The synergy of architecture and psychology

The interaction between architectural design elements, psychological well-being and behaviour in a dementia-friendly care home

Case study of Zuidoever

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The synergy of architecture and psychology

The goal of this scientific report was to examine the impact of the architectural design elements of the Zuidoever building on its residents, particularly in relation to dementia. This scientific report was driven by the need for a deeper psychological understanding of how architectural design elements influence user experience, psychological well-being, and behaviour. A collaboration between TANGRAM Architekten and the University of Leiden made this scientific report possible.

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Dear reader,

For my Master's degree Applied Cognitive Psychology, I am doing an internship at TANGRAM Architekten. TANGRAM is an architecture company based in Amsterdam that specializes in architecture, landscape and urban densification. During my internship, I analyzed the 'Zuidoever' building and the influence of its architectural design elements on the residents of a care home for individuals with dementia. The research was driven by the need for a deeper psychological understanding of how architectural design elements influence user experience, psychological well-being, and behaviour. This scientific report presents the findings of that analysis, integrating data from current research. However, as research on Zuidoever is still ongoing, a complete analysis is not yet possible. Therefore, only descriptive statistics from the ongoing research have been integrated into this report.

The goal of my internship was to examine the impact of the Zuidoever building on its residents, particularly in relation to dementia. To achieve this, the scientific report is structured as follows: first, an introduction to the Zuidoever building is provided, followed by an overview of dementia and its implications for architectural design. Subsequently, key architectural design elements, such as daylight, and (indoor) greenery, are analyzed. This is followed by a comparison between traditional and dementia-friendly care homes to assess how different architectural design elements influence residents' experiences. The report then discusses the significance of interdisciplinary collaboration between architects and psychologists in designing environments that promote residents' well-being and influence their behaviour. Additionally, an appendix is included with recommendations for architects from a psychological perspective. Thus, the report evaluates the effectiveness of architectural design elements and provides insight into their impact.

During my 7-week internship, I examined the architectural design elements of the Zuidoever building from a psychological perspective and wrote a scientific report on their effects on residents. This research would not have been possible without the support of numerous individuals, to whom I extend my sincere gratitude.

First of all, I would like to thank my supervisors, ir. Bart Mispelblom Beyer and ir. Charlotte ten Dijke, the owners of TANGRAM, for welcoming a psychologist into their architectural firm. Their willingness to share their expertise and provide valuable insights into the field of architecture has been invaluable.

I would also like to thank my university supervisors, Prof. dr. Ineke van der Ham and Dr. Guido Band, for their guidance and constructive feedback throughout the research process. Additionally, I would like to thank my fellow students who conducted research at Zuidoever and for sharing their research data, and Elaine Herkul for her insightful discussions and moral support.

Finally, I would like to thank my colleagues at TANGRAM - Bas Weststrate, ir. Lejla Duran, and ir. Ludo Schoone - for answering my questions about architecture, and for their clear explanations of the field. Their openness and willingness to share their knowledge greatly enriched my internship experience.

Kind regards,

Anisa Opdam

A picture of me in front of the green wall

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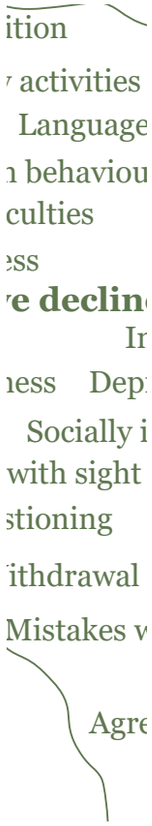
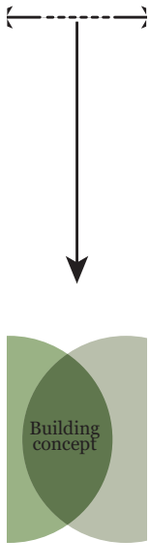
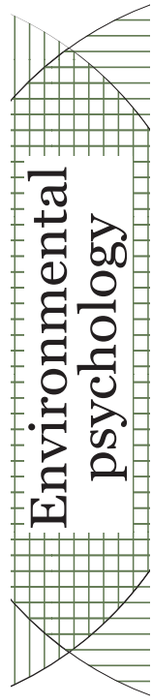






Zuidoever

Zuidoever

Location: Zuidas, Amsterdam
Function and capacity: 54 residential care units and facilities for individuals with dementia or somatic complaints; 3 apartments are suitable for living with a partner.
Completion: 2021

The 'Zuidoever' building is a health care facility designed to provide a comfortable, homelike living environment for elderly individuals with high care needs. Two groups of elderly individuals with different conditions live in Zuidoever: those with dementia and those with chronic physical illnesses (including Parkinson's, COPD, stroke) (TANGRAM architecture and urban landscape, n.d.).

A study conducted at Zuidoever examined 18 residents. The results show that eleven residents have Alzheimer's disease, five have vascular dementia, one has Lewy body dementia, and one has dementia associated with Parkinson's disease. However, since not everyone completed the survey, the results are not representative.

The diverse needs of these residents place high demands on the residential care environment. Individuals with dementia often benefit from a more private and secure environment. Individuals with physical limitations, on the other hand, want contact with others and the outside world. Zuidoever offers both: it offers a larger outside world and the ability to shrink into a safe, homely place. At Zuidoever, good care is combined with high-quality living. The overall well-being of the residents comes first. The building and interior design facilitate this and positively encourage residents to live an active life and to interact socially (TANGRAM architecture and urban landscape, n.d.).

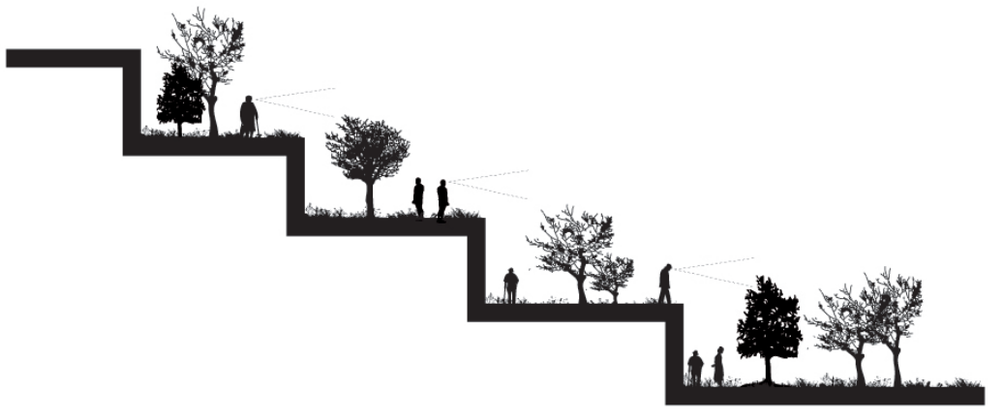
TANGRAM was responsible for both the building and its interior. The interior is all about (sensory) activation, comfort, and optimal orientation. Of course, this was achieved without compromising on safety and medical needs. These components are cleverly integrated invisibly into the design. Zuidoever is a building with a high-quality image that puts residents first. It does not close residents in, but embraces them with warmth. The building offers comfort and privacy, but also contact with other residents and the outside world. Zuidoever offers a life as much as possible as the residents are used to, a home that adapts to their abilities, not the other way around (TANGRAM architecture and urban landscape, n.d.).

Entrance of Zuidoever

Figure 1
Location of Zuidoever

Zuidoever is located at the head of Amsterdam's Zuidas (see figure 1). The choice of this location - in the middle of the bustling city - is no coincidence. Individuals from the city should not be moved to the suburbs when they are old and needy. The city offers the hustle and bustle that are still an important part of life, especially in the early stages of the disease. Zuidoever has a lot of indoor greenery and facilities within walking distance. Essential to the Zuidoever is the greenhouse in the 'hollowed out' central area of the building. The glass roof connects the blocks, provides a sea of daylight and offers year-round protection from noise pollution (A10 highway), particulate matter, rain, wind, and cold. Residents can go outside and meet each other all year round in this intermediate climate. Good ventilation ensures that it never gets too hot. In the winter, the greenhouse acts as a buffer against the weather. Partly because of the greenhouse, Zuidoever feels like a green oasis. The greenery start at street level, continue into the greenhouse, and cascade up to the top floor (see figure 3). As a result, all residents live close to green, even on the upper floors and greenery is integrated in such a way that it is visible from every point of view (see figure 2). The interior is strongly connected to the exterior (TANGRAM architecture and urban landscape, n.d.).

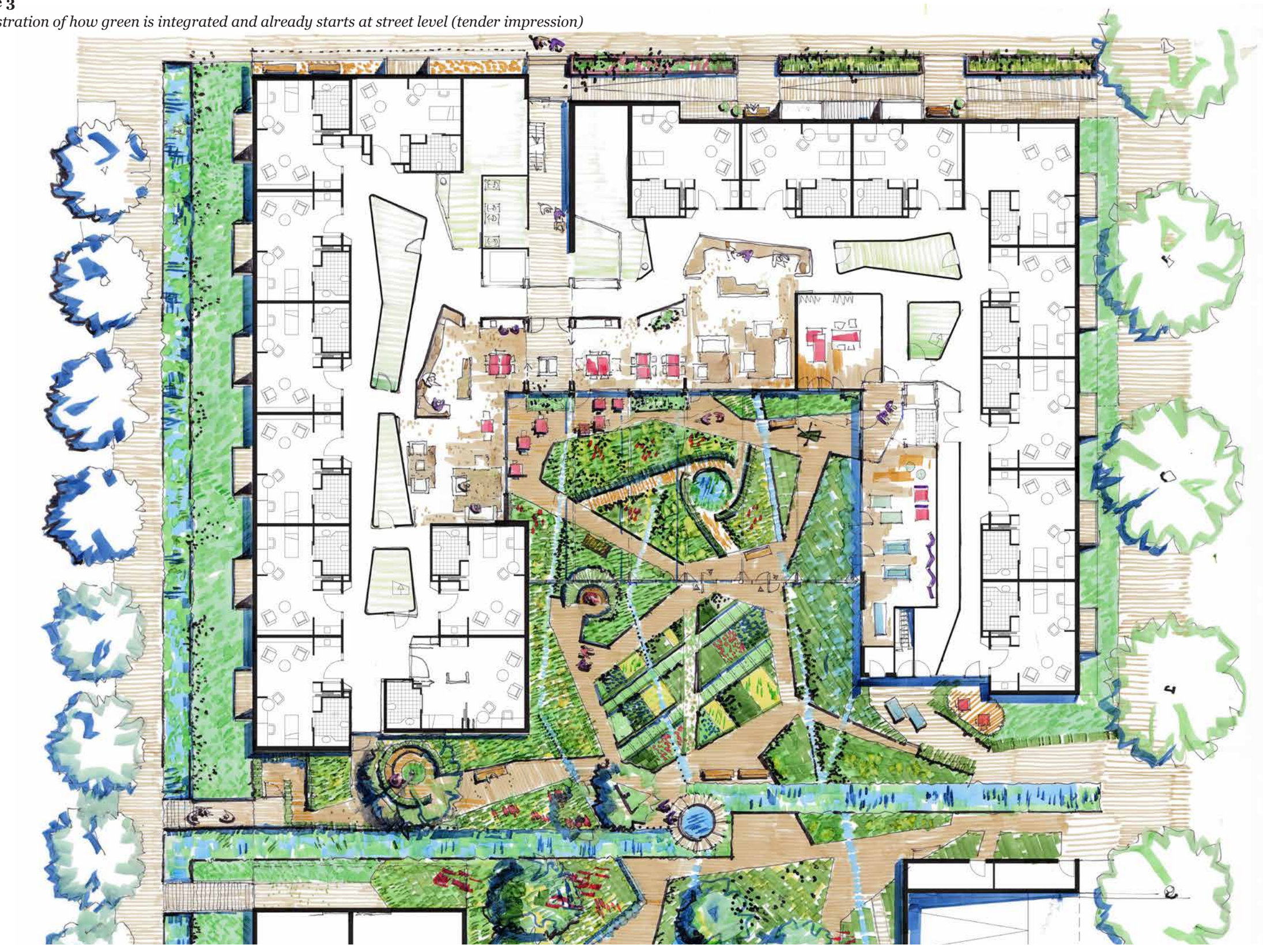
Figure 2
An illustration of how green is integrated and visible from every point of view



View of the greenhouse from the living room

Figure 3

An illustration of how green is integrated and already starts at street level (tender impression)



Traditional care homes often feature dead-end corridors. However, this concept has been eliminated in Zuidoever. The architects introduced a paradoxical solution: the wandering zones. These zones are specifically designed to encourage movement and social interaction. The design incorporates living rings that allow individuals with different mobility ranges to interact naturally. Residents can walk around in multiple ways and to link routes for greater reach. There are no dead-end corridors, instead the traditional corridor structure has been replaced by spaces with islands to walk around (see figure 4 and 5) (TANGRAM architecture and urban landscape, n.d.).

Figure 4

An illustration of the transition from a traditional corridor structure to spaces with islands to walk around

Figure 5

A picture of an island to walk around

Another architectural design element is the variation in light intensity and the use of colours and materials. Nowhere in the building is the lighting uniform or cool-toned. First, light levels increase as residents move higher in the building. Second, the interior colours are adjusted accordingly, becoming lighter or darker depending on the amount of natural daylight available. The architects carefully selected tones that complement the surrounding environment, which ensures harmony within each space. For example, a warmer shade of grey may be more suitable for a hallway on the first floor than a darker tone, as it better aligns with the available daylight. This approach enhances the overall atmosphere and creates a cohesive design (TANGRAM architecture and urban landscape, n.d.).

