a result of overtemperature. Extra thermal mass was added to the interior space by replacing the wooden flooring with a 50 mm layer of exposed concrete flooring in the south-facing rooms. The addition of thermal mass reduced hours of overtemperature

to 22 hours above 26 degrees and 31 hours for 20% glazing ration and 25% glazing ration, respectively. The reduction of overtemperature by the inclusion of thermal mass was not associated with either a significant alteration of energy consumption or ventilation rates; approximately a 1,2% reduction in energy consumption was displayed by the inclusion of concrete for the simulation with 20% glazing, a similar result was displayed for 25% glazing ration.

As indicated by the findings, the building will be designed with windows based on the proportions of design 1 and 25% glazing ratio. The choice ensures sufficient daylight levels in all the apartments, low energy consumption and acceptable indoor climate. The strategy to include concrete as an energy capacitor will not be applied, as the benefit in thermal comfort is outweighed by the more comforting sensory experience of wood; concrete increased the environmental footprint and the required increase in the dimension of structural members to support the increased weight.


TO DO!
• Renders
• Construction
• Ventilation
Deadline
30/5/2018
DSE
TUTOR 2016

04

Presentation

Urban structure

The proposed urban structure, as displayed in fig. 77 and fig 78, is the result on consideration on environmental-, social- and economical sustainability. The administration functions, including the entrance and reception of the asylum center are positioned towards the west, in the position that was previously suggested in the site study to be designated for entrance.

The healthcare building is position on the northern hillside, this positions offers pristine visual permeability and establish a sensation of disconnect from the accommodation buildings. The disconnect and the ability to overlook the accommodation buildings, is hypothesised, to increases the patients ability to reflect on their current state of life, by granting them a literal perspective on their current state of life and creating a sensation of distance. The disconnect also enforces the perception, that the residents are living a mimic of a normal life and hopefully minimizing the individuals sensation of being admitted into a healthcare facility when they occupy there accommodation or uses other facilities of the asylum centre.

The buildings housing accommodation and activities are positioned in the southern portion of the site. The buildings are organized along a central street; ensuring navigation through egocentric strategies . The dimensions of the building are governed by the respective buildings composition of accommodation units. Each of the buildings includes two stairwells granting access to a mixture of accommodation types. The desired goal of this mixed combination of accommodation types is to enforce interaction between individuals with different social connection within the semiprivate areas of the stairwells; ensuring that individuals with no social relations interact with individuals with pre-established social connections, hopefully, resulting in increased social ties for both partners involved, thereby improving both individuals ability to seek social support.

The position, orientation and height of the buildings are governed by the requirement of granting access to direct- and diffuse sunlight and to ensure a significant degree of locomotive- and visual permeability within the urban space. Furthermore, the relatively small width of the apartment blocks, ensures that the scale of the architecture does not overpower the impression of the natural environments, by ensuring the individuals always are visually connect with the pristine ambient nature.

The activities; workshops, gym, communal space, library, kindergarten and classrooms are positioned on the ground floor of the accommodation buildings, scattered across the site. These functions is not detailed in the project.