Figure 6

A picture of how well the colours and materials are adjusted accordingly

The design and environment of the Zuidoever building play a crucial role in supporting the well-being of its residents. The thoughtful integration of architectural design elements such as the greenhouse, which, in turn, may contribute to their emotional and psychological well-being. It has turned out that medication use has decreased, the atmosphere is more quiet, and employees have more time to spend with residents. Other research conducted at Zuidoever found that, out of seventeen respondents, eleven residents are often happy, anger or crying (see figure 7, 8, and 9 for an overview). However, as the study has not yet included a control group, there is no reference point for comparison. As a result, no formal tests have been conducted, and it remains unclear whether residents' happiness can be attributed specifically to architectural design elements or to other factors.

Figure 7

Frequency distribution of how often residents are happy

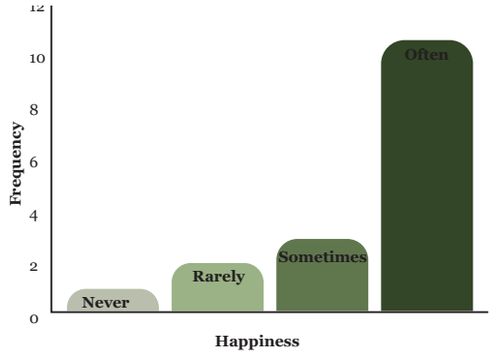


Figure 8

Frequency distribution of how often residents are angry

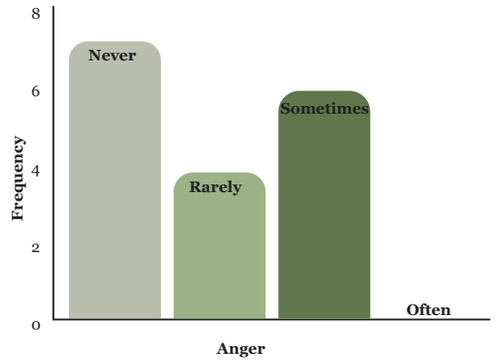


Figure 9

Frequency distribution of how often residents are crying

View of the greenhouse from the garden

02

Symptoms of dementia
Dementia and Zuidoever

Dementia

One of the two groups living at Zuidoever consists of elderly individuals with dementia. There are currently 47 million people living with dementia around the world, and this number is expected to rise to 131 million by 2050 (Arvanitakis et al., 2019). Dementia is a widespread public health problem (Prince et al., 2015), with over fifty different types, including Alzheimer's disease, vascular dementia, and Lewy body dementia. Of all forms of dementia, Alzheimer's disease is the most common (Alzheimer Nederland, n.d.), ranking as the sixth leading cause of death overall and the fifth among individuals over the age of 65 (Health, United States, 2015, 2016; Wang et al., 2016). Dementia is a devastating disease characterised by progressive cognitive and functional decline, often with neuropsychiatric symptoms. It can lead to loss of independence, disability, and ultimately death (Corbett et al., 2012). However, its progression is not always linear and varies from person to person (Kitwood & Bredin, 1992). Providing a dementia friendly environment is therefore essential to foster a supportive environment and enhance the well-being of individuals with dementia, a growing challenge for society.

Symptoms of dementia

Signs and symptoms of impaired perception, thought content, mood, or behaviour are defined as behavioural and psychological symptoms of dementia (Finkel et al., 1997). These symptoms typically occur in clusters, including psychosis (delusions and hallucinations,) agitation, aggression, anxiety - which may involve worrying, and shadowing, the act of following the caregiver (Tucker, 2010; Joller et al., 2013) - and motor disturbance, which include purposeless repetitive activities like wandering and rummaging (Kaufer et al., 2000; Rockwood et al., 2014). Other common symptoms include depression, repetitive questioning, sleep problems, and a wide range of socially inappropriate behaviours (Lyketsos et al., 2011). Almost all individuals with dementia experience one or more symptoms during their illness (Lyketsos et al., 2011). See figure 10 for an overview of the symptoms of dementia.

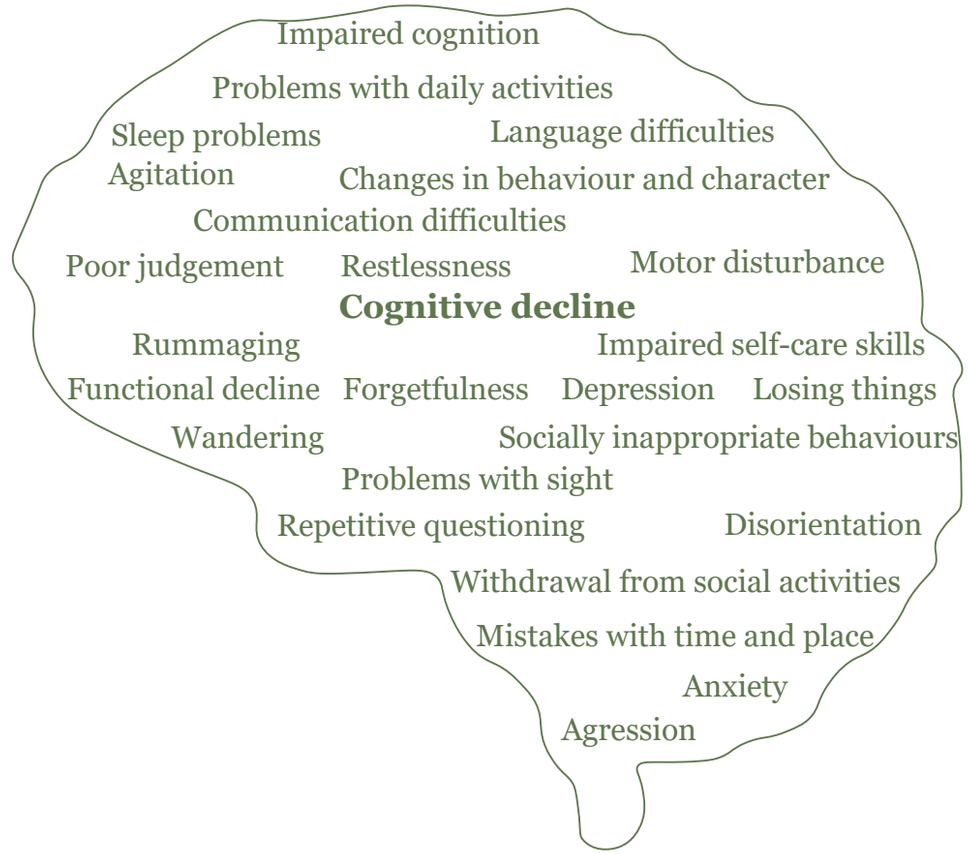
Dementia and Zuidoever

It is essential to promote a supportive environment and to enhance the well-being of individuals with dementia. By no means are all environments dementia-friendly. However, the building Zuidoever comes pretty close. In this report, I will analyze the architectural design elements, such as the intelligent integration of daylight, that make Zuidoever an excellent environment for individuals with dementia. For example, the challenge of treating individuals with dementia is often exacerbated by the communication difficulties experienced by the majority of individuals with the disease, particularly in the later stages when language, cognition and self-care skills are severely impaired (Scherder et al., 2009). This is precisely where the design of Zuidoever excels.

If a resident has difficulty speaking but wishes to visit the greenhouse, they do not need to ask employees for directions. Even better, the intuitive layout naturally guides them to their direction without the need for verbal communication, reducing frustration and promoting independence. A key factor in this intuitive navigation is the stimulation of the senses. Visual cues, such as daylight and colour, guide residents, while gradual transitions from silence to livelier areas aid in auditory orientation. Additionally, the scents of cooking in the kitchen and greenery provide olfactory guidance, while the textures of materials enhance tactile engagement. Residents are naturally drawn toward the brightest and most inviting areas, allowing the sensory environment to serve as an unspoken guide within the building. This strategic use of sensory stimulation enhances wayfinding, supporting residents in orienting themselves without relying on verbal instructions.

Figure 10

Word cloud of the symptoms of dementia



03

Circadian rhythm
Dementia and Zuidoever

Daylight

A picture of daylight in the building

The intensity, direction and colour of daylight change continuously throughout the day, helping to regulate the body's biorhythm. Daylight contains various types of radiation, some of which are important for the production of vitamins. In contrast, artificial light is inherently monotonous and has a relatively weaker effect on the body due to its lower intensity. It is therefore useful to get as much daylight as possible. Additionally, daylight is free and environmentally friendly and it not only benefits residents but it also enhances working conditions for employees. Sufficient daylight improves visibility, helping employees carry out tasks safely and reducing the risk of accidents. Furthermore, exposure to light makes us feel fit, especially natural daylight produced by the sun. However, excessive exposure to uv-radiation can be harmful to the skin, necessitating a balance between benefits and potential risks.

Circadian rhythm

Impaired cognition, and behavioural and psychological symptoms of dementia such as sleep problems, agitation, depression and psychosis are characterised in individuals with dementia (Cerejeira et al., 2012). In the early stages of dementia, more than 70% experience sleep disturbances (Rongve et al., 2010). Behavioural and psychological symptoms and sleep problems are a source of distress for the patient and their family members (Cerejeira et al., 2012), making it crucial to implement effective interventions. Individuals with dementia often exhibit circadian dysregulation, with multiple periods of sleep and wakefulness occurring throughout the 24-hour day (Wu et al., 2017; Pat-Horenczyk et al., 1998). Some individuals with behavioural and psychological symptoms of dementia exhibit a diurnal rhythm, with increased agitation, confusion, and wandering in the afternoon and evening. This phenomenon is called 'sundowning.' It is thought to reflect a breakdown in circadian rhythmicity (Khachiyants et al., 2011; Vitiello & Borson, 2001; Coogan et al., 2012).

Figure 11
A picture of the integrated greenhouse that maximises daylight

As individuals age, yellowing of the lens and narrowing of the pupil reduce the amount of light reaching the retina (Duffy et al., 2015; Turner & Mainster, 2008). The retina is made up of special cells called photoreceptors, which capture the light entering the eye in the form of images and convert these images into electrical signals. These electrical signals then travel along the optic nerve to the brain, where they are converted into the image we see. While compensatory mechanisms may preserve some light sensitivity (Najjar et al., 2014), yellowing of the lens has been associated with self-reported sleep disturbances (Kessel et al., 2011).

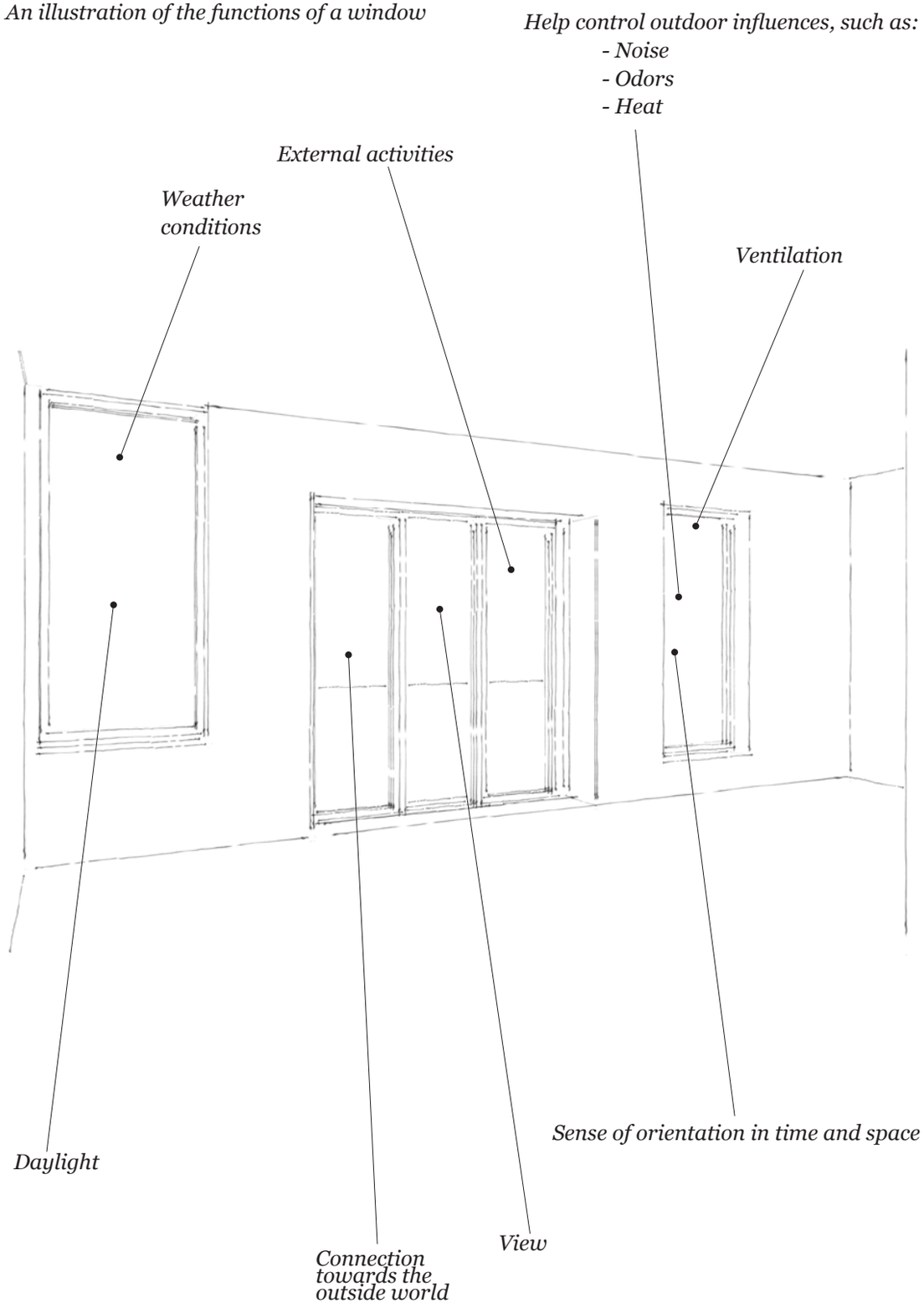
Beyond age-related changes, pathological changes in the retina and optic nerve have been linked to Alzheimer's disease. In particular, these include the loss of intrinsically photosensitive melanopsin-containing retinal ganglion cells (pRGCs), which are largely responsible for non-image-forming (NIF) responses (La Morgia et al., 2017). pRGCs are a small fraction of the total number of ganglion cells that are photosensitive. They convert light into NIF neural signals that are transmitted via the retino hypothalamic tract (RHT) to the supra-chiasmatic nuclei (SCN) of the hypothalamus in the brain (Hattar et al., 2002; Lucas et al., 2013). The SCN, or biological clock, generates and regulates a number of endogenous rhythms in the human body through its connection to the central nervous system (Khademagha et al., 2016). Thus, daylight plays a role in regulating circadian rhythm. Specifically, a short-wavelength of 470 nm (blue) light has been shown to delay falling asleep and affects cortical and subcortical networks that are involved in cognitive processes such as attention, arousal, and memory (Chellappa et al., 2014; F. Perrin et al., 2004; Vandewalle et al., 2011; Vandewalle et al., 2007; Vandewalle et al., 2009). Furthermore, increased melatonin suppression, decreased subjective sleepiness, and decreased reaction times are associated with exposure to blue light (Cajochen et al., 2005).

In contrast, there was a reduced arousal response and faster sleep induction of sleep with the longer wavelength of 530 nm (green) at the same intensity (Pilorz et al., 2016).

Glaucoma, macular degeneration, pupillary dysfunction, and reduction in optic nerve fiber thickness are other ocular changes associated with Alzheimer's disease that may disrupt circadian regulation (Valenti, 2009). Additionally, elderly individuals with dementia are often exposed to inadequate light levels, which in turn contribute to sleep problems and circadian disruption (Shochat et al., 2000; Figueiro et al., 2012). Consequently, increasing appropriate light exposure has been proposed as a promising non-pharmacological intervention for managing sleep disturbances and behavioural and psychological symptoms of dementia (Hanford & Figueiro, 2013). In light of this, the architects of the Zuidoever building have integrated architectural design elements that maximise daylight exposure, which supports the circadian rhythm and improves sleep patterns for residents. They also strategically minimised daylight in front of the bedroom doors while increasing daylight exposure in the greenhouse, intuitively guiding residents to the greenhouse.

Figure 12

An illustration of the functions of a window



Windows

Windows play a crucial role in providing several key benefits to indoor environments. They offer daylight, ventilation, and a view, all of which connect residents to the outside world. In addition, they provide information about weather conditions, time of the day, and external activities, helping residents maintain a sense of orientation in both time and space. Moreover, the materials, design, and use of windows help control outdoor influences such as odors, noise, and heat, thereby improving overall indoor comfort (Knoop et al., 2019).

At Zuidoever, residents benefit from having windows in their bedrooms, allowing them to experience these advantages. The building also features an integrated greenhouse which serves multiple purposes. Not only does it act as a sound barrier, protecting the building from noise generated by the nearby A10 highway, but it also shields the space from rain, wind, and cold. Additionally, it ensures a comfortable indoor climate throughout the year through effective ventilation.

The windows at Zuidoever are dynamically placed on the facade, with varying heights that create multiple perspectives. These varying levels allow residents to experience different views - weather conditions, a view, and the street.

Physical comfort can be influenced by the specific spectral power distribution and brightness of daylight. Physical comfort refers to the feeling of well-being when thermal and lighting conditions of an environment are perceived as pleasant and satisfactory. Sunlight entering a room increases its temperature, and windows are a source of heat transfer to and from the outside. Thermal discomfort, caused by high or low temperatures, activates biological cooling such as sweating or heating such as shivering (Knoop et al., 2019). Discomfort can also arise from the thermal asymmetry between the cool inner surfaces of windows and the warmer walls (Marino et al., 2017).

Several aspects of physical and mental well-being can be affected by the view from a window (Knoop et al., 2019).

Ulrich (1984) investigated whether a window view affects recovery by comparing patients with a natural view with trees to those with a wall view. The study involved participants, recovering from gallbladder surgery, who were assigned to hospital rooms with either a natural landscape or a blank wall as their view. Findings revealed that patients with a natural view had shorter hospital stays and received more positive notes from nurses than those facing a wall. This suggests that a natural view accelerates physiological recovery from stressful experiences (Hartig et al., 1991; Ulrich et al., 1991).

Furthermore, research suggests that in dense urban areas with obstructions, constant accommodation and adaptation takes place by the eye muscles. This is because the muscles are required to keep an image fixed on the fovea. The fovea is the part of the eye that provides the clearest and sharpest vision. When looking at an object, the part of the image focused on the fovea is the most detailed part of the image. Conversely, views of deep space can relieve eye strain and reduce muscle tone, allowing the cerebral cortex to relax from constant information processing. Additionally, one study has found that patients in an intensive therapy unit with translucent windows had better memory and orientation, and fewer hallucinations and delusions than those in a windowless unit (Keep et al., 1980). As the symptoms of dementia include hallucinations, delusions, and disturbed sleepiness, the Zuidoever provides plenty of daylight, and keeping residents informed about the situation outside is a well-considered design choice to support their cognitive and (psychological) well-being and their circadian rhythm.

Figure 13
A picture of the facade at Zuidoever

These findings indicate that daylight is a crucial element in creating dementia-friendly environments. Not only does ample natural light benefit the circadian rhythm, but it also offers additional benefits, such as ventilation, a connection to the outside world, and insights into weather conditions. Furthermore, daylight can influence physical comfort by regulating room temperature. This highlights the importance of integrating daylight into architectural designs to support the circadian rhythm and comfort for residents.

Figure 14
A picture of the integrated greenhouse in the hall

Figure 15
A picture showing that there is daylight in the kitchen in Zuidoever

04

Wayfinding
Differentiation
Landmarks
Bringing personal belongings

Orientation within the buidling

Individuals with dementia and aging experience a marked decline in their ability to orient and navigate (Benke et al., 2013; Lester et al., 2017). This gradual loss of navigational skills is evident in individuals with Alzheimer disease, of which disorientation is usually one of the first symptoms, (Pai & Jacobs, 2004; Serino et al., 2015) and in an environment that is unfamiliar to them (Wiener & Pazzaglia, 2021). Designing nursing homes for individuals with declining navigational skills in mind would make the transition to their new environment easier (O'Malley et al., 2015). To facilitate spatial orientation and compensate for declining navigational abilities, care homes must be designed thoughtfully to memorise this with relative ease. This would enable residents to adapt more easily to their new homes, improve their quality of life and well-being, maintain a greater degree of independence, and reduce the workload of their caregivers (Marquardt & Schmieg, 2009).

Wayfinding

Wayfinding refers to the coordinated and purposeful movement through an environment (Montello et al., 2005), involving the process of determining and navigating a route from a starting point to a destination (Golledge et al., 2018). Effective wayfinding skills - derived from the interaction of individual and environmental factors - are an important source of quality of life and autonomy (Wiener & Pazzaglia, 2021).

The design of the Zuidoever building exemplifies support for efficient wayfinding. The manager of the Zuidoever building reported: "The residents behave in a very natural way. They walk quietly to the greenhouse or through the building, and nowhere is there a banging of doors. It is so nice to see that it works." This indicates that the design of the Zuidoever building supports efficient wayfinding. The architects incorporated multiple access points that serve as decision points in the context of navigation (Wiener & Pazzaglia, 2021), which are important for navigation (Aginsky et al., 1997). Dementia-friendly design guidelines emphasize making spaces easily recognizable and meaningful (The King's Fund, 2014), for example by using landmarks (Wiener & Pazzaglia, 2021). In large places or areas within the built environment, designers have more options to create navigable spaces (Wiener & Pazzaglia, 2021).

"The residents behave in a very natural way. They walk quietly to the ***greenhouse*** *or through the building, and nowehere is there a banging of doors.*
It is so nice to see that it works."

- Manager Zuidoever

Differentiation

In the Zuidoever building, residents have access to the entire building, with strategically designed or coloured furniture, different colour schemes, and distinct wallcovering used to clearly distinguish different locations (Davis et al., 2008). These visual elements serve as important cues that aid in navigation and orientation. An essential factor in navigation is its degree of differentiation, which refers to the degree of differentiation or uniformity in an environment (Evans et al., 1980). Differentiation involves visual or interior design features as well as spatial features. Visual differentiation involves how easily different elements of a building of space, such as corridors, floors, etc., can be distinguished from each other (Wiener & Pazzaglia, 2021). Varying sizes, shapes, architectural styles, and colours within a building can have a positive effect on its navigability (Gärling et al., 1986). The architects of the Zuidoever building applied this principle by using different colours on each floor, helping residents in orienting themselves more easily. For instance, the first floor has distinct colours on the walls compared to the second floor, making it easier for individuals to identify their location and navigate the space effectively. Such design choices highlight the importance of incorporating visual cues in architecture to support wayfinding and ensure that environments are easier to navigate, especially for the residents who face challenges with spatial memory and/or orientation.

Landmarks

Navigation includes landmark-based navigation (Zhao & Warren, 2015) or, in the world of architecture, mental mapping. Landmarks - any object or feature of the environment that is easily visible and recognizable - play a key role in this process. They help establish position and can be essential in finding the way around (Raubal & Winter, 2002). Landmark-based navigation for homing, reorientation, and wayfinding is based on visual landmarks and other environmental information (Trullier et al., 1997). In other words, a landmark-based navigation is a system that relies on environmental cues (landmarks) to guide individuals, and is therefore more likely to be improved by making appropriate design choices (Wiener & Pazzaglia, 2021). Recognizing and using landmarks to determine where you are and to guide your steps in the right direction is crucial (Krukar et al., 2017).

Figure 16

A selected overview of materials used in Zuidoever

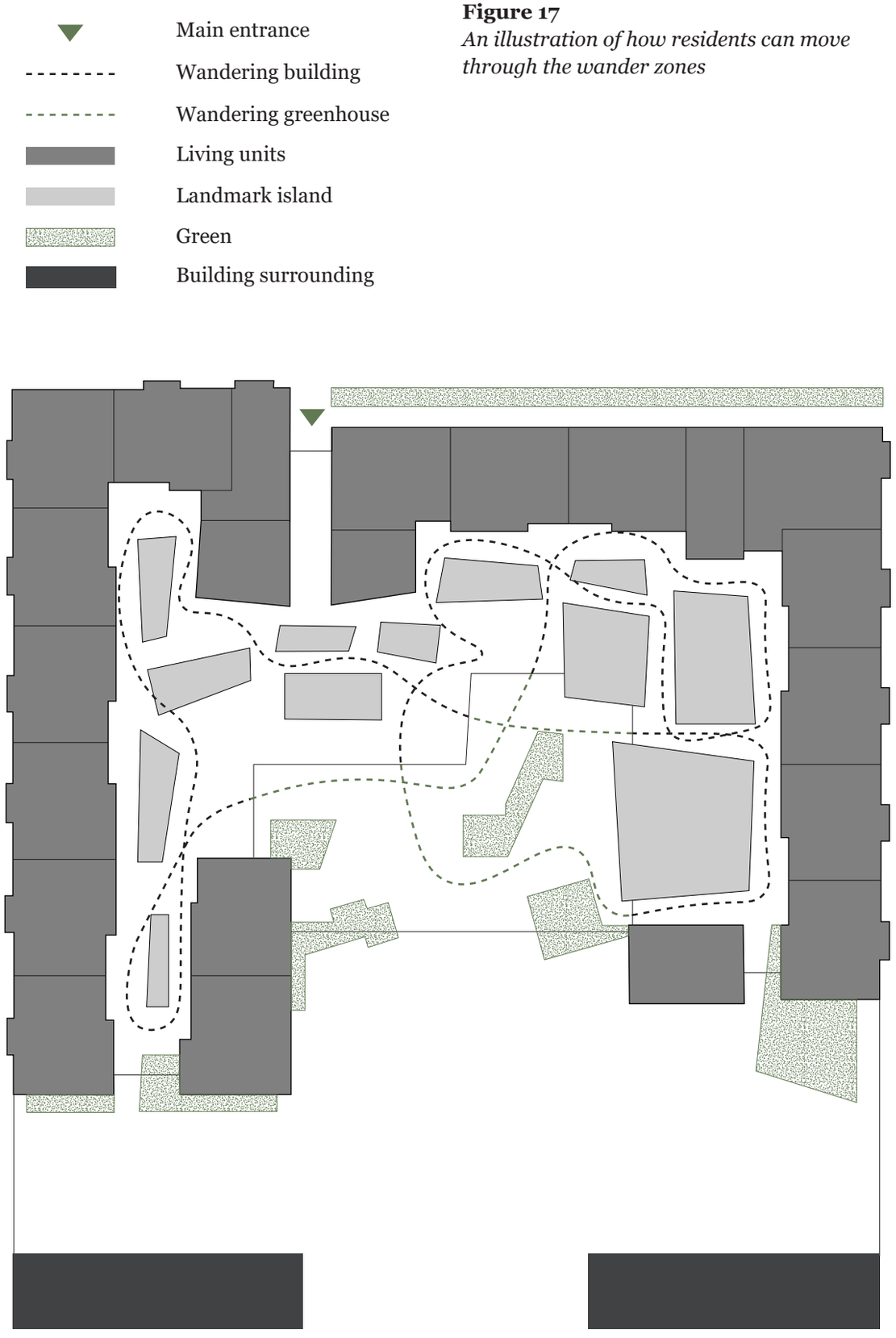


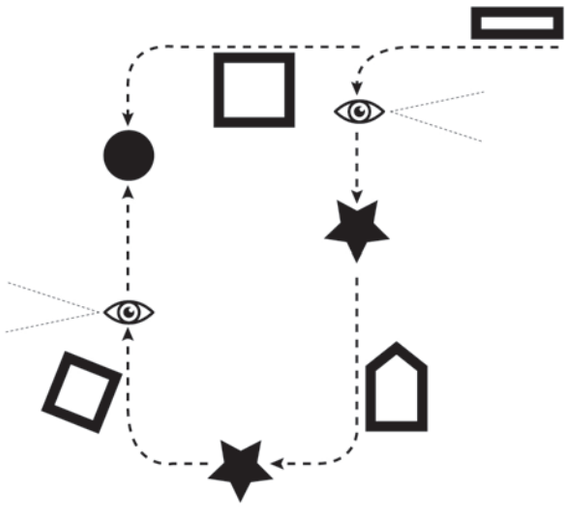
Figure 17
An illustration of how residents can move through the wander zones

The Zuidoever building provides a clear example of how landmark-based navigation or mental mapping can be facilitated through architectural design elements. Navigation within the building follows a structured sequence, beginning with distinct spatial islands. Once passed these distinct islands, residents pass through a series of recognisable and visually distinct spaces, including the kitchen, library, seating- and dining area, and balconies, before reaching the greenhouse. Each of these spaces serves as a landmark, contributing to the mental mapping process by offering distinct characteristics that help residents orient themselves. For example, the kitchen may be associated with specific smells, colours and sounds, while the library provides a quieter environment with books as visual anchors.