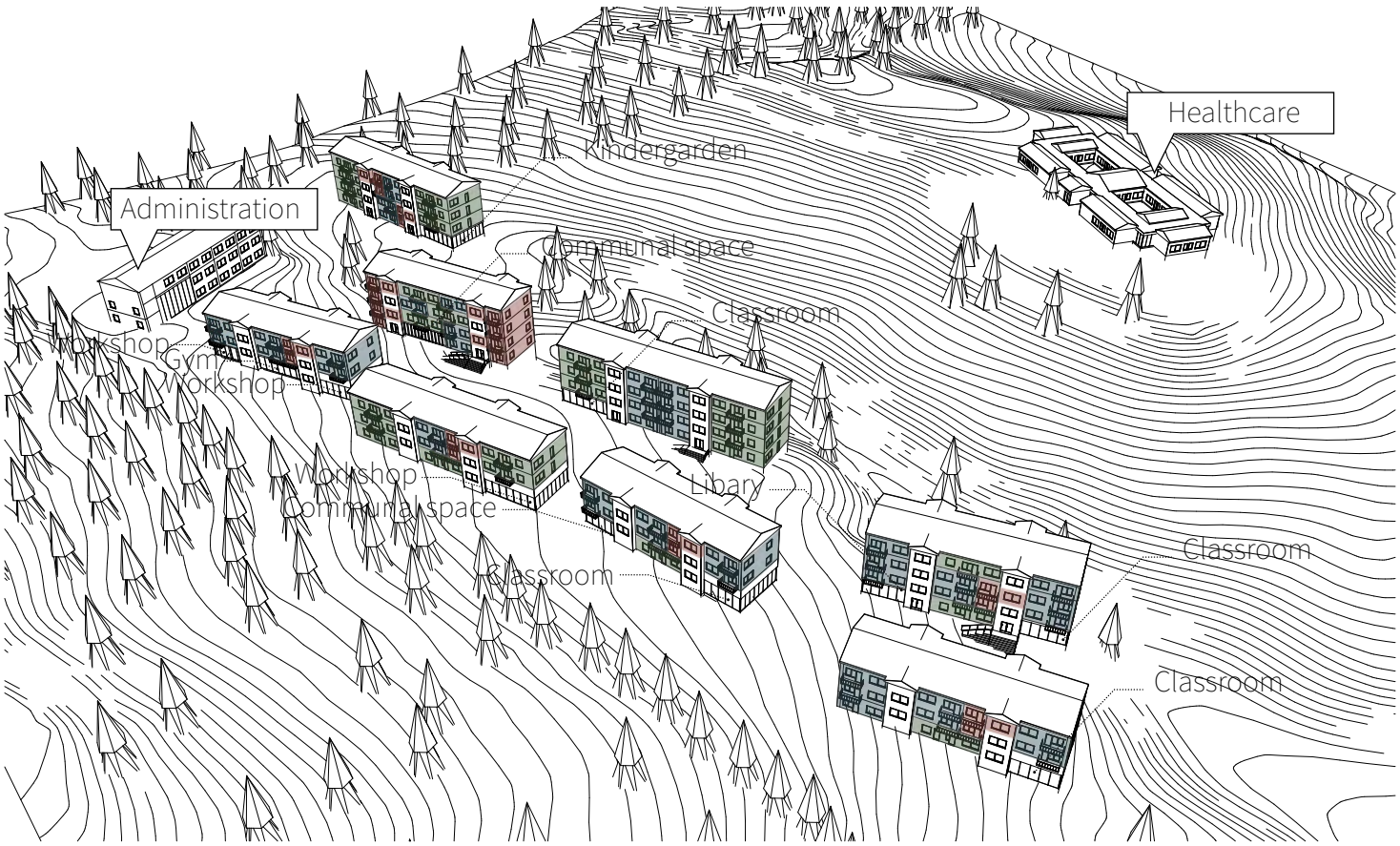


Fig: 77 - 3D Siteplan

Img: 18 - Urban render 1

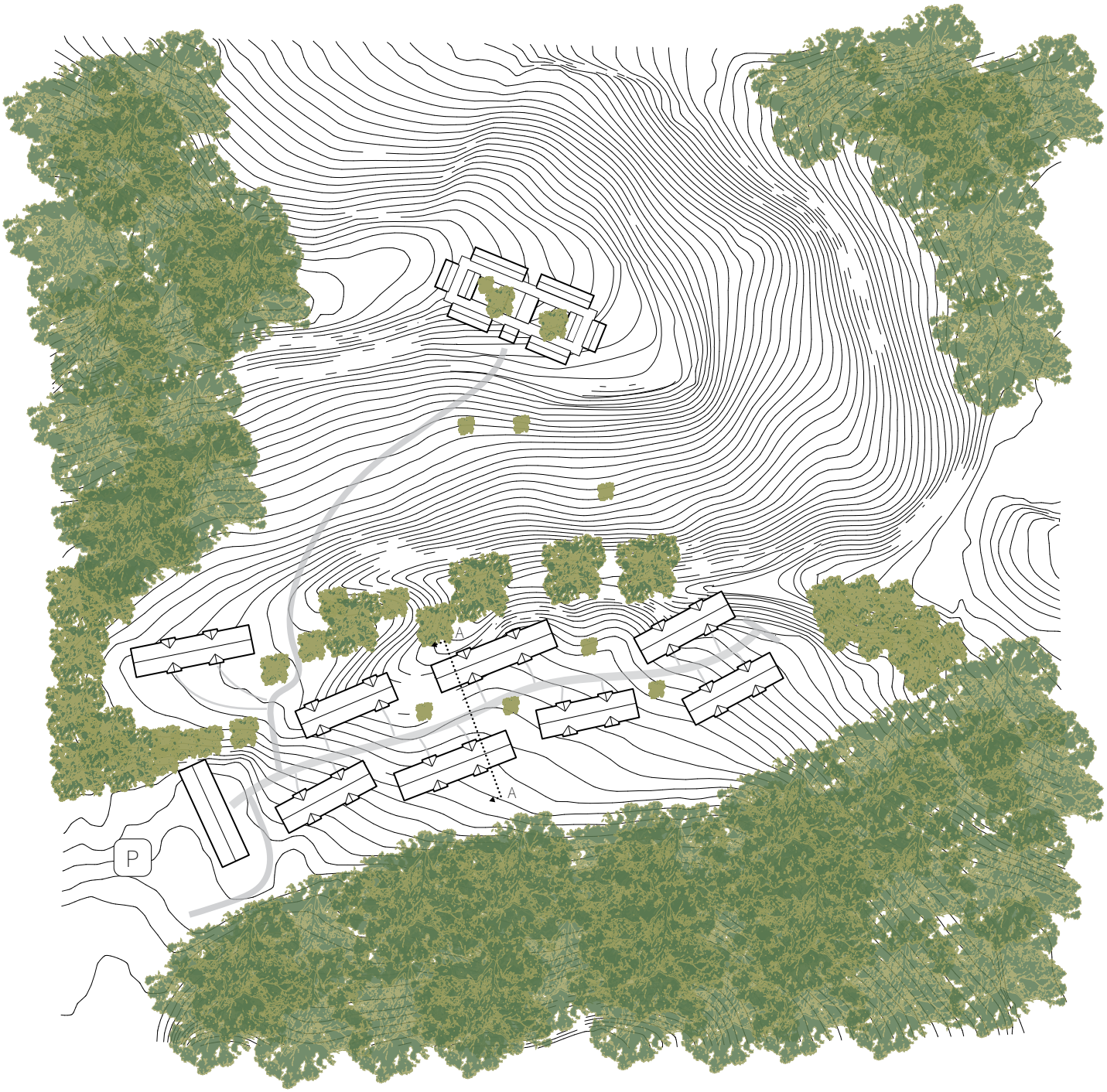


Fig: 78 - 2D Siteplan - Scale 1:2000

The urban space

The distance between the facades of the accommodation buildings, along the central street, varies between twelve and a half meters and twenty one meters. Besides the distance affordance of excellent access to diffuse and direct sunlight, the distance also ensures that individuals are able to maintain their desires interpersonal distance to other people, within the public urban space. As depicted in the visualisation, the urban space has not been detailed in the project, but as depicted in Fig xx.xx, the urban environment should be organized into two different zones; a central public area, flanked by two semi-public zones. The division between these individuals' zones should be constructed with trees and other elements of nature. The spacing between the individual trees should be correlated with the findings of Jiang, Chang and Sullivan (2014). The purpose of the division is to nudged people to occupy the central public zone; increasing the sensation of privacy in the accommodation units, and to divide the spaces into multiple distinct adjoined zones, thereby positively influencing emotional modulation in correlation with the previous discussion of the findings of Jiang, Chang and Sullivan (2014) and Kaplan and Kaplan (1989) notion of mystery.

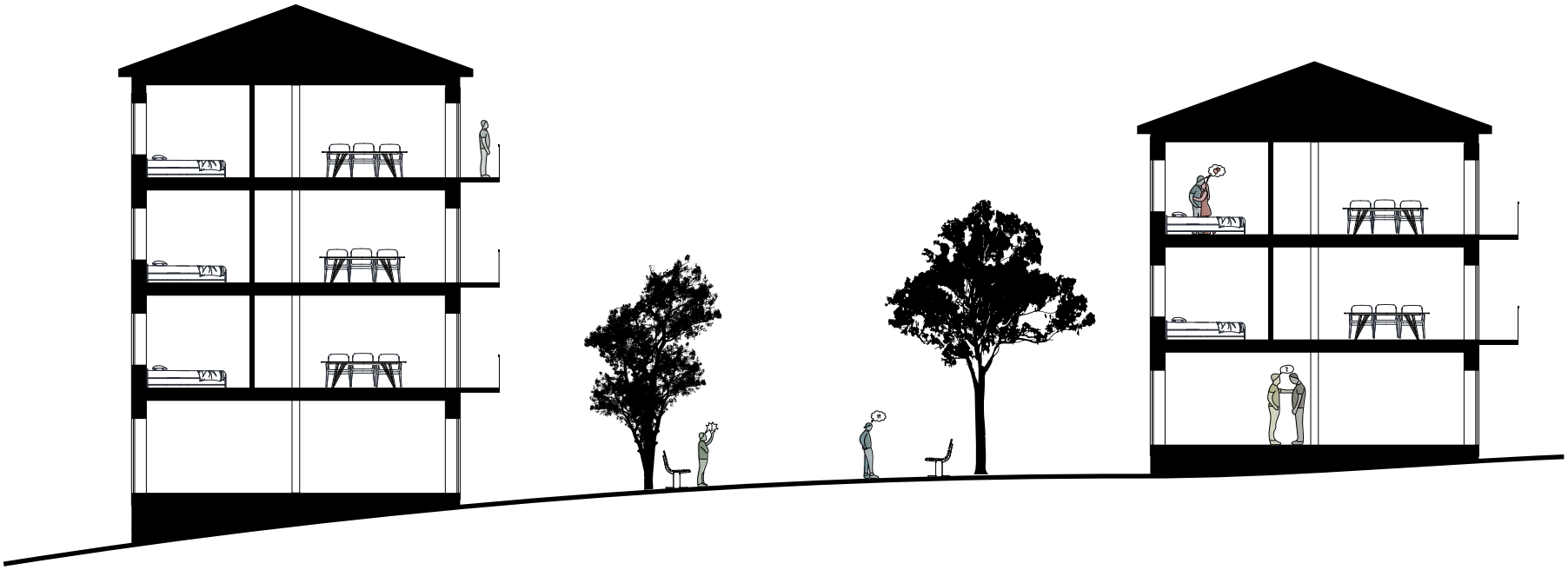


Fig: 79 - Urban section A-A - Scale 1:200

Img: 19 - visualization of accomendation buildings

img: 20 - visualization of accomendation buildings

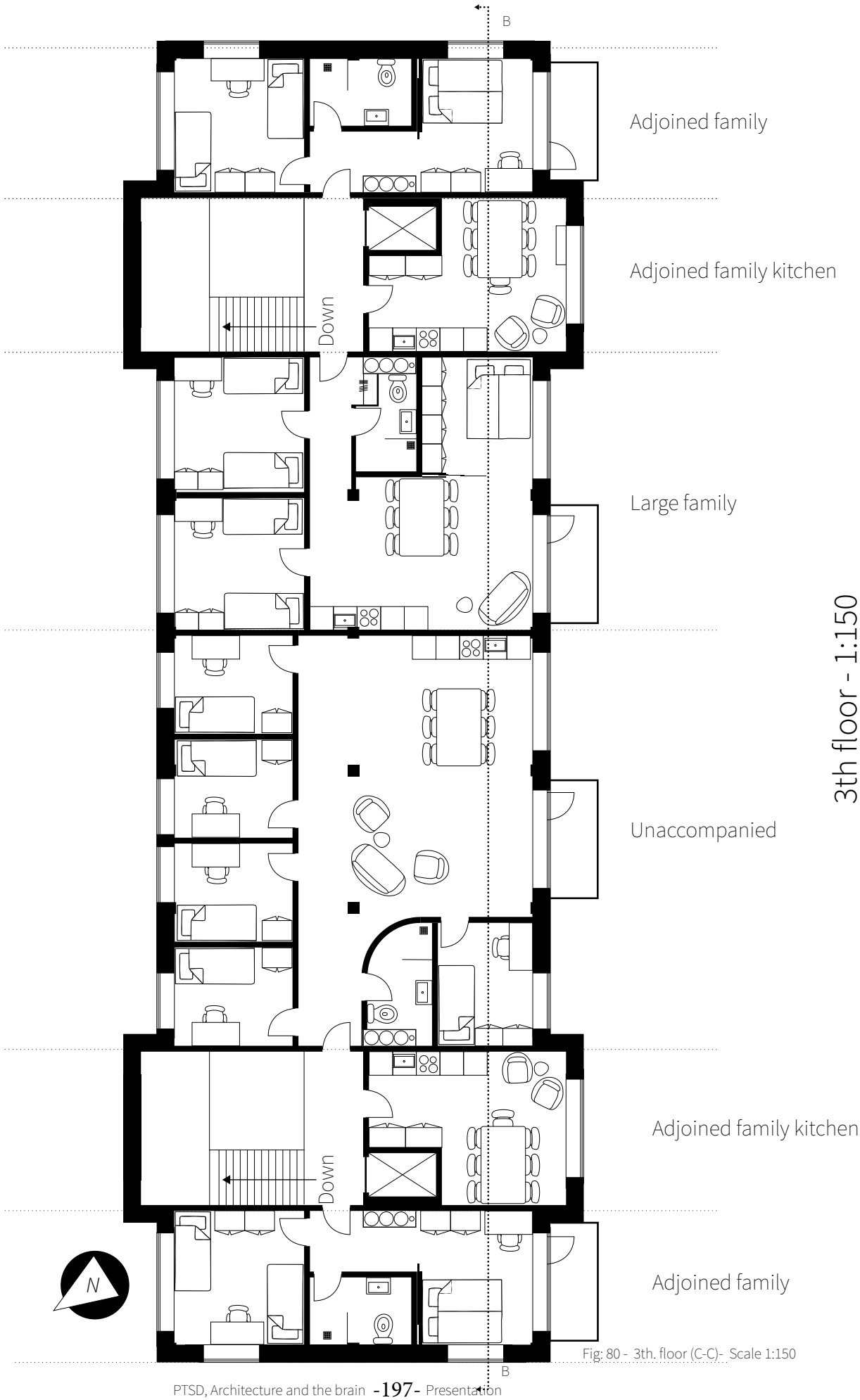
Accommodation building

As previously depicted in fig 77; the accommodation buildings varies in its composition of accommodation types, resulting in six different building types. Furthermore the variation by the inclusion of public functions within the building, results in that all the buildings are unique in its composition and façade. The following floorplans, section and elevation is, therefore, only a representation of a single building.