These spaces ensure that residents can form a mental map of the environment, which allows them to navigate intuitively. At the final stage of this sequence, the greenhouse acts as a prominent landmark. The greenhouse integrates multiple spatial elements - it features an open space with a visible upper ceiling, and all floors are visible, creating a strong visual anchor that makes it a whole. Additionally, the greenhouse functions as a transitional element, intuitively guiding residents toward the outside environment. Its design - with natural light, greenery, and an open connection to outdoor spaces - creates a gradual and seamless transition, reinforcing spatial awareness and orientation.

By integrating distinct, recognizable spaces and a clear hierarchy, the Zuidoever building enhances mental mapping, which supports residents in their navigation and spatial awareness.

Figure 18
An illustration of wayfinding/mental mapping, where each location has a view



A picture of the greenhouse as a cohesive whole

Bringing personal belongings

Spatial navigation efficiency depends on the resident's ability to immediately recognize where they are going (Wiener & Pazzaglia, 2021). The King's Fund (2014) assessment tool addresses dementia-friendliness environments, recommending that private bedrooms and bedroom doors be highly distinguishable to facilitate recognition. But not every door is distinctive. In rooms where the residents have nothing to do, the door is covered with the same material as the wall. Nolan et al. (2002) recommend making these highly distinguishable by memory boxes containing pictures and other personal belongings. This is particularly important, as moving from a familiar home to a care home can be challenging for elderly individuals. Adjusting to a new setting can be especially difficult for elderly individuals. In order to feel at home, it requires a sense of familiarity with the environment (Van Hoof et al., 2016).

Similar strategies have been implemented in hospitals, where increased personalization has been shown to improve well-being and promote faster recovery (Van Doesum, 2024). Therefore, allowing individuals to bring personal belongings to a care home and designing environments that consider these needs can significantly enhance their well-being and support their adjustment to a new setting.

To achieve psychological well-being, positive social interactions are essential (Dröes et al., 2016; Kitwood & Bredin, 1992; Lawton, 1983). Research indicates that social interaction offers benefits for individuals with dementia (Perrin, 1997), particularly improving mood, cognition, and quality of life (Dröes et al., 2016). While the ability to interact spontaneously with others is maintained in nursing home residents with moderate dementia, as dementia progresses and cognition, communication and physical function decline, positive social interaction becomes a challenge (Mabire et al., 2016).

Figure 19

Frequency distribution of how often residents feel at home on the department

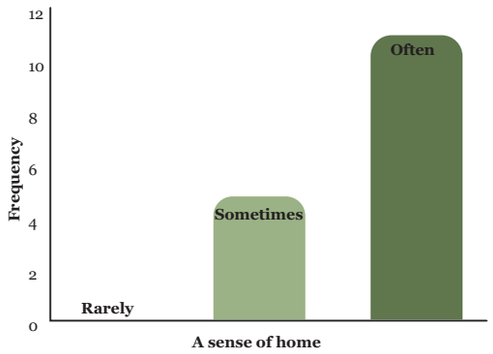


Figure 20

Frequency distribution of how often residents have social contact with other residents

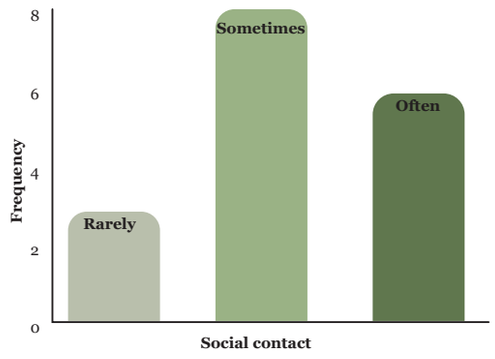


Figure 21

Frequency distribution of how often residents react positively when approached

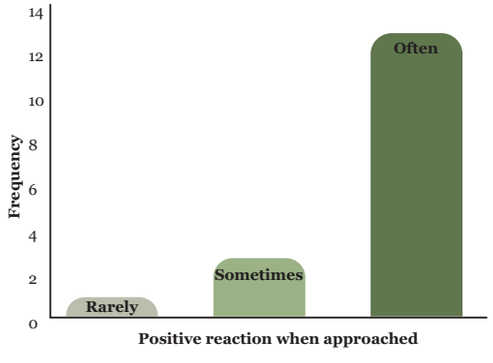


Figure 22

A picture of a resident feeling at home

Figure 23

A pitcture of social interaction between residents

Figure 24

A pitcture of a compass of a mathematician

Given the importance of social interaction, the design at the Zuidoever building offers a practical example of how the physical environment can support this. At Zuidoever, elderly residents can place personal belongings next to their doors to recognize their room and make them feel more at home (Van Hoof et al., 2016) - serves as an example of fostering positive social interactions. For instance, one resident placed a compass by their door (see figure 24), which created interactions with other residents who asked about the significance of the compass according to the manager of Zuidoever. Unlike a simple photo on the door, personal belongings with unique stories can promote social interaction, enhancing residents' sense of community and belonging.

Research conducted at Zuidoever reveals that, out of sixteen responses, eleven residents reported often feeling at home in the department (see figure 19), further illustrating the role of design in bringing personal belongings. However, up to now, the study did not include a control group, meaning there is no reference point for comparison. As a result, no formal tests have been conducted, and it remains unclear whether employees' enthusiasm can be attributed to greenery or to other factors.

These findings highlight the importance of orientation in dementia-friendly environments. Differentiation between spaces, the use of landmarks, and the incorporation of personal belongings all play a crucial role in helping individuals with dementia navigate their surroundings with greater ease. Additionally, bringing personal belongings can support social interaction, positively influencing mood, cognition, and quality of life. The benefit of bringing personal belongings is that it supports social interaction, which is beneficial for their mood, cognition, and quality of life (Dröes et al., 2016), and it can give the resident the feeling of being at home (Van Hoof et al., 2016).

The use of colours and materials

When colours are perceived, a related feeling or emotion is generated in the brain, which is called ‘colour emotion’ (Yildirim et al., 2011). The human eye perceives colour as a stimulus in the form of light, and the brain continues to process this perception, resulting in feelings and emotions being evoked (Billmeyer & Saltzman, 1981). The wavelength of a colour determines its hue or gradation - shorter wavelengths correspond to ‘cool’ colours, with violet having the shortest wavelength, followed by blue. Conversely, longer wavelengths are associated with ‘warm’ colours, with red having the longest wavelength, followed by orange (Yildirim et al., 2011).

Several studies found a relationship between colour and emotion (Levy, 1984). Cool colours were reported to generate ‘calm feelings,’ such as relaxation from blue and calmness from purple (Yildirim et al., 2011). Experimental research has shown that cool colours, blue and green, seem to have a relaxing effect, making an interior seem peaceful and generating increased perception of spaciousness.

However, a number of studies failed to find a significant effect of colour on emotional states or moods (Caldwell & Jones, 1985; Ainsworth et al., 1993). Others suggest that mood responses to colour are more complex than simply stating that red is stimulating and blue is calming. Nevertheless, architects should carefully consider the use of colour in healthcare design and practice, as colours can generate emotions, influence behaviour, and affect physiological responses (Dijkstra et al., 2008).

An alternative to using colours is to use natural elements, such as wood. The comfort of the human body expired from wood, along with its visual effects, tactile sensations, and artistic value, are key elements in modern interior design. In addition, wood has both the physical properties of easy processing and the tactility of its tender texture, which can help create a physical environmental atmosphere in interior design. Using wood in interior design can have its effects in human physiological and psychological comfort. Wood with high lightness creates a bright, clean, and beautiful impression, while the lightness is decreased by colourants, resulting in a more steady, deep, and elegant appearance. Furthermore, low chroma woods make individuals feel simple but elegant, messy and calm, while high chroma woods make individuals feel lush, exciting and luxurious (C. Lin, 2015). Also, wood can absorb ultraviolet light to reduce harmful radiation to individuals, and it can reflect infrared rays to provide warmth (Shen, 2009). Wood is characterised by diffuse reflectance and fine luster. Luster of wood refers to the brightness of the light reflection on the wood, and is related to tree species, wood structure characteristics, and the angle of reflection of the light beam on extracts and sediments, the cut surface of the wood and other factors. When users want to relax and release pressure at home, light-coloured wood with a soft natural texture is preferable and exquisite wood textures for interior decoration, such as birch, beech and maple (C. Lin, 2015). In general, individuals have a positive attitude toward wood and perceive it as a natural material that provides a sense of comfort, relaxation, and warmth (Rice et al., 2006; Burnard & Kutnar, 2015; Watchman et al., 2017). Also, the yellow-red hue of wood is associated with warmth, while the knots create a natural and rustic look (Rice et al., 2006). At Zuidoever, natural elements such as wood have been used in the interior, see figure 25.

Figure 25
A selected overview of different types of wood used in Zuidoever

A picture of wood on the wall in Zuidoever

Figure 26
Pictures of a hospital interior design and its colour palette

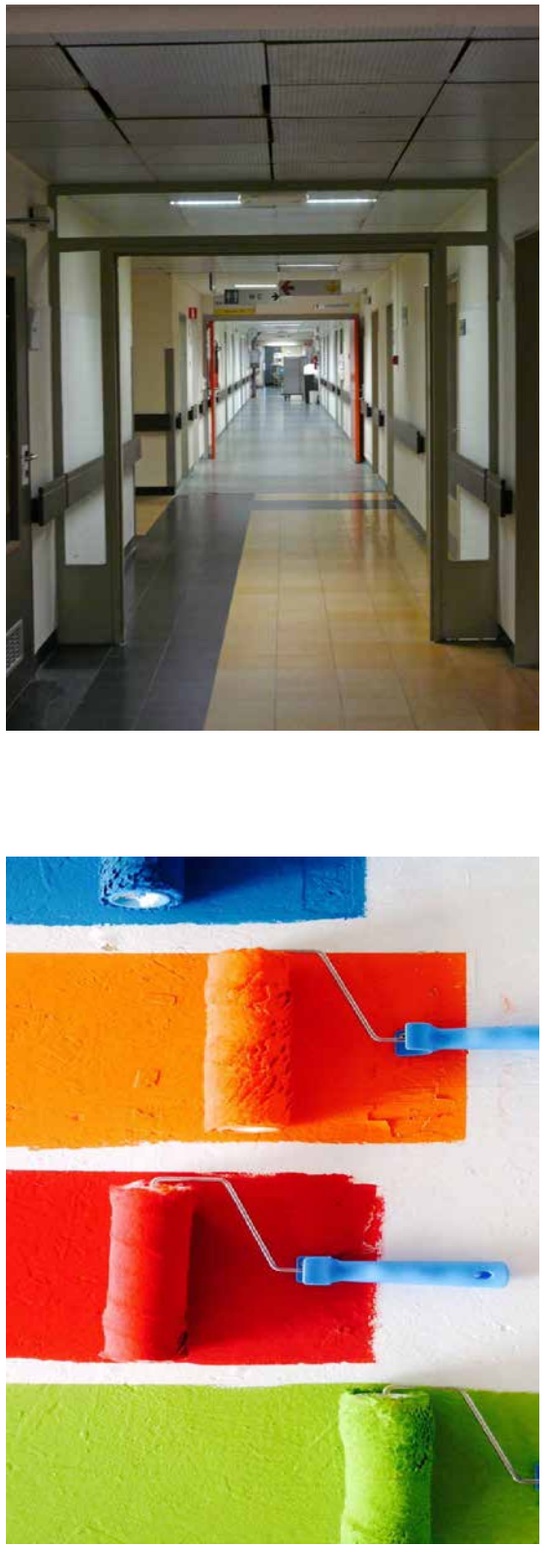
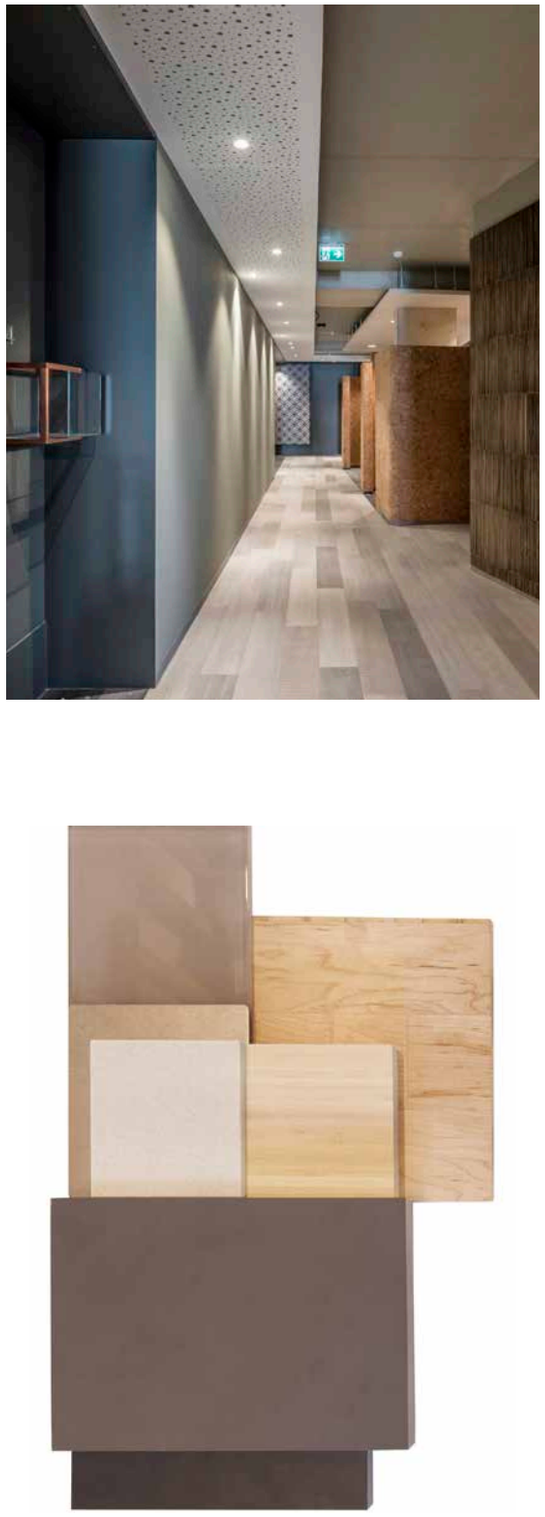


Figure 27
Pictures of a home like interior design with colours adjusted accordingly and its colour palette



For example, Sakuragawa et al. (2007) investigated the effects of contact with different materials, including wood, plastic and aluminium, using subjective ratings and blood pressure measurements as indicators of physiological stress responses. They found that contact with wood elicited feelings of safety and comfort, as well as coarse and natural sensations. Moreover, individuals have a preference for materials with distinct tactile qualities, particularly wood. The results showed that contact with wood did not increase blood pressure. In contrast, contact with aluminum or cold acrylic plastic elicited feelings of artificiality, danger, and discomfort, along with increased systolic blood pressure.

In addition to natural elements, grey is a natural colour used in the Zuidoever building, which is the opposite of white, to distance it from a hospital atmosphere (see figure 27). Grey is a versatile and sophisticated colour that can bring a classic and elegant touch to interior design. Warm greys, in particular, create a vibrant and inviting atmosphere when they are paired with other warm colours. Combining warm grey with complementary tones can result in a space that is harmonious and visually appealing. Grey has a balanced and calming effect, and it allows the other elements in the room to stand out. Whether used to dominate or accent, grey adds depth and sophistication to the overall design.

Figure 28
A picture of the interior design using wood and grey in Zuidoever

When it comes to choosing a colour palette, a combination of grey with pastel or neutral shades can create a room that is both captivating and memorable (Enwin et al., 2023).

It is essential to approach colour as part of a cohesive whole. The interaction between different colours and their nuances plays a crucial role in design. Not every shade of red complements wooden elements, but a warmer tone may be more suitable than a lighter red in certain spaces. The appropriateness of a colour depends on the overall palette and its interaction with other colours in the environment. At Zuidoever, the architects have thoughtfully designed the interior. They have created a balance between natural colours and elements.

In conclusion, integrating green spaces and natural elements into design are shown to facilitate relaxation, stress reduction, and improvement in mood as well as creativity (Tsunetsugu et al., 2009; Tyrväinen et al., 2013). At Zuidoever, natural elements such as wood are incorporated into the interior, contributing to a warm and comforting environment. This is particularly important for individuals with dementia, as a familiar and calming environment can help them feel more at ease. However, this study only looked at wood and grey. Therefore, it is important for future research to explore alternative natural colours and elements, such as bamboo or brown. This could lead to new insights into how architects can make use of colours in a meaningful way.

Figure 29
A picture of using grey in Zuidoever

06

Exposure to nature

Attention Restoration Theory
- **Psycho-environmental characteristics of resorative environments**

Stres Reduction Theory

A healing garden
- **Stimulating the senses in the healing garden**

Wilson (1984) defined biophilia as an innate tendency to focus on life and living organisms. This could be one reason why individuals spend time in nature, because they have an innate tendency to do so. Being in nature could have beneficial effects for individuals with Alzheimer's. For example, individuals with Alzheimer's who have had access to a healing garden provide a sense of nature, weather and plants, which reduces fear and promotes security. These residents enjoyed being outdoors and a relaxing effect on their health and well-being was observed in terms of a reduction in anxiety and aggression (Zeisel, 2001).

A large body of research has shown that positive experiences in nature can trigger beneficial psychological and physiological responses, such as lower blood pressure and heart rate, reduced muscle tone, better concentration, lower stress hormone levels, and improved creative problem-solving skills (Hansmann et al., 2007; Kaplan, 1995; Beyer et al., 2014; Elsadek et al., 2019; Tyrväinen et al., 2013; Lin et al., 2019). It has been found that more frequent contact with green spaces brings benefits and that natural distance affects the frequency of use, with greater distance being associated with less frequent use (Lin et al., 2019; Astell-Burt et al., 2014). Both passive and active engagement with nature outdoors have been found to increase positive affect, reduce psychophysiological arousal, and renew the ability to perform tasks that require concentration (Bringslimark et al., 2009). Bringslimark et al. (2009) used the term 'psychological benefits' in this context, a broad term encompassing changes in cognition, emotion, and physiology that are positively valued and/or enhance effectiveness and adaptability, as well as valued outcomes in which psychological processes may play a mediating role, such as increased social interaction and reduced experienced and poor health symptoms (Bringslimark et al., 2009). Early exposure to green spaces has also been shown to reduce the risk of later psychiatric disorders (Engemann et al., 2019).

Furthermore, having green and blue spaces (water) around where individuals live has been shown to be negatively associated with mental disorders (De Vries et al., 2016). While fewer studies focus on long-term care settings, research indicates that access to greenery in nursing homes is associated with improvements in residents' overall health (Dahlkvist et al., 2016), quality of life (Edwards et al., 2012; Artmann et al., 2017), and mental well-being (Dahlkvist et al., 2019; White et al., 2017). Thus, according to this, nature interventions have positive effects on mental health (Hubbard et al., 2020; Tillmann et al., 2018; Trostrup et al., 2019).

A picture of outdoor greenery

Attention restoration theory

The effects of exposure to nature on restorative benefits have been studied in various ways, with two main theories coming from an environmental psychology perspective: attention recovery theory (ART) and stress reduction theory (SRT). Kaplan (1995) stated with the ART that directed attention requires effort, maintaining focus, is under voluntary control, is sensitive to fatigue, and controls distraction through the use of inhibition.

Prolonged mental effort can lead to directed attention fatigue, which impairs effectiveness and increases the likelihood of human error. Restoring effectiveness is dependent on recovering from directed attentional fatigue. While sleep is one effective method of recovery, it is insufficient.

An alternative way to resist fatigue is through a form of attention that requires no effort. When an individual engages in involuntary attention, directed attention has the opportunity to rest. This effortless attention is also known as fascination. ART proposes that natural environments provide a 'soft fascination' that allows individuals to focus effortlessly (Kaplan, 1995; R. Kaplan & S. Kaplan, 1990). The ability of nature to moderately hold someone's attention while leaving sufficient headspace for reflection allows for the 'essential mental housekeeping' (Kaplan, 1993, p. 48) necessary to deal with lingering, unresolved thoughts that might otherwise be a drain on attentional resources (Basu et al., 2018). This modest attentional hold is described by ART as 'soft' fascination. In contrast, 'hard' fascination fully engages the mind, leaving little room for contemplation (Basu et al., 2018). Environments and activities that rely on soft fascination help to restore attention by leaving enough mental space to reflect on the thoughts that often run through the mind, such as a brief respite looking out the window. It may be easier to recognize and process such thoughts with soft fascinating stimuli (Basu et al., 2018).

Individuals with dementia often experience impairments in perception, thought content, mood, or behaviour. Therefore, they could positively benefit from a green environment. The concept of soft fascination in nature provides them with the opportunity for contemplation, which may help reduce anxiety, worrying, and ultimately improve their overall well-being. Furthermore, employees at Zuidoever may also experience stress in their work. The presence of indoor greenery and easy access to the garden can provide restorative benefits, helping them to recover from mental fatigue.

Psycho-environmental characteristics of restorative environments

There are four psycho-environmental characteristics of restorative environments to reduce anxiety and worrying of residents. Firstly, being away from daily activities. For extended restorative opportunities, natural environments are often the preferred destinations. The seaside, mountains, lakes, streams, forests, and meadows are all idyllic places for the sense of 'getting away.' Yet for many individuals in the urban context, the opportunity to get away to such destinations is not an option. However, the environment does not have to be distant for the feeling of being away. Thus, natural environments that are easily accessible provide an important resource for resting directed attention (S. Kaplan, 1995).

Secondly, fascination. Nature is certainly well endowed with fascinating objects and offers many processes that individuals find captivating. Many of the fascinations of the natural environment can be classified as 'soft' fascination: clouds, snow patterns, the movement of leaves in the breeze-these easily hold the attention, but in a low-threshold way. Attending these patterns is effortless, and they leave ample opportunity to reflect (S. Kaplan, 1995).

Thirdly, extent. In the distant wilderness, extent comes easily. However, extent does not involve large tracts of land. Even a relatively small area can be used to give a sense of extent. Trails and paths can be designed to make small areas seem much larger. Miniaturization is another way to create a sense of being in another world, even though the area itself is not extensive. Japanese gardens sometimes combine these two devices to convey a sense of both extensiveness and connectedness. Extent also works on a more conceptual level. For example, environments that include historical artifacts can promote a sense of connection to past eras and past environments, and thus to a larger world (S. Kaplan, 1995).

Fourthly, compatibility. The natural environment is experienced as particularly compatible. It is as if there is a special resonance between the natural environment and human tendencies (S. Kaplan, 1995). For many individuals, functioning in the natural environment seems to require less effort than functioning in more 'civilized' environments, even though they are much more familiar with civilized environments (Cawte, 1967; Sacks, 1987). In other words, the environment must be in line with what the resident is trying to do and what the resident would like to do (S. Kaplan, 1995).

Figure 30

An overview of the four psycho-environmental characteristics of restorative environemnts

A nearby, easily accessible natural environment cannot provide the context to fulfill all goals and purposes. But even such a setting is likely to support the inclinations of those who seek respite there (S. Kaplan, 1995). This applies to the garden at Zuidoever, as the garden may not immediately evoke a sense of being away. Nevertheless, the greenery in the garden can still foster a sense of fascination for residents. Furthermore, the garden reflects compatibility by offering various options that meet different needs: spaces to relax, social interaction, activation through activities like gardening, sensory stimulation like interacting with water features. This aligns with the concept of compatibility in natural environments.

Stress reduction theory

SRT suggests that nature's presence evokes evolutionary psychological responses related to safety and survival. As a result, exposure to nature activates the parasympathetic nervous system and helps recover from psychophysiological stress (Ulrich et al., 1991). While SRT indicates that individuals benefit most from natural environments, studies show that even unstressed individuals respond more positively to nature than to non-natural environments (Ulrich, 1983). It is possible that the residents of Zuidoever, dealing with dementia, may experience heightened stress or anxiety, possibly linked to fears of wanting to return home. Olmsted (1865) states that for those under stress, nature 'employs the mind without fatigue and yet exercises it; calms it, yet invigorates it; and through the influence of the mind upon the body, provides a sense of refreshing rest and renewal to the entire system.' Arousal theories (Berlyne, 1975; Mehrabian & Russel, 1974) suggest that recovery from excessive arousal or stress should occur more quickly in environments with low levels of arousal-enhancing features such as complexity, intensity, and motion. Supporting the arousal perspective, studies using abstract, non-environmental visuals have shown that when individuals are stressed or anxious, their preference for complexity decreases (Berlyne & Lewis, 1963; O'Leary, 1965). Since natural environments generally feature lower levels of complexity and other arousing properties compared to urban environments (Wohlwill, 1976), arousal theory suggests that nature should have comparatively restorative effects on stress.

A healing garden

A hospital healing garden is a nature-oriented space, either indoor or outdoor, designed to have therapeutic or rehabilitative benefits (Marcus & Barnes, 1999). Such a nature-oriented space can fulfil the innate human tendency to connect with living organisms. This concept is evident in the Zuidoever building, where greenery is part of the interior design, and residents have access to the outdoor garden.

The trend in the 1990s was the reintroduction of nature into the urban environment (Smith, 1998; Gardam et al., 1998). Landscape architects promoted the creation of parks and public gardens, lined streets with trees and designed indoor environments with plants, flowers and water effects (Scarfone, 1996). The aim was to make it possible to live in a healthy and recreational environment to help individuals from unhealthy stress (Barnes, 1996).

Stimulating the senses in the healing garden

The healing garden is also useful to stimulate the senses of the residents. In the healing garden, patients with severe brain damage and reduced consciousness were thought to receive sensory stimulation (Gutman, 1996) through the reticular activating system, via responses to various plant materials (Bryant, 1991; Shirtliffe, 1995). In a healing garden, various sensory experiences can enhance cognitive and emotional responses. Firstly, smell. Flowers provide opportunities for stimulation by smelling and looking. Arousal would be increased by memories associated with the sense of smell. Secondly, sight. Butterflies and insects encourage visual tracking, engaging the eyes. Thirdly, taste. Taste would be stimulated by vegetables and spices grown in the garden. Fourthly, touch. The touch of the hand would be stimulated by leaves of different species, with rough, smooth or hairy surfaces. Also, sand, ground and water would make bare feet feel stimulating. Fifthly, hearing. Natural sounds, such as water, birds, bumblebees and soil, contribute to auditory stimulation and sound orientation. The movement of bamboo and reeds in the wind, creates natural music that can stimulate the auditory senses (Söderback et al., 2004) (see figure for an illustration of the healing garden at Zuidoever).