Despite the differences in composition, the buildings are constructed in accordance with an essential set of coherences, to ensure cost-efficiency and ensure a uniform and orderly visual impression. The accommodation buildings are designed based on a timber frame construction systems, organized in a grid with a CC distances of 4250 mm and 3500 mm. The structural dimensions, were based on the functional requirements of the three accommodation types; ensuring that a coherent structural system were applicable for all three accommodations types the variation of the buildings composition do therefore not resolve in increased constructions cost as results of increased structural complexity. The structural system is stabilised by the two stairwells and the elevator shafts. The stairwell walls and elevator shaft is constructed in CLT panels. The stairwells are positioned symmetrically, ensuring an orderly coherent visual impression and coherence for all the accommodation buildings.

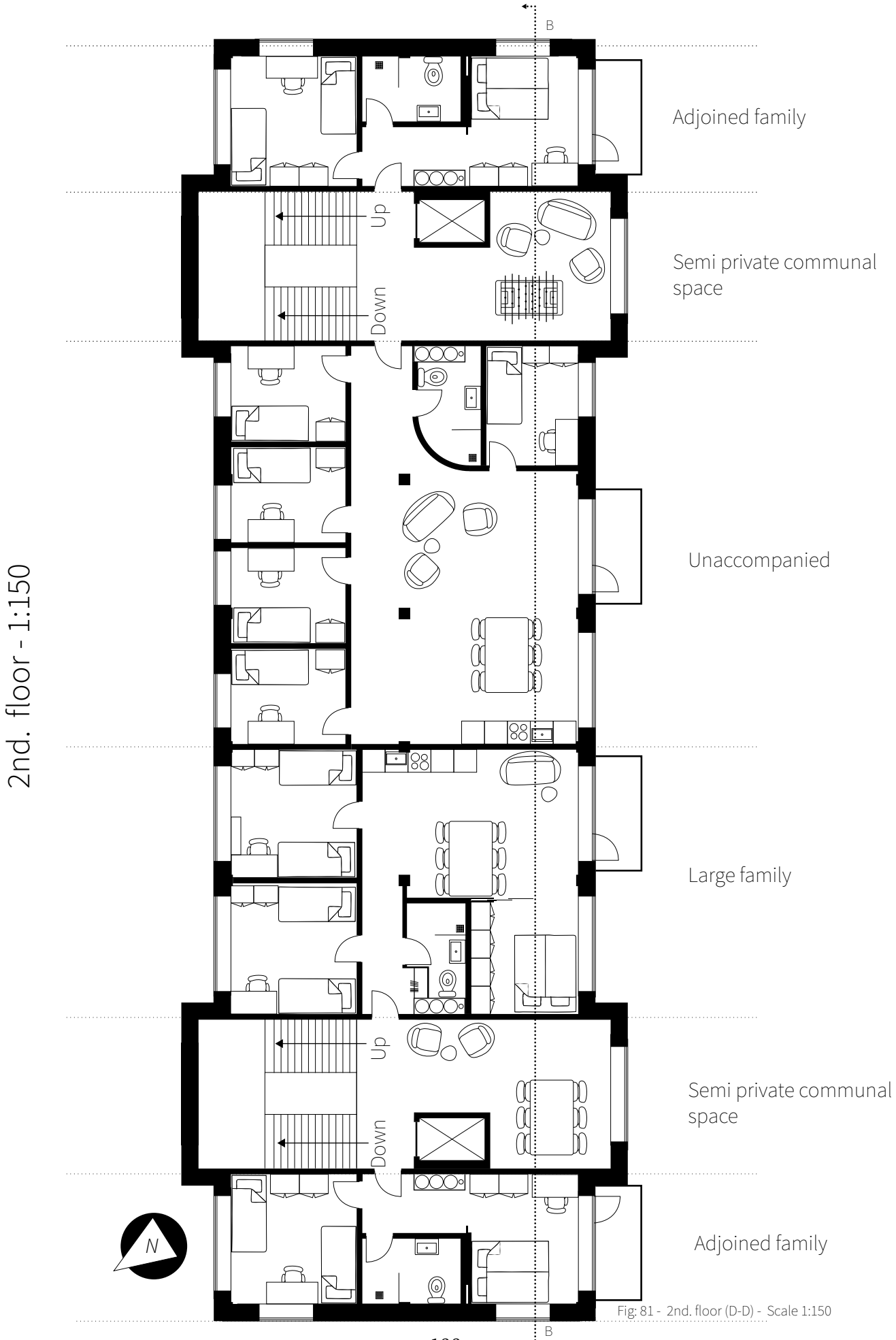
Besides ensuring access and structural stability, the stairwell also supports an essential social function in the accommodation buildings, as this semi-private space, a place previously in the project to be established to be essential to ensure social interaction and positive emotional modulation. To ensure positive emotional modulation, the dimensions of the stairwell were increased, in comparison with regulation. The width of the stairs increased to 1400 mm, the landing expanded, resulting in a depth of 1600 mm and the opening between the stairs resulted in 600 mm. The purpose of the enlargement was to increase visual- and locomotive permeability of the stairwell, thus effecting emotional modulation. The assumed return from this increased investments, is based on the assumption that reduction of the environments anxiety response will resolve in increased and improved social interaction. The improvement of social interaction within this semi-private realm is essential, both to improve the emotional associations with that given space but also to improve the emotional with the private realm, as this is the adjoined space. Furthermore, to improve social interaction almost each floor above the ground floor is designed with a space designated for social engagement. This space acts as a neutral gathering point, were the individuals of the accommodation units can gather and interact, without violating their sensation of privacy by inviting them into their private accommodation unit. The kitchen for the adjoined accommodation units are also positioned at the same placement, but that space is only accessible for the respective users of the kitchens assigned apartment units. The floor plan of the stairwell will, therefore, vary based on the requirement of installation of a kitchen to serve the adjoined family accommodation units.

The buildings are designed with decentralized HVAC unit; supplying the apartments with fresh air and heat. Six to eight apartments are connected vertically to the same HVAC unit, ensuring that the HVAC units heat recovery function acts as source of heat distribution, reducing the buildings energy consumption.