Residents at Zuidoever have access to the garden, which positively impacts their well-being by offering a space for relaxation and sensory stimulation. The integration of greenery both indoors and outdoors provides opportunities for visual, olfactory, tactile, and auditory engagement, aligning with research on the benefits of healing gardens. By fostering a connection to nature, the garden contributes to stress reduction, cognitive engagement, and overall quality of life, making it an essential element in the design of a dementia-friendly environment.

Figure 31

Four pictures of the stimulated senses in the garden at Zuidoever

Sound

Touch

Smell

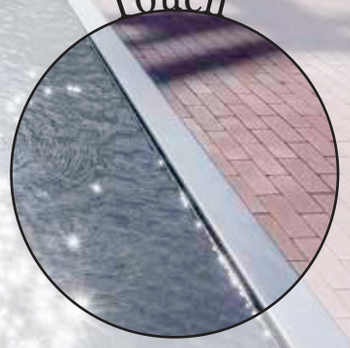
Sight

Sound

Sight

Smell

Touch



07

Indoor greenery

Stress reduction
Improvement of air
Impact of green on employees

Figure 32

Four pictures of indoor greenery in Zuidoever

Indoor greenery

Contact with nature, in any form or experience, is likely to result in positive health benefits (Xu et al., 2022). But how does it work with indoor greenery? Built environments influence our health, behaviour, and mental well-being (MacNaughton et al., 2016; Bluyssen, 2009). Incorporating indoor greenery has been shown to benefit both the physical and psychological well-being of building occupants, resulting in reduced health complaints and sick leave (Fjeld, 2000; Bringslimark et al., 2007). Indoor greenery has also been shown to reduce stress and improve the subjective well-being of individuals in built environments where individuals lack contact with nature (Bringslimark et al., 2007; Grinde & Patil, 2009). It is made clear that indoor greenery is beneficial for human beings, but how indoor greenery affects psychological performance is still unclear and needs further research (Deng & Deng, 2018). As shown in figure 32, there is a lot of indoor greenery at Zuidoever.

Stress reduction

Laboratory studies have shown that looking at plants can reduce indications of stress, such as heart rate variability and blood pressure (Choi et al., 2016; Lohr et al., 1996). Studies in healthcare (Dijkstra et al., 2008), retail (Brengman et al., 2012), and learning environments (Van Den Bogerd et al., 2021) have also shown the stress-reducing effects of plants, which is partially explained by increasing the attractiveness of the space. The visual aesthetic experience of the environment is believed to affect individual's perceptions, mood and stress levels (R. Kaplan & Kaplan, 1989; De Korte et al., 2011). The visual presence of plants may be one stress-reducing factor, as affective responses to visual stimuli perceived as aesthetic may relieve tension. Beauty has been defined as visual input that gives pleasure to the mind, so aesthetics by definition provides a positive experience. A theoretical examination of aesthetic values points to the importance of elements that reflect nature, such as complexity, choice of colour, perspective, and balance (Grinde, 1996).

Improvement of air

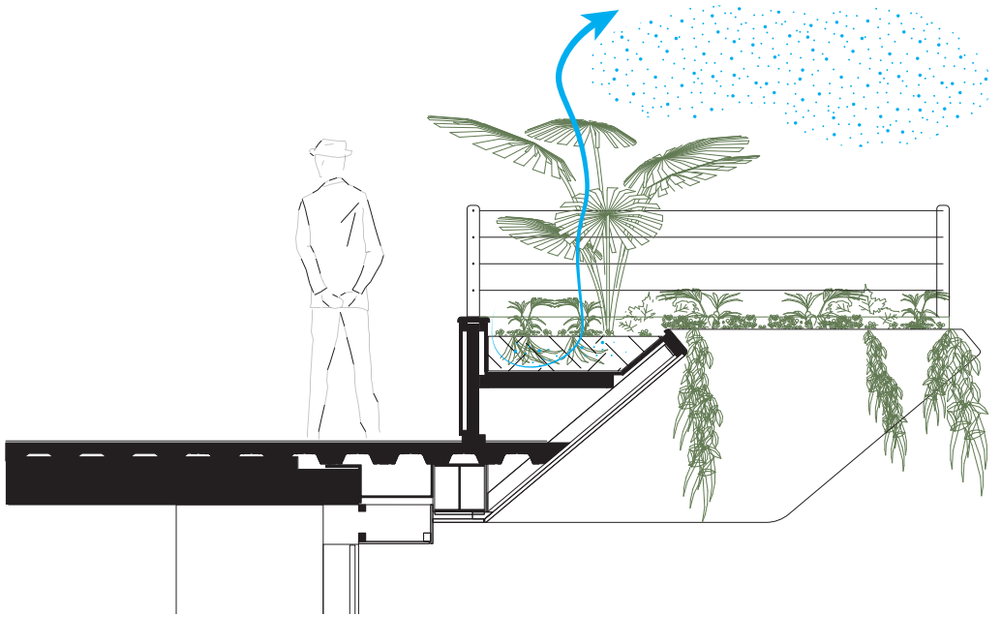
Individuals spend an average of 80% of their time indoors (World Health Organization, 2010; Orwell et al., 2004). As a result, the health risks from indoor air pollution may be greater than those from outdoor air pollution (Fjeld, 2000; Fjeld et al., 1998). Research shows that indoor environmental quality (IEQ) can play an important role in the work performance, productivity and health of residents (Bluyssen et al., 2015; Al Horr, 2016; Frontczak et al., 2011; Raanaas et al., 2010; Wyon, 2004; Kosonen & Tan, 2004). Since personal exposure to air pollutants is largely determined by the indoor environment (Franklin, 2007), it is crucial to ensure a healthy indoor environment. One effective approach is incorporating indoor greenery, as they interact with individuals in multiple ways and contribute to a healthier living environment (Deng & Deng, 2018).

Firstly, plants convert carbon dioxide (CO_2), light, and water into energy through photosynthesis. Oxygen (O_2) is released as a by-product. Oxygen is essential for the survival of other organisms, and these processes make up the earth's carton and oxygen cycles (Messinger & Renger, 2008). Furthermore, the photoelectric effect (photosynthesis in leaf tips) can produce negative air ions (NAIs), which play an important role to play in the absorption of dust, cleaning the air, and the improvement of the environment of human health (Perez et al., 2013; Wu & Lee, 2004; Yan et al., 2015). Given these benefits, incorporating indoor greenery into living spaces can enhance air quality and comfort (Deng & Deng, 2018).

Secondly, indoor greenery also contributes to humidity regulation through transpiration, the process by which water moves from the plant roots to leaves, where it is converted into water vapor and released into the atmosphere. This natural mechanism makes plants useful for the regulation of relative humidity in indoor environments (Kichah et al., 2012). See figure 33 for a scheme of this process.

Figure 33

An illustration of the indoor greenery in Zuidoever, which helps to regulate humidity through transpiration. Water moves from the plant's roots to its leaves. The leaves convert the water from the roots into water vapor and release it into the atmosphere to help regulate humidity.



Thirdly, new furniture, decorations, and household products can cause high levels of volatile organic chemicals (VOCs) and other chemical pollutants inside the home (Deng & Deng, 2018). Some VOCs are toxic and some, such as formaldehyde and benzene, can cause skin irritation and dry throat at low concentrations. Conversely, high concentrations of VOCs have been shown to be carcinogenic (Deng & Deng, 2018). The ability of plants to remove VOCs depends on several factors, such as plant species, pollution, pollutant concentration, exposure duration, size of the room, and level of light (Deng & Deng, 2018). Xu et al. (2011) suggest that the root zone, rhizosphere micro-organisms and adsorption of plant shoots play a crucial role in formaldehyde removal.

Figure 34

A picture of the greenhouse during the construction of Zuidoever

Figure 35

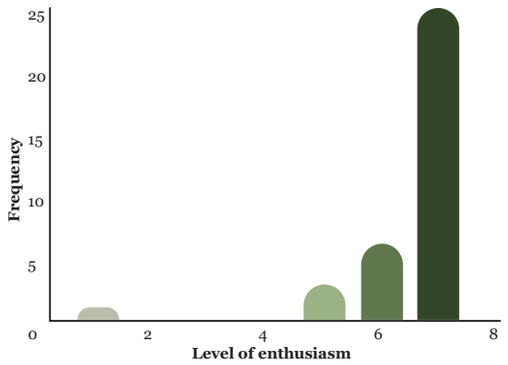
A picture of the greenhouse after several years

Additionally, environmental conditions also play an important role in the effectiveness of indoor plants in removing pollutants. It has been shown that 21 °C is the correct temperature for maximum removal of formaldehyde from potted plants (Sawada & Oyabu, 2007). The effectiveness of plants is also influenced by light exposure (Kil et al., 2008). Thus, ensuring adequate lighting indoors can maximise the air-purifying effects of plants.

These findings emphasize the importance of integrating green into dementia-friendly environments. Research indicates that access to greenery in nursing homes is associated with improvements in residents' overall health (Dahlkvist et al., 2016), quality of life (Edwards et al., 2012; Artmann et al., 2017), and mental well-being (Dahlkvist et al., 2019; White et al., 2017). The effects of exposure to nature on restorative benefits can be explained by the attention restoration theory (Kaplan, 1995) and stress reduction theory (Ulrich et al., 1991). Furthermore, healing gardens can offer therapeutic or rehabilitative benefits (Marcus & Barnes, 1999), while indoor greenery contribute to stress reduction and improve the subjective well-being of individuals in built environments where individuals lack contact with nature (Bringslimark et al., 2007; Grinde & Patil, 2009), and to improve the air. Given these positive effects, incorporating green elements should be a key consideration in dementia care design.

Figure 36

Frequency distribution of how enthusiastic employees are



Impact of green on employees

Greenery is a valuable asset to the environment of the urban workplace (Popov et al., 2023). Natural stimuli, such as indoor plants, nature walks and/or window views of outdoor greenery, can have a positive effect on employees by reducing stress (Lottrup et al., 2012), improving mood (Barton et al., 2009), stress recovery (Ulrich el al., 1991) and psychophysiological status (Chang & Cheng, 2005), increasing job satisfaction (Dravigne et al., 2008), attention and memory at work (Raanaas et al., 2011).

Using plants as design elements in the work brings nature indoors, creating inviting spaces that can reduce stress and increase overall well-being, resulting in healthier work and living environments. Interaction with plants can change human attitudes, behaviours and physiological responses. It can also reduce absenteeism, increase productivity, and improve individuals overall satisfaction and happiness (Gray & Birrell, 2014; Lohr et al., 1996; Shoemaker et al., 1992; Relf, 1990). ART and SRT provide frameworks for understanding why natural elements positively affect human functioning (see ART and SRT chapter).

Research at Zuidoever indicates that employees are enthusiastic to work there. The study used a scale from one to seven, with one being the lowest and seven the highest score. Out of 36 respondents, 25 employees rated their job satisfaction at the highest level, indicating strong enthusiasm for their work (see figure 36). The average rating across all responses was 6.47, which is close to the maximum score of seven.

Among the respondents, 12 out of 18 employees reported working 32 hours per week. Additionally, 30 out of the 36 employees stated that they had not left earlier due to health problems in the past seven days. However, up to now, the study did not include a control group, meaning there is no reference point for comparison. As a result, no formal tests have been conducted, and it remains unclear whether employees' enthusiasm can be attributed to greenery or to other factors.

A picture of an employee working in the kitchen in Zuidoever

08

What does work and what does not?
- **Small scale units**
- **Outdoor spaces**
- **Sensory stimulation**
  - **A multi-sensory environment**

Traditional care homes vs. dementia-friendly evnironments

Traditionally, a medical and nursing approach has been used in residential care for individuals with dementia (De Rooij et al., 2012). Traditional facilities follow general building design guidelines, whereas non-traditional facilities aim to create a dementia-friendly environment (Richards et al., 2015). Traditional institutions are criticised for the emphasis on physical care needs over non-pharmacological, social and environmental care strategies (Reimer et al., 2004; Ronch, 2004), this can result in monotony of routine, starkness of the physical environment and few meaningful activities (Cohen-Mansfield, 2005; Reimer et al., 2004). In contrast, non-traditional facilities feature: open floors, accessible garden areas, physical connections between indoor and outdoor environments, a minimisation of visible clinical elements, and home-like, age- and generation-appropriate furnishings (Topo et al., 2012) to promote stimulation (Richards et al., 2015).

What does work and what does not work?

Small scale units

Residents of small scale units have been compared to residents in traditional wards, and they score better on the relational domains of quality of life, including caregiver relationships, social relations, social isolations, and having something to do (De Rooij et al., 2012). Small scale living settings have a more home-like character, with smaller groups having a different vision of care and the organizational structure. These settings are more likely to foster increased contact between residents, family members, and professional caregivers compared to traditional settings. This, in turn, may result in a relatively higher level of social engagement in small-scale facilities than in traditional dementia care units (De Rooij et al., 2012).

Furthermore, research indicates that social interaction offers benefits for individuals with dementia (Perrin, 1997), particularly improving mood, cognition, and quality of life (Dröes et al., 2016). Given the importance of social interaction, this increased contact in small-scale living settings is a well-thought dementia-friendly architectural design element.

Studies in the past have also shown that residents in small-scale livings exhibit greater interest in their surroundings (Reimer et al., 2004), form stronger relationships with others in the nursing home (Kane et al., 2007), and seem to be more socially involved in general (Te Boekhorst et al., 2009). Since the focus in small-scale facilities is on enabling residents to maintain lifestyles similar as they were used to in their own homes, it is also plausible that residents in these settings score higher in terms of having something to do (De Rooij et al., 2012).

Furthermore, small-scale, home-like nursing homes may provide a better person-environment fit for individuals with dementia (Lawton, 1982) because they promote activity engagement and enhance quality of life (Smit et al., 2015). To support positive outcomes, there must be a match between individuals' needs, abilities, and the demands of the environment. Examples of positive outcomes in small-scale settings are increased well-being, better nutrition, reduced medication use, and more person-centered care (Bortnick, 2017; Brownie & Nancarrow, 2013; Geboy, 2009). However, as dementia progresses and environmental demands exceed functional abilities, residents may experience a decline in person-environment fit. This results in lower activity engagement (Iwarsson, 2005).

Outdoor spaces

Traditional care homes do not always have outdoor spaces or easy access to them, which can result in residents spending the entire day indoors. This lack of outdoor exposure does not contribute to their well-being. Fresh air is beneficial for everyone, including individuals with dementia. In contrast, non-traditional care homes integrate natural environments and elements into indoor spaces, providing individuals - especially those who may not always be able to go outside - the opportunity to experience the positive effects of nature. Engagement with outdoor natural environments has been shown to have significant positive physiological and psychological health benefits. This suggests that incorporating natural elements into indoor spaces can be an effective way to increase engagement with nature and benefiting individuals, such as improved task performance, better health, reduced stress (Bringslimark et al., 2009; Shibata & Suzuki, 2002), and stimulating the senses.

Figure 38

A picture of residents going outside to enjoy their garden

Figure 37

A picture of a home like character

Sensory stimulation

The sensory and emotional areas of the brain remain relatively unaffected despite the increasing loss of cognitive function in individuals with dementia. As a result, sensory experiences in everyday life can continue to provide pleasure and encourage active responses that contribute to the well-being of the individual (Bowlby, 1993). In addition, sensory input stimulates brain activity, which in turn helps to improve functions and performance such as dressing and self-care in individuals with dementia (Jakob & Collier, 2017). However, individuals with dementia are at risk of sensory deprivation due to the age-related sensory decline and, more importantly, due to their increasing dependence on caregivers and decreasing ability to initiate activities that stimulate their senses (Vozzella, 2007).

On the other hand, sensory overstimulation can also be problematic in care homes, where common areas are noisy, with too much going on and lack of quiet places for retreat (Jakob & Collier, 2017). If there is too much noise or other people in the room, there is too much arousal which can increase agitation (Onrust Als Symptoom Van Dementie, n.d.). This can also lead to sensory deprivation as the person with dementia finds it difficult to understand and process the information they are receiving. In other words, sensory overstimulation can lead to withdrawal and reduced brain activity (Bowlby, 1993). Symptoms of sensory deprivation include apathy, reduced alertness, reduced interaction, depression, and self-stimulatory behaviours such as banging, clapping, rocking, and repetitive verbalizations (Vozzella, 2007). Additionally, challenging behaviour, such as becoming agitated can be triggered when overstimulated (Jakob & Collier, 2017). These negative effects highlight the importance of creating a multi-sensory environment (MSE) tailored to the needs of the individual (Jakob & Collier, 2017).

This is especially important in the later stages of dementia when cognitive abilities decline, and non-verbal communication becomes more effective (Vozzella, 2007). Providing an appropriate multi-sensory environment enhances the quality of life for individuals with dementia. It helps them feel better, calmer, more alert, and more engaged while also improving functions such as self-care. Additionally, it benefits caregivers by making it easier for them to establish and maintain connections, ultimately reducing the level of care required (Jakob & Collier, 2017).

Research at Zuidoever reveals that six out of the seventeen respondents, six residents are sometimes restless (see figure 39 for an overview).

Figure 39
Frequency distribution of how often residents are restless

Figure 40
Frequency distribution of how often residents are calling

Research also shows that out of sixteen respondents, seven residents are never or rarely calling (see figure 40 for an overview). However, up to now, the study did not include a control group, meaning there is no reference point for comparison. As a result, no formal tests have been conducted, and it remains unclear whether employees' enthusiasm can be attributed to greenery or to other factors.

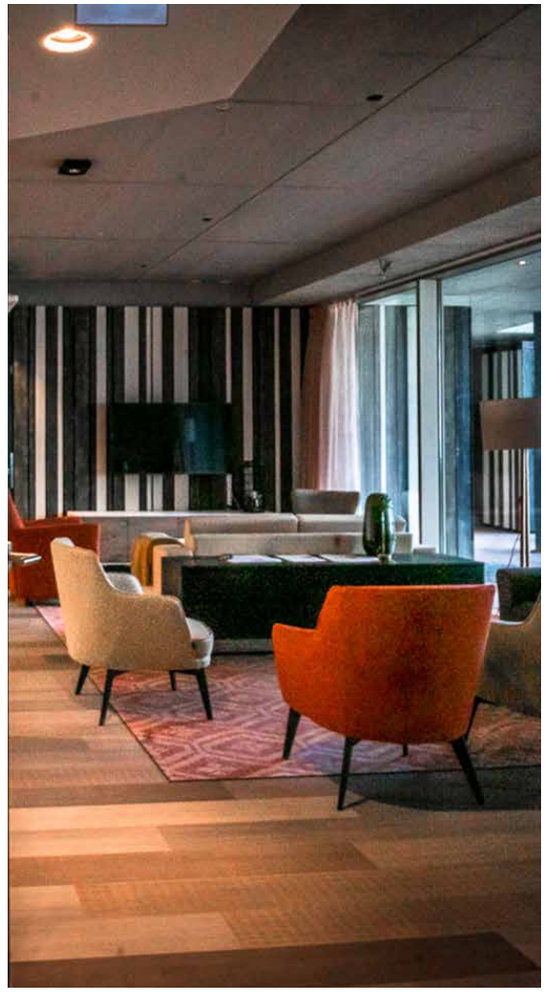
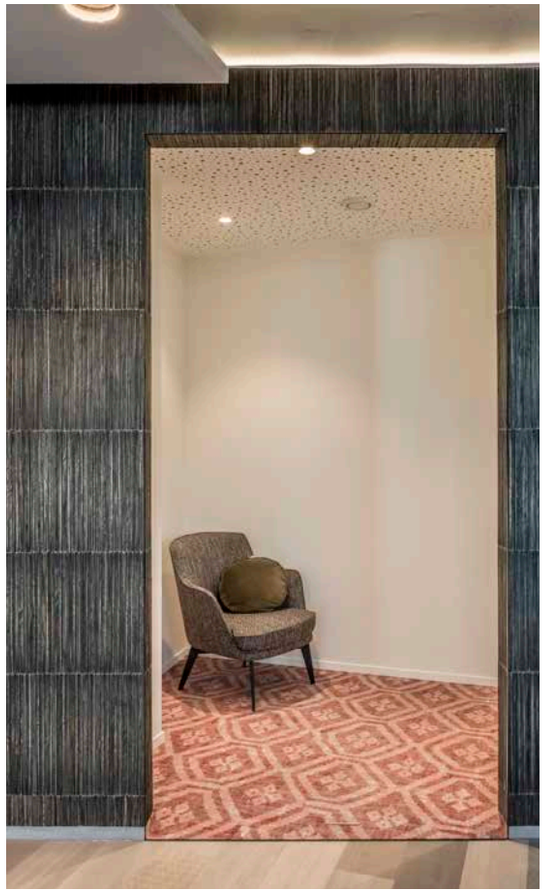


Figure 41
Pictures of the opportunities for residents to retreat in Zuidoever

Figure 42
Impressions of Zuidoever



A multi-sensory environment. While several architectural design elements, such as daylight and indoor greenery, have been proven to be dementia-friendly, they are not the only architectural design elements to consider in a dementia-friendly environment. Another important aspect is the implementation of a multi-sensory environment (MSE) to provide a balance between overstimulation and relaxation. The concept of an MSE has already been introduced in dementia care homes and in Zuidoever. It is a designated space designed to provide a stress-free, positive environment offering sensory enriched experiences and activities - either stimulating or relaxing - to enhance comfort, wellbeing and concentration. With limited or no need for higher cognitive processing, MSE engages the senses of sight, touch, hearing, smell, taste and movement (Jakob & Collier, 2017).

Textiles can play a key role in tactile stimulation. Tactile cushions, specifically designed for individuals with dementia, offer both tactile and visual experiences through the use of ribbons, buttons, zippers, different textures, and embroidery. These cushions have been found to provide soothing hand occupation as well as sensory stimulation (Jakob & Collier, 2017).

To maximise the benefits of an MSE for individuals with dementia and to support the daily work of their carers and caregivers, several key principles have been considered. First, the environment must foster a sense of *comfort and safety*. A soft, warm and intimate atmosphere should be provided in a closed and quiet space with minimal or no capacity for disturbance or distraction (Jakob & Collier, 2017). A sensory experience at a low level activates the parasympathetic nervous system, including a state of calm (Poza et al. 2012), as this helps to reduce stress and anxiety. This enables individuals with dementia to relax and focus on activities (Jakob & Collier, 2017). At Zuidoever, there are several niches where residents can retreat when the environment becomes too busy. Although these niches are not completely closed, they provide a quieter environment than the main living areas, thereby supporting a calm and secure retreat.

Second, in order to promote comfort and a sense of feeling secure, sensory experiences must be within the individual's range of understanding and coherent to all senses (Zeisel, 2013). An MSE should offer *familiar, personal and meaningful experiences* tailored to the individual's life and stage of dementia (Jakob & Collier, 2017). Sensory activities should reflect the interests and abilities, which motivates residents to participate and engage in activities (Bowlby, 1993; Vozzella, 2007). At Zuidoever, residents are encouraged to bring their own books into these niches to make them feel more at home which reflects their interests and abilities.

Third, to maximise the desired effect, an MSE should engage all primary senses, since sensory perception varies from person to person and for some individuals stronger in one area than another. In addition, some senses may decline faster than others with age and progressive dementia. Therefore, carers can better respond to individual preferences, needs and abilities by providing *multi-sensory experiences*. It offers the person with dementia more ways to connect with and enjoy their environment and/or activities. Because the world is highly multi-sensory, influencing our perceptions and informing our memories, the person with dementia may find it easier to relate to environments and activities that combine sensory input on multiple levels (Jakob & Collier, 2017).

Fourth, a sensory-enriched space in a residential home provides an environment in which several groups can enjoy the environment. Not only residents enjoy the environment, but also visitors, carers and care staff. It should therefore support both *stimulating* or *relaxing* experiences. For individuals who lack adequate or appropriate sensory input, an MSE provides the opportunity for focused and controlled active stimulation, where the type and intensity of the stimulus can be tailored to the specific needs of the individual. This is particularly important in the later stages of dementia when stronger sensory cues are needed to help individuals perform better (Collier et al., 2010). Conversely, individuals who feel overwhelmed by the ongoing activities in a care home and other residents, a dedicated sensory room can serve as a place for retreat, quiet and calming activities (Jakob & Collier, 2017).

Fifth, the environment should provide opportunities to make manageable choices. Individuals with dementia should be allowed and encouraged to *control and interact* with their environment to the extent of their abilities. This includes changing the amount and type of stimulating experience received and exploration of the space or intervention at their own pace. Encouragement and empowerment of the individuals with dementia to play a more active role increases confidence and feelings of self-worth (Valenzuela, 2008), provides the feeling of personal competence and control (Bowlby, 1993), and is considered to be a more effective method of care than passive (receptive) interventions (Sánchez et al., 2016).

Sixth, an MSE should be ergonomically designed and arranged to accommodate older individuals with physical limitations (Jakob & Collier, 2017). To preserve the dignity and respect of individuals with dementia, the environment should be designed with mature, *age-appropriate and usable* furnishings and equipment, avoiding elements that may feel juvenile or childish (Bowlby, 1993; Hope & Waterman, 2004).

Finally, a multi-sensory room in a residential home should be *flexible* and *adaptable*, providing opportunities for a range of activities, and cost effective to implement, overcoming economic barriers. This ensures that MSEs can be widely used to improve the quality of life for individuals with dementia and those who care for them (Jakob & Collier, 2017).

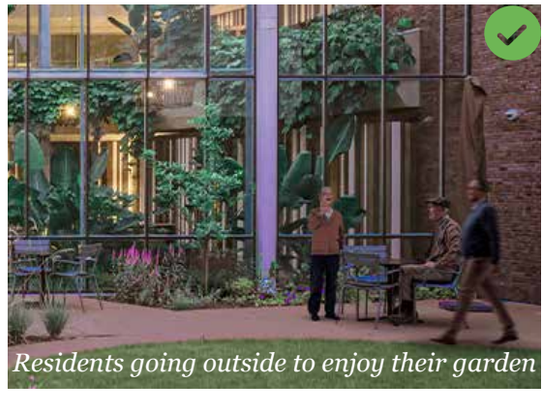

A hospital character with long (dead-end) corridors and closed doors


A home-like character care home


A large group with less social interaction


Social interaction between an employee and a resident


A resident being stuck inside


Residents going outside to enjoy their garden


An overstimulated room in a care home with no place to retreat


A place to retreat for relaxation

Architects and psychologists

The importance of interdisciplinary collaboration between psychologists and architects is underappreciated. There are several reasons why psychologists and architects must collaborate. The first reason is that psychologists understand and have insights into how users of a building react to their environment. Psychologists know that environmental factors, such as use of colours or daylight, can influence well-being and behaviour. For example, it has been proven that every individual needs daylight (Hanford & Figueiro, 2013). If an architect designs a building without sufficient daylight, it can negatively impact the user. Therefore, architects can use these psychological insights to design buildings and spaces that are not only functional but also promote the well-being of the users.