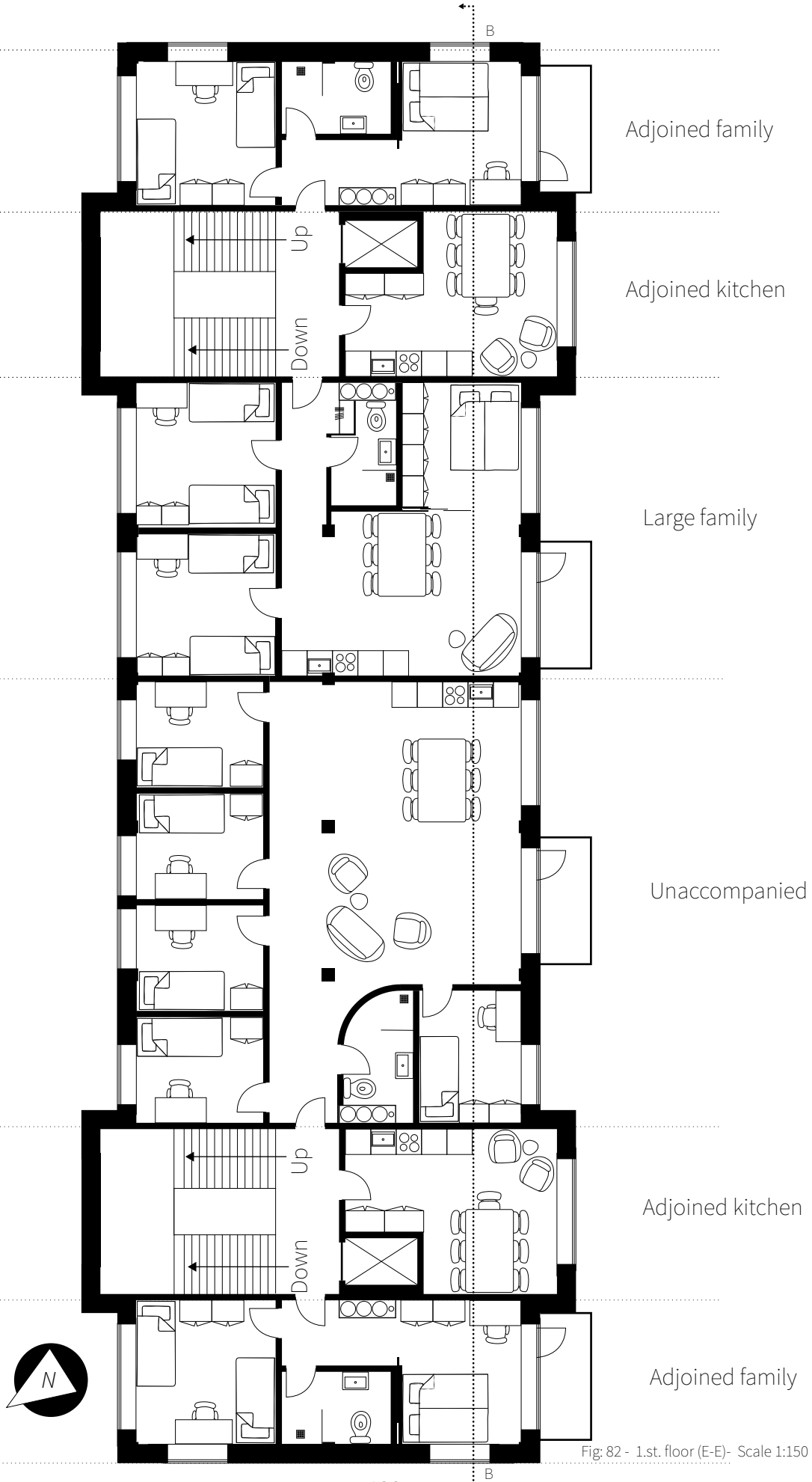
3th floor - 1:150

Fig: 80 - 3th. floor (C-C)- Scale 1:150



2nd. floor - 1:150

Fig: 81 - 2nd. floor (D-D) - Scale 1:150



1st. floor - 1:150

Fig: 82 - 1.st. floor (E-E)- Scale 1:150

Ground floor - 1:150

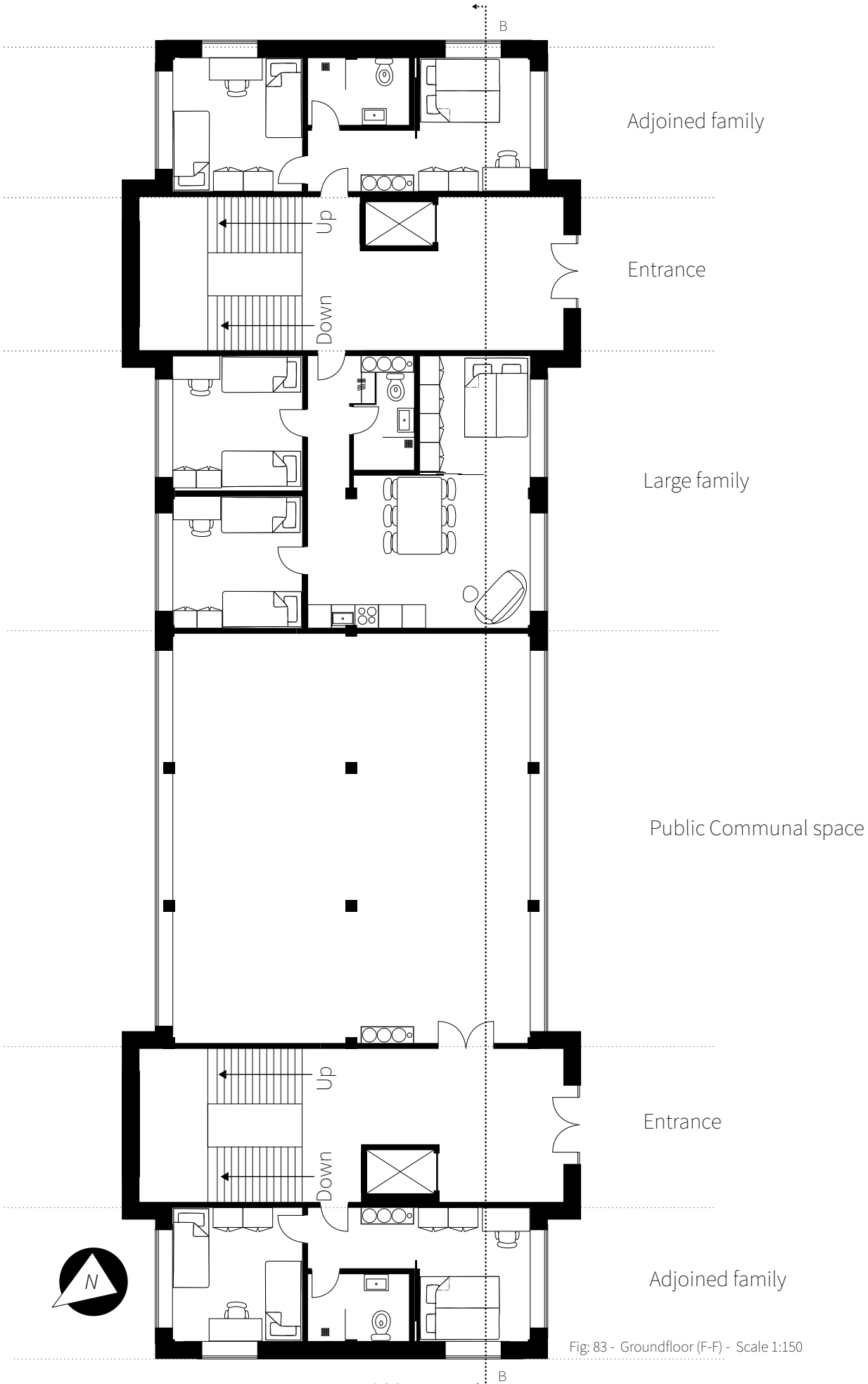


Fig: 83 - Groundfloor (F-F) - Scale 1:150

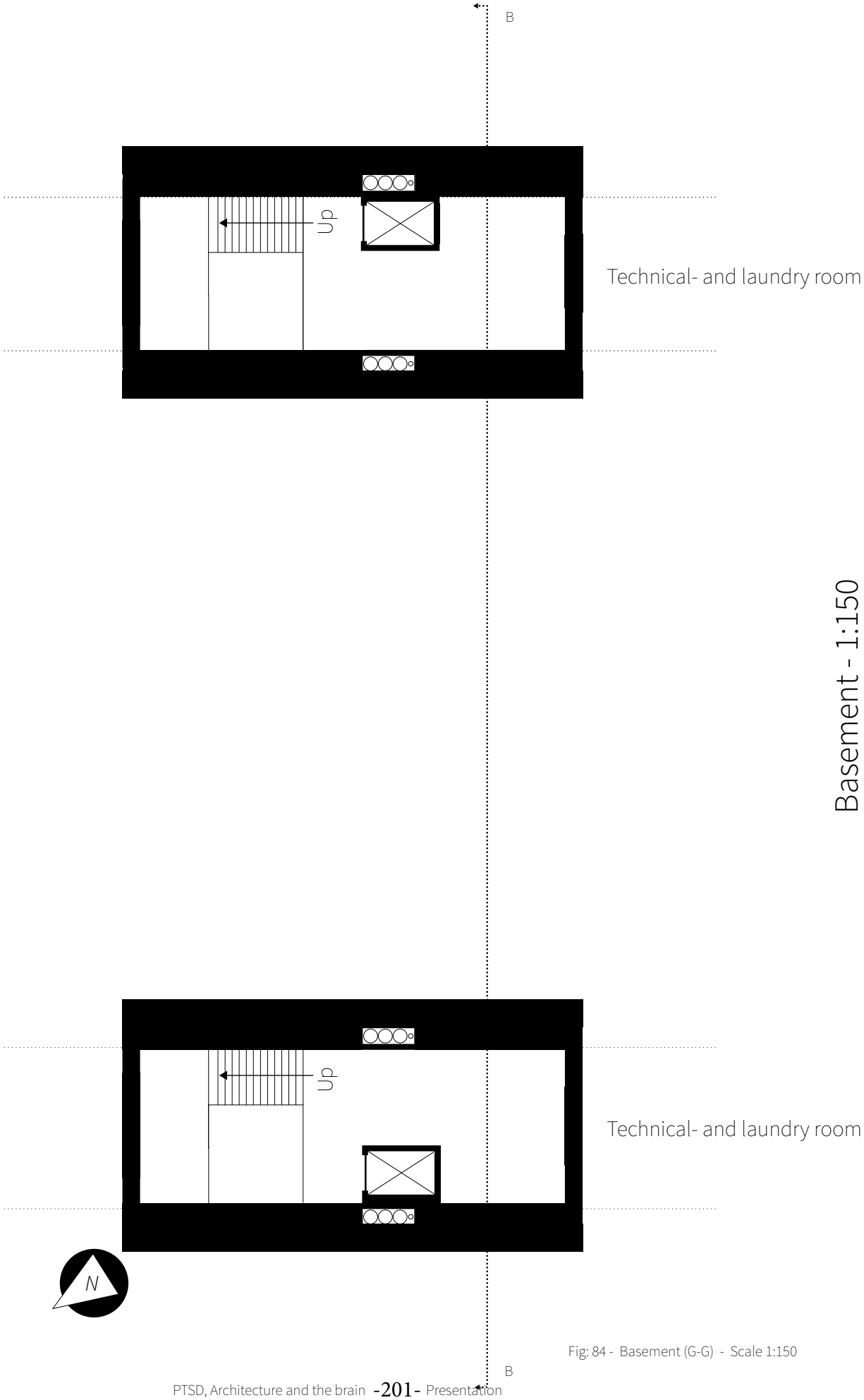


Fig: 84 - Basement (G-G) - Scale 1:150

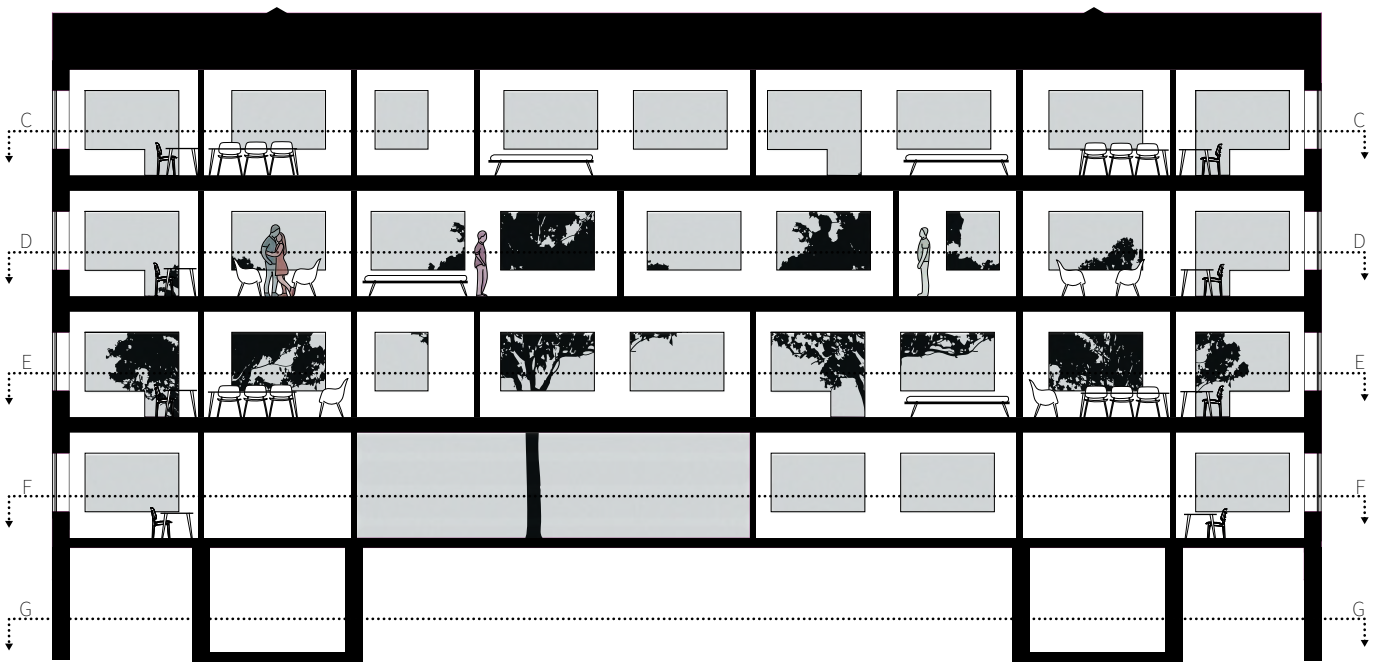


Fig: 85 - Section B-B - Scale 1:200

Img: 21 - visualization living room family accommodation

Interior materials

As depicted in the visualisation (img 21) and in accordance with the psychological-, physiological and environmental benefits of wood based materials, the vast majority of the materials of the interior spaces are wood. The structural columns are exposed in the interior space, both to increase the sensation of depth and to minimize the cold bridge as result of wooden structure positioned in the building envelope; the columns extrudes 50 mm into the exterior space. The interior side of the exterior wall in the accommodation units are cladded with light coloured slim, closely spaced, wooden vertical lamellars positioned on acoustic foam; thereby both increasing the sensation of depth and improving the acoustic comfort of the room. To increase the visual complexity of the space, the other walls are cladded, as illustrated, by horizontal dark coloured wooden boards. The boards is envisioned to be of large colour difference; enhancing the complexity of the visual impression. This cladding is, therefore, ideally sourced by up-cycling of wooden products, as variation in colour, thickens and dimensions is only positive in accordance with the desire to achieve a degree of visual complexity with a coherent object, furthermore also reducing the buildings combined environmental impact, improving atmospheric comfort and reducing ventilation rate. The flooring and celling is light coloured wood to increase distribution of light. White panel highlight the different wood products by visual separation.