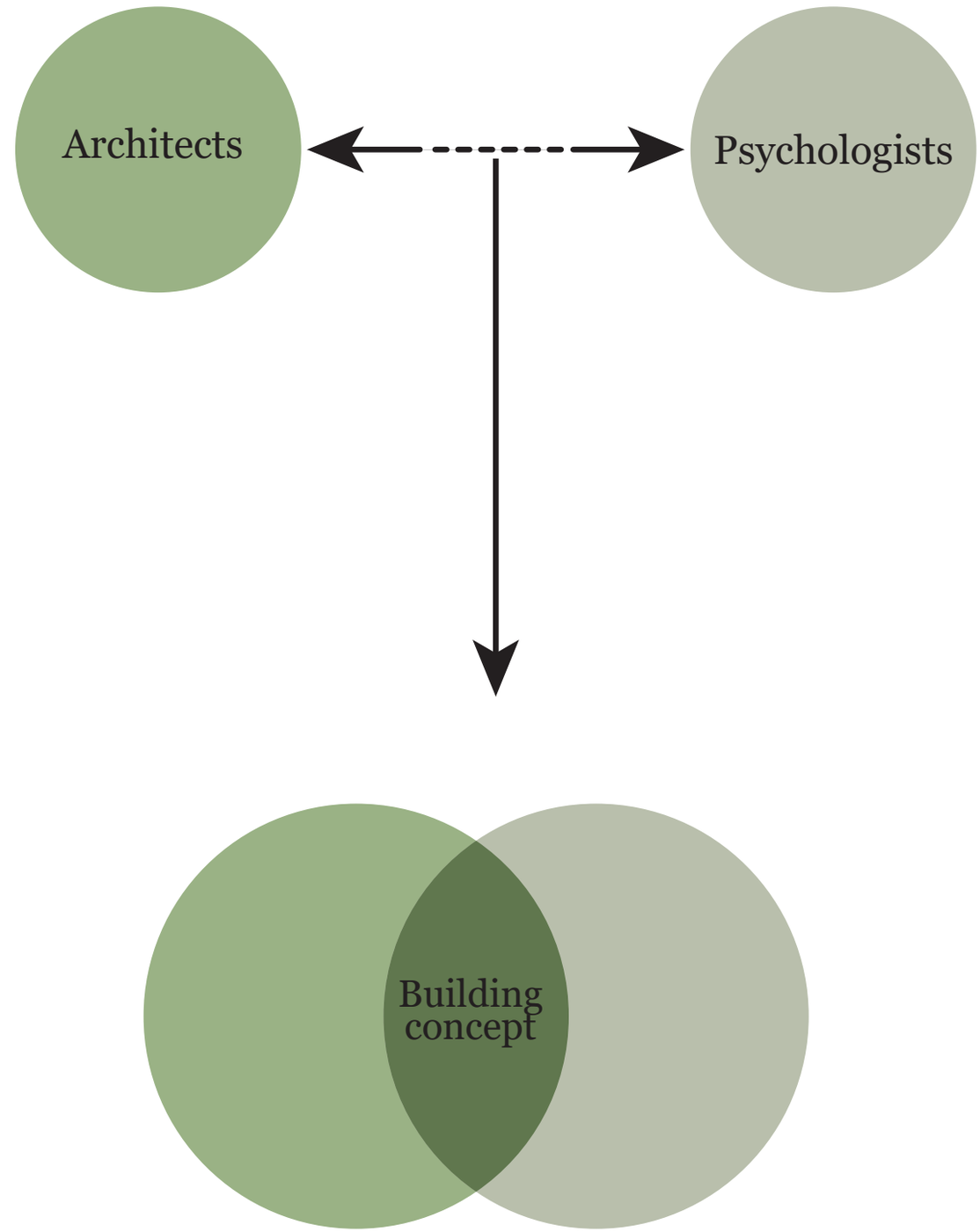
Evans et al. (1996) conducted research on architectural depth and psychological distress. The results show that high density leads to psychological distress, social withdrawal and disturbs supportive relationships within home. Architectural depth refers to the number of spaces a user must pass through to move from one place to another. For example, to reach the greenhouse, a resident must first pass through the wander zones (see figure 17), there are no traditional corridors. Since Zuidoever has no corridors, the building exhibits high architectural depth due to the presence of wander zones.

Psychological distress can occur when there is no opportunity for withdrawal, especially if the user feels that the environment is too crowded or dense. The study's results suggest that distress caused by high density can be alleviated by increased architectural depth. This allows users to better control their social interactions, as they can more easily change the degree of physical separation between themselves and others.

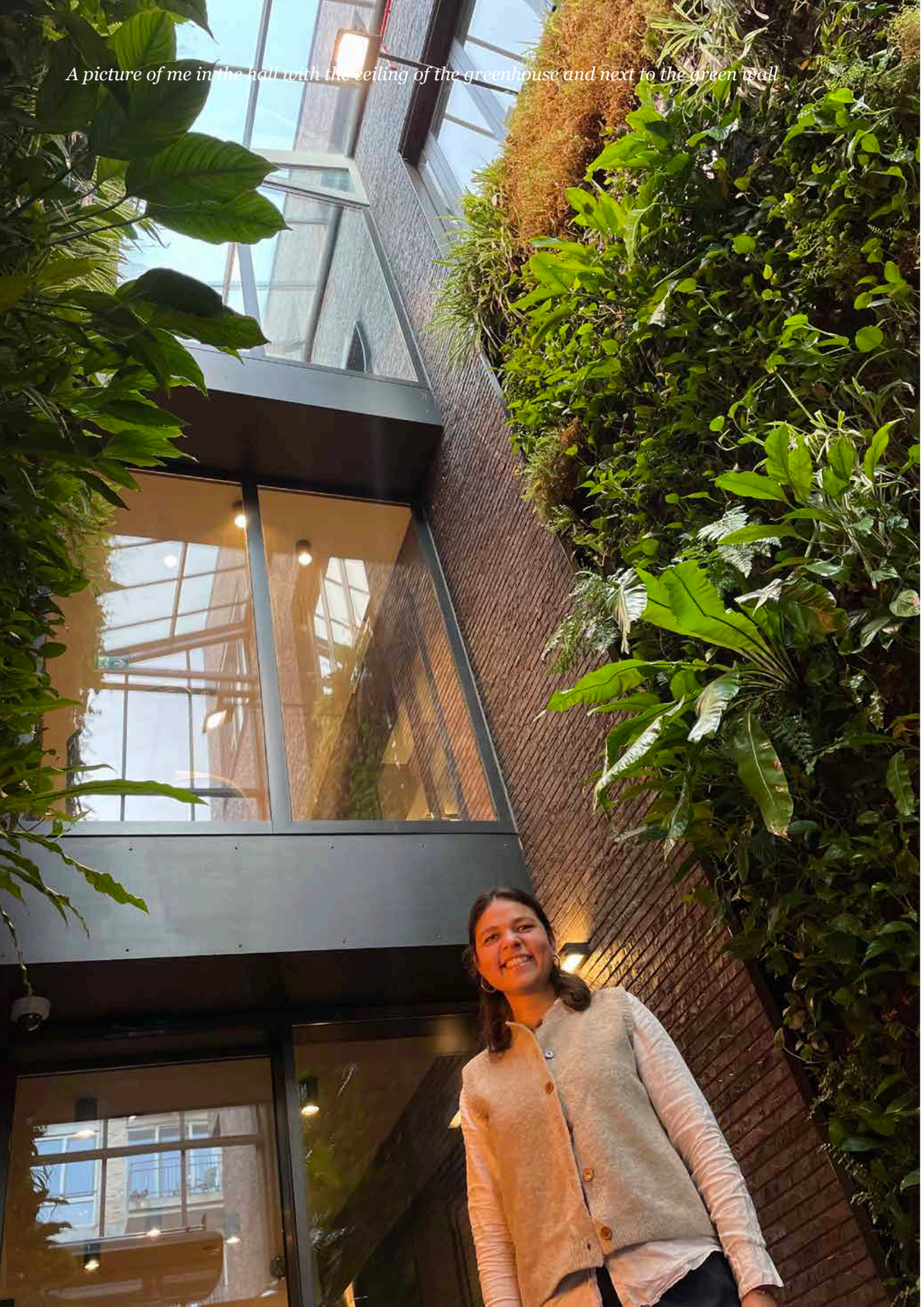
This increased control can, in turn, reduce social withdrawal. In addition, when users do not have the feeling of withdrawal, they are more likely to maintain positive relationships with others and avoid experiencing psychological distress. Thus, architects can use this kind of information to optimise room layouts, ensuring an efficient use of space. By considering psychological needs, such as the opportunity for withdrawal and control over social interactions, architects can design buildings that not only meet functional and aesthetic requirements but also promote the well-being of users. For example, increasing architectural depth can help reduce psychological distress in high-density environments, allowing users to maintain better relationships and experience less social withdrawal.

In conclusion, the collaboration between psychologists and architects is essential because architects can design buildings that are not only aesthetically and functionally but also positively influence the well-being of the users. Integrating psychology into the design process will result in better environments that promote users' well-being. For example, incorporating a greenhouse into the design can help users connect with nature and help improve the air, contributing to their overall well-being and behaviour.

Figure 43
An illustration of the collaboration between architects and psychologists



Personal touch



A picture of me in the hall with the ceiling of the greenhouse and next to the green wall

Unfortunately, I did not have the opportunity to go inside the building, as it is too disruptive for the residents. It was only possible to stand in the hall in front of the 'locked' entrance door, where I caught a glimpse of the daylight filtering through. This is the beginning of the greenhouse, which evokes a feeling of space and openness. This glimpse of daylight creates a welcoming atmosphere, which offers a graduate shift between the exterior and interior. Because I could not enter, I walked around the building to experience it from the outside. This allowed me to observe how the architectural design interacts with its surroundings.

My first impression was that the building radiates a sense of serenity. The choice of colours and materials contributes to a warm and serene appearance which avoids the cold feeling that some care homes can radiate. The architects used wood for the gate and natural-coloured bricks to enhance the warmth appearance of the building.

I also noticed that it was difficult to look into the rooms, which suggests that the graduate transition has been successfully implemented. This transition is designed to increase privacy for the residents on the ground floor while still allowing them to feel connected to the outside world.

Another striking architectural design element was the dynamic facade. The windows stand out, and the height of the windows next to the outstanding windows varies on different sides, creating a lively and dynamic visual effect. This variation also ensures that residents have multiple views from their rooms, namely the weather conditions, a view, and the streets. Additionally, some windows were noticeably covered with a glass plate which is designed to reduce noise from the nearby A10 highway.

Furthermore, it was noticeable that the building does not have an overwhelming height of twenty floors. Instead, it has a compact and pleasant height and appearance, which contributes to a more human-centered environment. If the building were much taller, I would feel small and overshadowed by the surroundings.

Zuidoever is located next to the A10 highway, and while the highway is visible when standing near the building, it is not a dominant presence in terms of noise disturbance. Additionally, a park next to the building enhances the natural ambiance with its greenery. The presence of trees softens the urban surroundings and provides a calming effect, which is especially important in a dementia-friendly environment.

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Appendix A. Recommendations for architects

The following is a list of recommendations for architects to consider when designing a building.

Ψ ***Create a multi-sensory environment:*** Implement an environment that provides a balance between overstimulation and relaxation to enhance comfort, well-being and concentration (Jakob & Collier, 2017), while avoiding overstimulation, which can lead to agitation (Onrust Als Symptoom Van Dementie, n.d.), withdrawal, and decreased brain activity (Bowlby, 1993).

Ψ ***Optimise orientation for residents with dementia:*** Individuals with dementia experience a decline in their ability to orient and navigate (Benke et al., 2013; Lester et al., 2017), therefore make clear differentiation between spaces (Evans et al., 1980; Davis et al., 2008) and use distinctive landmarks (Raubal & Winter, 2002). Use personal belongings as recognizable cues so that residents can easily identify whether they are in their own bedroom, for example (Nolan et al., 2002). In doing so, this approach promotes a sense of familiarity and being at home (Van Hoof et al., 2016) and encourages social interaction which is beneficial for mood, cognition and quality of life (Doës et al., 2016).

Ψ ***Integrate natural colors and elements:*** Choose natural colors and elements such as grey and wood in your (interior) design. Grey has a balanced and calming effect (Enwin et al., 2023) and wood helps to create a relaxed feeling (C. Lin, 2015) and gives a sense of comfort and warmth (Rice et al., 2006; Burnard & Kutnar, 2015; Watchman et al., 2017).

Ψ ***Integrate nature:*** Incorporate green elements into your building design, such as a greenhouse or a garden. This not only meets the innate tendency to connect with nature (Wilson, 1984), is restorative (Kaplan, 1995), stimulates the senses (Gutman, 1996), but also improves the overall health of residents and employees (Dahlkvist et al., 2016), quality of life (Edwards et al., 2012; Artmann et al., 2017) and mental well-being (Dahlkvist et al., 2019; White el al., 2017; Hubbard et al., 2020; Tillmann et al., 2018; Trostrup et al., 2019).

Ψ ***Maximise daylight:*** Include ample access to natural daylight in your design. Not only is it essential for vitamin production, a connection and protection to and from the outside world (Knoop et al., 2019), and for promoting a healthy circadian rhythm (Sochat et al,., 2008; Figueiro et al., 2023; Hanford & Figueiro, 2013), but it also serves as an intuitive navigation aid, buffering their communication difficulties (Scherder et al., 2009). Design spaces to naturally guide residents to the brightest areas, and facilitate orientation without relying on verbal instructions.

Ψ ***Collaborate with other disciplines:*** Involve other disciplines, such as environmental psychologists in the design process. Their research can be useful in designing buildings that positively influence residents' behavior and well-being.

The synergy of architecture and psychology

Dementia affects 47 million people worldwide, and this number is expected to increase to 131 million by 2050 (Arvanitakis et al., 2019). With over fifty different types, including Alzheimer's disease, vascular dementia, and Lewy body dementia (Alzheimer Nederland, n.d.), dementia is characterised by cognitive and functional decline, often leading to loss of independence, disability, and ultimately death (Corbett et al., 2012). Creating dementia friendly environments is therefore essential to foster a supportive environment and enhance the well-being of individuals with dementia, a growing challenge for society.

Zuidoever: the synergy of architecture and psychology' explores how architects and psychologists can collaborate to design environments that enhance the quality of life for individuals with dementia. This book analyzes key design principles - such as the intelligent use of daylight, intuitive navigation, the use of color and material, and indoor greenery - that contribute to a sense of orientation, and physical and psychological comfort. By bridging the gap between architecture and psychology, Zuidoever demonstrates how thoughtful design can positively impact residents, helping them feel more at ease, engaged and connected to their surroundings.