Exterior materials

Slates and heat threated abodo, ash and pine cladding were selected as the materials for the exterior cladding, and this selection is consistent with the previous assessment of exterior cladding environmental impact and the zoning regulation. To increase the visual complexity by high-frequency representation in the exterior façade; each function in the accommodation was assigned a corresponding cladding: stairwell – slates; family accommodation – pine; adjoined family accommodation – ash and the unaccompanied accommodation – abodo. The wood based products, were mounted as wide vertical wooden lamellers to highlight the colour and difference in complexity of the materials. The resulting visual impression is a moderate complexity in the high-frequency representation, which indicates the function of the space within a coherent and symmetrical impression perceived by low-frequencies.

North facade - 1:200

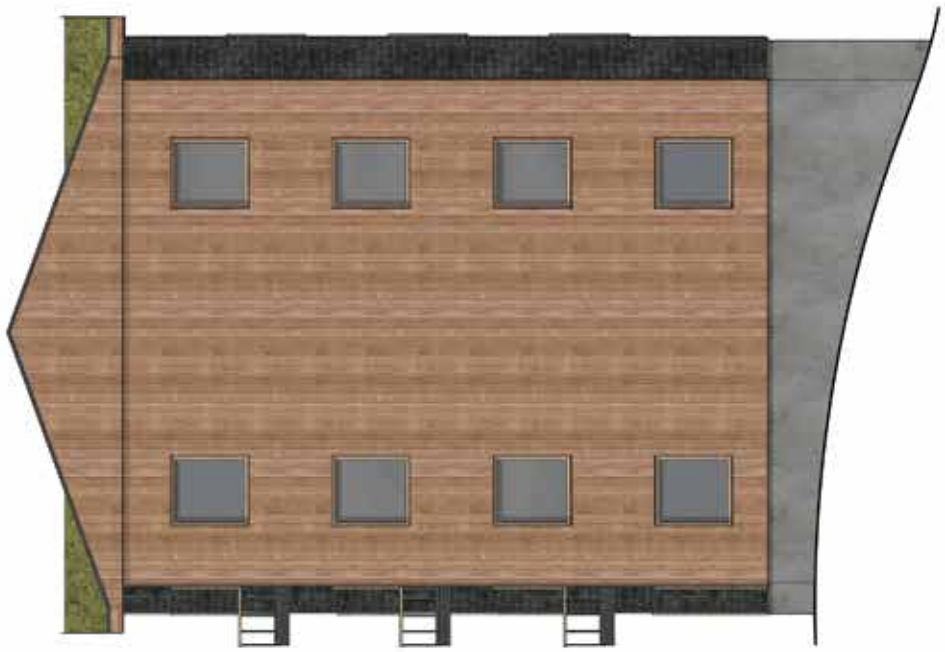
Fig: 86 - Accomendation buillding north facade

South facade - 1:200

Fig: 87 - Accomendation buillding South facade

East facade - 1:200

Fig: 88 - Accomendation buillding east facade



West facade - 1:200

Fig: 89 - Accomendation buillding west facade

Large family accomendation

The large family accommodation is designed to house, comfortably, a maximum of six individuals. This is achieved with three separate bedrooms; two bedrooms, each with two single beds, and a master bedroom towards the south. The master bedroom is separated from the common space / kitchen with a sliding door; allowing the opportunity to include the bedroom into useable common space during the daytime. Thereby, increasing the visual- and locomotive permeability and daylight levels. The common space and kitchen is positioned towards the south as this space is believed to be associated with the highest usage, therefore, most essential room to achieved circadian light.

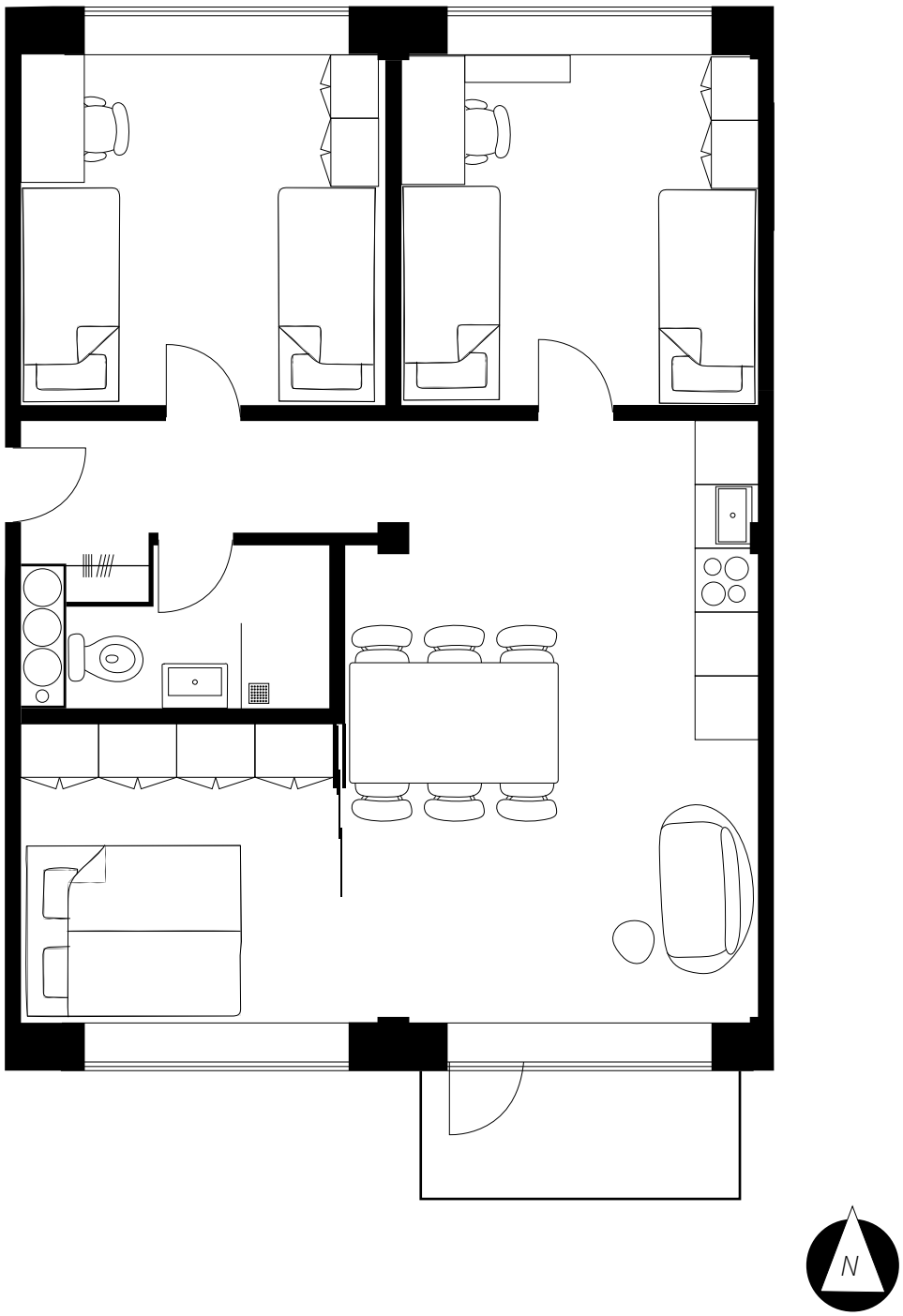


Fig: 90 - Family accomendation - scale 1:75

Adjoined family accommodation

The adjoined family accommodation consist of two separate and private apartment units and a separate shared kitchen. The apartment's composition closely resembles that of the large family accommodation with a bedroom towards the north with two single beds and a master bedroom/common space towards the south. A sliding door is installed to increase the spaciousness of the apartment during the daytime. Contradicting Img. 91, the two units sharing the kitchen is not placed on the same floor, but placed on two separate floors.

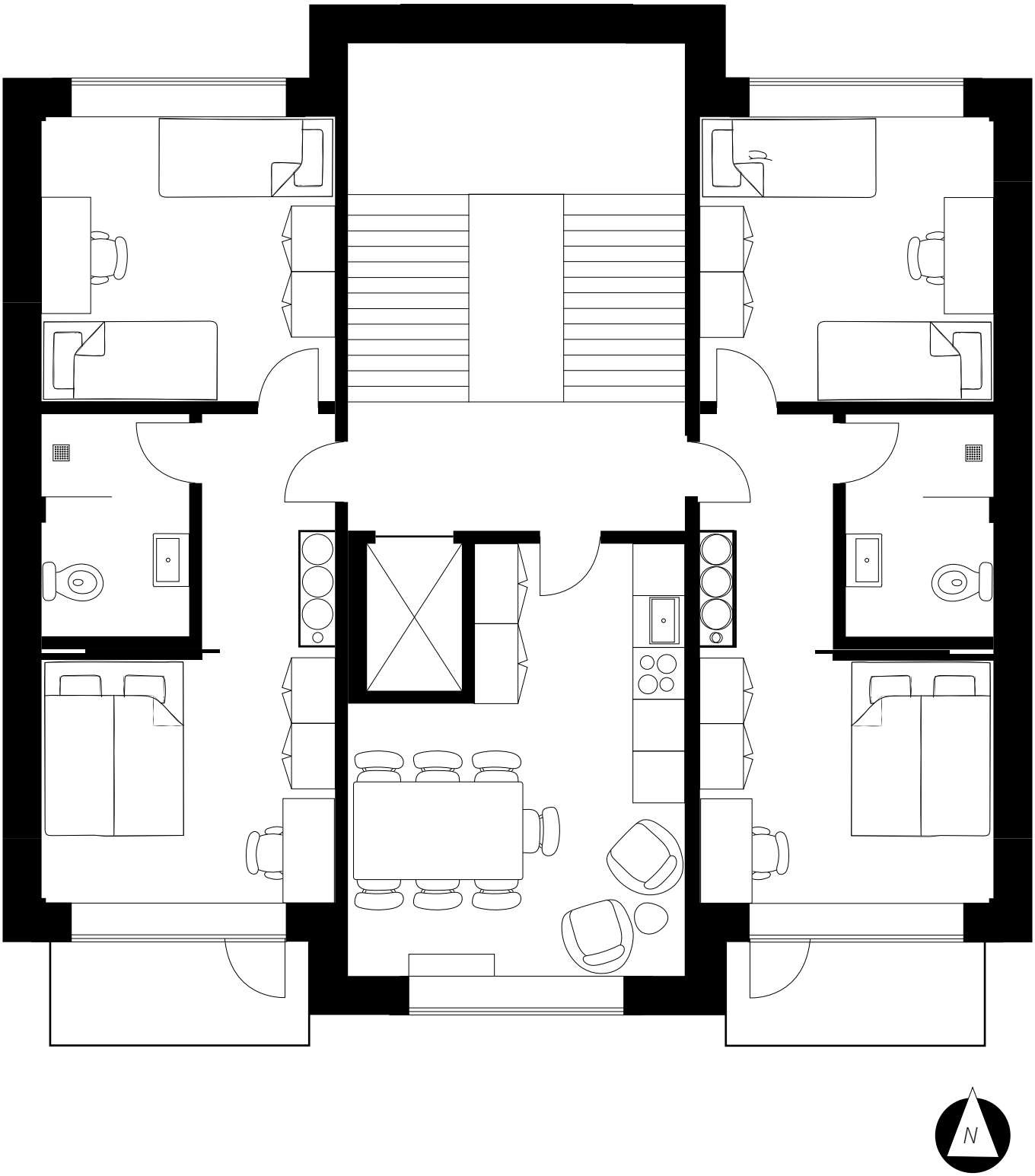


Fig: 91 - Adjoined family accomendation - scale 1:75

Unaccompanied accomendation

The unaccompanied accommodation consist of four single bed bedrooms towards the north; a single bed bedroom towards the north; a bathroom and a common space. The bedrooms are positioned around the open floor planed common space towards the south, ensuring visual- and locomotive permeability. The unaccompanied accommodation includes a curved bathroom wall, this inclusion is to increase the amount of visual permeability and alter the information flow when individuals enter the unit; to ensure positive emotional modulation.

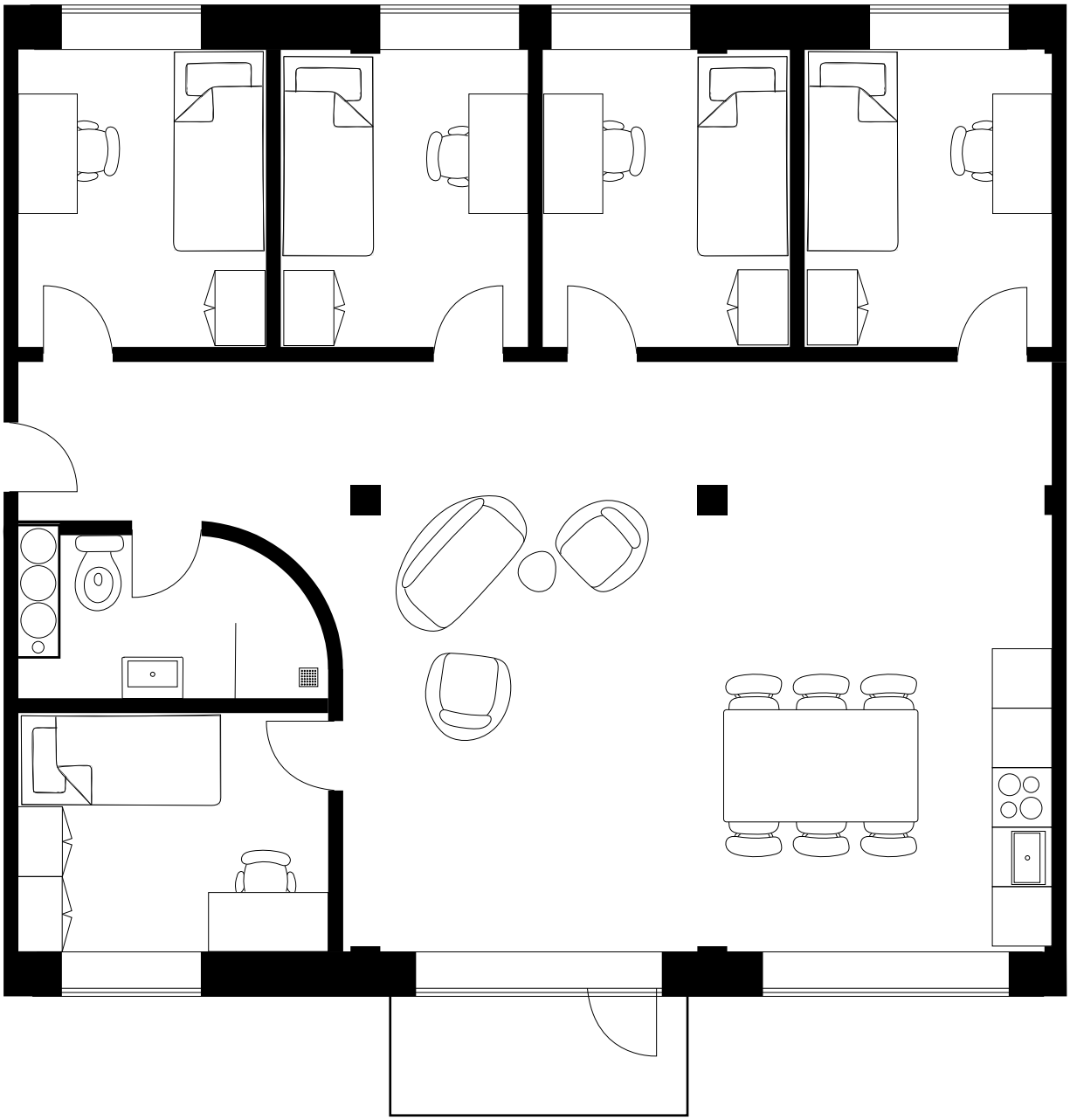


Fig: 92 - unaccompanied accomendation - scale 1:75

Healthcare building

The composition of the healthcare building is a mimication of the urban layout of the accommodation and administration buildings. The final design of the healthcare building consists of ten different separate buildings joined by a looping hallway structure. Each of the buildings serves different functions; the psychotherapy is contained in the building portion towards the east, in combination with an area designated for conversations and reading. The orientation of the psychotherapy offices is governed by that the west orientation is the directions that offers the most pristine views and corresponding visual permeability. Towards the west, rooms for medical treatment are positioned in combination with an office for the employees of the healthcare center. The building in middle is designed for social gatherings, such as meetings and presentation. The entrance building with reception and medical dispensary is similar located in the middle of building along the south façade. The composition resolves in two inner courtyards, acting as social gathering point and increases the visual- and locomotive permeability throughout the hallways of the healthcare building, and most importantly increases the visual permeability around the corners of the hallway, by giving a prior indication of what is around the bend. The walls of the hallway structure facing outwards consists of large glazing walls, to increase the interiors connections with the ambient nature; exploiting the pristine views granted by hilltop position.

The psychotherapy rooms are designed with as therapy rooms flanking a central office for the therapists; the therapy rooms and the office are connected with a sliding door. The sliding door enables the therapist to increase visual permeability and grant the patients an egocentric representation of a path of locomotion, presumably reducing an anxiety response. The two resulting routes of escape also enable the therapist to escape easily from a patient outbursting violently. Waiting area is positioned in the hallway along the wall towards the courtyard; resolving in the visitors conducting movement closer to the exterior walls of the hallways, improving the information flow when an individual goes around a corner.

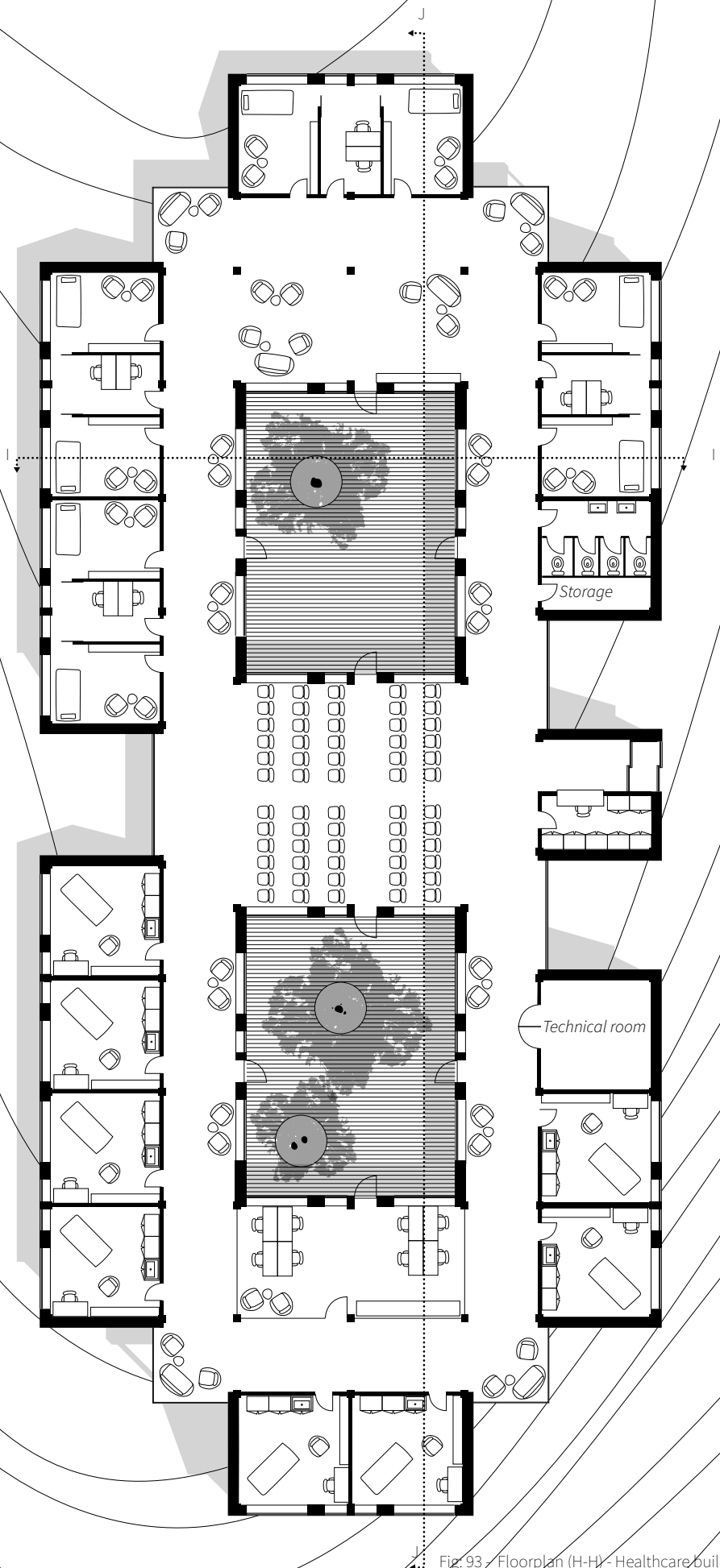


Fig. 93 - Floorplan (H-H) - Healthcare building -1:250

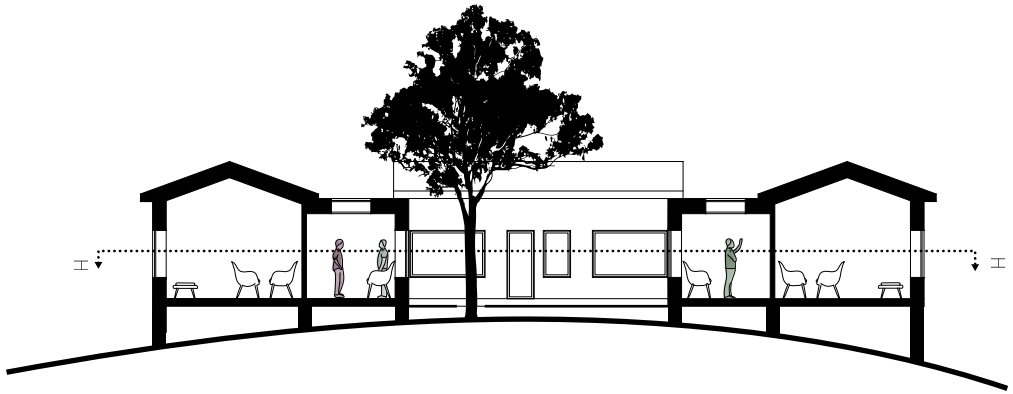


Fig: 94 - Section I-I - Healthcare building -1:250

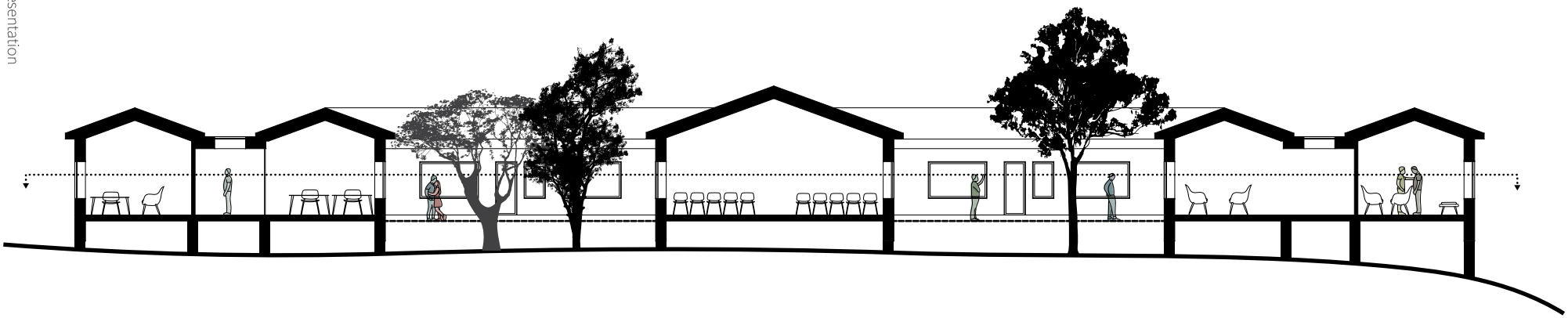


Fig: 95 - Section J-J - Healthcare building -1:250

Img: 22 - visualization of west and north facade -healthcare

Img: 23 - visualization of north and east facade - healthcare

Exterior facade and materials

Similarly to the accommodation buildings, the healthcare building is cladded with vertical wood lamellers of pine, ash and adobo. The pinewood is applied to the buildings associated with psychotherapy; the treatment rooms and reading walking area. The ash wood is applied to buildings associated with medical treatment and the office space. The abodo wood is applied to the public functions; the entrance building and the central gathering building. The hallways structure is cladded with oxidized aluminium to create a sharp contrast to the transparent glass and the wood cladding. The exterior cladding is coherent with the architecture of the accommodation buildings and similarly grants indication of the buildings function by high-frequency visual representation.

Fig: 96 - Accomendation buillding north facade

North facade - 1:200

South facade - 1:200

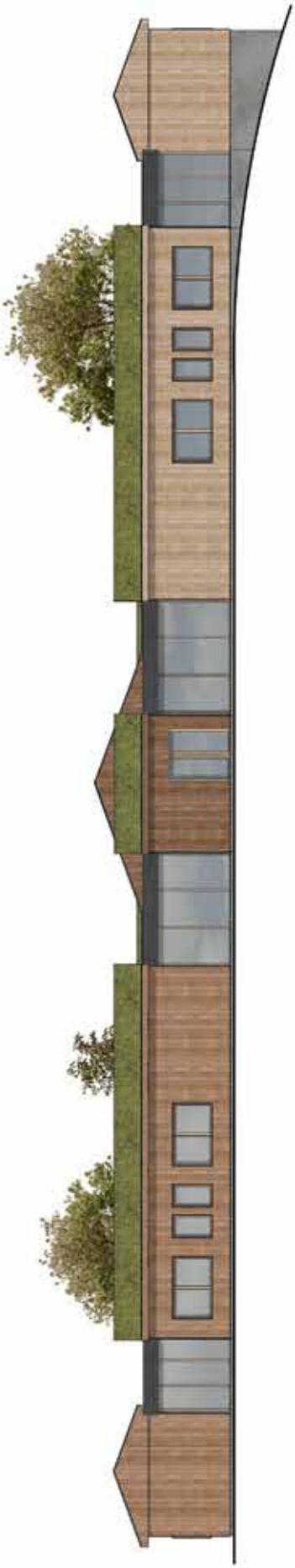


Fig: 97 - Accomendation buillding South facade

East facade - 1:200

Fig: 98 - Accomendation buillding east facade

West facade - 1:200

Fig: 99 - Accomendation buillding west facade

Interior space materials

The underpinning logic of the materials applied in the interior space of the healthcare center is identical to that of the accommodation building. As displayed in the visualisation of the therapy room (img. 24), the same materials is applied to the same surfaces. Similarly, in the visualisation of the hallway (img. 25) and reading area, the wood lamellar cladding with acoustic properties is applied on the walls towards the internal courtyard. The ceiling cladding follows the same concept, by increasing the surface area with wooden horizontal lamellar with behind laying acoustic foam, designed to reduce sound transmission along the hallways. The interior walls of the buildings is not depicted in the visualisation, these are cladded with the same material as the exterior, of the respective building, ensuring that the high-frequency representation of the exterior façade is associated with the functions and navigation of the interior space.

Img: 24 - visualization of psychotherapy room

Img: 25 - visualization of hallway and commonspace

Conclussion

The final proposed design of the asylum centre has been based on a preliminary theoretical assessment of architectures correlation with the human emotional system, especially the neuroendocrine system, as cortisol concentration at the MR- and GR- receptors in the hippocampus has been correlated with the severity and treatment of post-traumatic stress disorder. The theoretical assessments extracted universal design strategies for environments reducing cortisol concentration. These design strategies correlates with previous empirical findings that displayed a direct correlation between these spatial variables (visual- and locomotive permeability and mystery) and cortisol concentration in humans (Brorson, 2013; Jiang, Chang and Sullivan, 2014).The theoretical assessments on architectures correlation with the emotional system were combined with inquiry on the neurological- and psychological abnormalities of post-traumatic stress disorder, to investigate the disorder interferences with preference for architectural design. The inquiry indicated that post-traumatic stress disorder patients are more significantly affected by the spatial properties associated with safety; visual- and locomotive permeability, mystery, refugee and social interaction. Furthermore, post-traumatic stress disorder is associated with reduction of allocentric spatial memory performance, and as indicated by assessment of the correlation between the memory system and the emotional systems; the reduction of allocentric memory performances is associated with increased reliance on egocentric spatial memory to conduct emotional modulation to ensure homeostasis balance: further enforcing the requirement of design architecture with a significant amount of visual- and locomotive permeability and an environment with steady information flow.

These design strategies, where incorporated into the design process together with consideration in regards to environmental-, economical- and social sustainability and the building site. The result of the design process is a cluster of different building types associated with low environmental impact, both in regards to embodied emission and emission associated with energy production for the usage phase. The buildings design is cost efficient and furthermore, the architecture will, theoretically, improve the treatment of post-traumatic stress disorder as a result of spatial design, material selection and considerations of the buildings social structure. Improvement of the mental state of the asylum-seekers health and well-being will improve their ability to productively integrate into the respective host nation; improving the likelihood of positive economic and cultural return from granting the individual accommodated in the design facility refugee status.

Reflection

The inclusion of a preliminary theoretical assessment on the correlation between architecture and the emotional system were a personally and academically interesting inquiry; trying both to understand the inner workings of the human mind; understand how architecture affects humans and how architecture should be designed accordingly. As it was demonstrated by the current state of the research on the correlation between architecture and emotional modulation, a few variables indicated to have a direct correlation. The variables that have demonstrated to have a direct correlation is visual- and locomotive permeability, refuge and the information flow component associated with term mystery (as defined by Kaplan and Kaplan (1989). These variables has been verified to have a direct correlation, indicating that these parameters is an vital consideration when designing architecture, as design decision alternating the environments affordances of the variables will have direct influence on the health and well-being of the occupants. Currently, the research on the topic has not displayed measurable values for the parameters; how much visual permeability is required? How much locomotive permeability is required? What is the ideal pace novel spatial information? How much refuge is required? And is refuge always required? The current state of the research on the correlation between architecture and emotional modulation does not indicate a presscribable dose of the parameters to ensure the best possible emotional modulation, only a theoretical and empirical indication of its correlation; resulting in the inclusion of the parameters to be a personal assumption on how much is required; hindering the efficiency and cost-efficient incorporating of the considerations into the design process.

The parameters are arguably regular consideration included in the architectural profession, should architects, therefore, increase the environments affordance of these parameters, as the result of him/her being consciously aware of the parameters influence on the emotional system? Or will this result in an over engineered solution? As the underpinning logic of the of parameters influence on the emotional system, is that the parameters affect the result of an unconscious decision making process affecting our preference of an environment; a process developed to rapidly assess environments to ensure biological goals. The design decision an architect made prior being conscious aware of the correlation between the parameters influence on emotional modulation, might therefore already be associated with positive emotional modulation, as the architect would unconsciously have applied his/her emotional system to evaluate the design solutions. This argumentation indicates the possibility to investigate the correlation between visualisation tools included in the design process and the resulting outcome. The inclusion of virtual reality into the evaluation process of architectural solution might result in the design solution being better reflection of architecture correlation with positive emotional modulation, compared to an architectural design as a result of 2D sketches or 3D drawings displayed in 2D as the medium of evaluation has improved significantly.

These considerations, also indicates the importance of inclusion of psychological and

neurological abnormalities of a specific user group when designing environments for mental illnesses, as these individuals will potentially have a common alteration of the emotional system reaction to environments. The occupants of the designed buildings architectural preference, might, therefore, be different from the architect's emotional system governing the projects design decisions.

As indicated by the theoretical assessment; social connections and the memory system played an essential role in regulation of the emotional systems. Resulting in corresponding requirement of the environments affordance of the parameters associated with reduction of a stress response to reduce the anxiety response. As there is a correlation between social connections, the memory system and architecture, improvement of the research on the correlation might, therefore, also improve the understanding of architecture and potentially result in "pressribable dose" for each variable in correlation with the occupant's previous understanding of the space and the individual's social connections with the other individuals associated with the setting.

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Reference list images and figures*

Img 1: Ponomarev, Sergey (2016) - Migrants wait to be escorted by Slovenian riot rolice to the registration camp outside Dobova, Slovenia (Permission pending)

Img 3: https://jooinn.com/brick-texture-24.html

Img 4: https://jooinn.com/brick-texture-24.html

Img 5: https://i.pinimg.com/originals/63/b8/46/63b8466b1a1d5454eca87ea871daefa5.jpg

Img 6: https://www.petersen-tegl.dk/cover/produkter/c21

Img 7: https://www.petersen-tegl.dk/cover/produkter/c11

Img 8: https://www.petersen-tegl.dk/cover/produkter/c33

Img 9: https://pixers.us/wall-murals/white-wood-texture-background-wooden-table-top-view-139217284

Img 10: https://i.pinimg.com/originals/1f/ae/9e/1fae9e12adfeec64a6731c050983e13a.jpg

Img: 11: https://www.patrickbazile.com/upload/2019/01/07/texture-seamless-wood-texture-wood-pinterest-texture-wood-ceiling-patterns-l-0a7061d5ddb63d97.jpg

Img 12: https://www.sketchuptextureclub.com/public/texture_m/0041-slate-roofing-texture-seamless.jpg

Img 13: https://www.goodtextures.com/cache/5001eec8/av463e0f9ef0b186c6a0b.jpg

Img 14: https://cdn.pixabay.com/photo/2016/10/28/16/10/slate-1778424_960_720.jpg

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