Emma Zijlstra

THE IMPACT OF THE HOSPITAL ENVIRONMENT

Understanding the experience of the patient journey

The impact of the hospital environment

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Chapter 1

General introduction

1.1 The hospital environment, why is this important?

A hospital visit is often an anxious and uncertain event for patients and their relatives. Patients are often concerned about a diagnosis and/or the treatment of their disease in an outpatient or inpatient setting. In these hospital settings, the impact of the environment on patients is still not well understood. Knowledge regarding the influence of this environment on patients is essential for facilitating the quality of health care. It is expected that an understanding of the experience of patients will allow designers and decision-makers in hospitals to positively influence the well-being of patients.

Hospitals aim to provide optimal health care and, to achieve this, they are focused on medical procedures and efficiency. In the Netherlands, approximately 50 percent of the adult population has one or more chronic illnesses, and patients with multimorbidity are the primary users of hospitals which increases the complexity of health care in them (CBS, 2018; Salisbury, 2012). Moreover, people live longer and, that the older people become, the more chronic illnesses they have (CBS, 2018). Health care costs are increasing in the Netherlands due to this increased demand, focus on quality of health care, and higher prices (Centraal Planbureau, 2011).

An increasing demand often requires construction changes in the hospital building. Building costs for Dutch hospitals are high and amount to approximately EUR 3,000 per square meter. In the Netherlands, recent developments in the health care real estate funding system make it necessary for hospitals to refund these building costs. Moreover, market forces create a competitive health care system. Health care providers anticipate to these developments by differentiating with spaces and services. However, building decisions are still mainly based on experience and intuition but not on scientific evidence (Becker & Parsons, 2007). How can hospitals be designed in a way that these actually improve patients' experiences and well-being? In this respect, research to understand the holistic experience of patients may be of significance.

To understand the patient's experience, research should be conducted from a wide variety of perspectives such as quality of health care, services, and spaces. According to Donabedian (1988), the quality of health care contains contextual aspects in which health care is delivered (structure), the interaction between patients and health care providers by the delivery of health care (process), and the effect of health care on the health status of patients (outcome). Donabedian contends that a good structure (material resources, human resources, and organizational structure) can positively influence the process which can consequently positively influence the patient's health.

In the structural context, environmental psychology is an interdisciplinary field that focuses on the relation between humans and their surrounding environment (Mehrabian & Russell, 1974). Mehrabian and Russell's model showed that both environmental and personality characteristics influence the emotional response of persons, which subsequently leads to a certain behavior (i.e., desire to approach or avoid an environment). Moreover, Bitner (1992) indicated that physical surroundings (i.e., ambient conditions, space/function, and signs, symbols, and artifacts) have an impact on the well-being of customers and employees in the servicescape (i.e., the environment in which the service is delivered). Customers and employees demonstrate cognitive, emotional, and physical responses to their physical surroundings which, in turn, influence individual behaviors and customer-staff interaction. It is expected that the individual characteristics (e.g., health condition and/or affective state) of patients in hospitals deviate from healthy people and, therefore, are potentially affected differently by the physical surroundings.

In health care, the physical surroundings can potentially modify hospital environments into healing environments (Dijkstra, Pieterse, & Pruyn, 2006; Stichler, 2001). Hence, the focus of evidence-based design research is the influence of environmental surroundings on both positive and negative patient outcomes (Becker & Parsons, 2007; Ulrich et al., 2008; Ulrich, 1981). The hospital environment can potentially improve the healing process of patients by reducing the length of stay, the severity of pain, levels of anxiety, levels of fatigue, and increasing the quality of sleep and mood or overall satisfaction with health care (Dijkstra et al., 2006; Harris, Ross, McBride, & Curtis, 2002; Ulrich, Quan, Zimring, Joseph, & Choudhary, 2004).

These previous studies have reported that the physical characteristics of organizations can potentially influence the health and well-being of patients. Thus far, however, there has been only minimal discussion regarding the holistic experience of patients that includes their emotional, physical, and cognitive well-being. In this dissertation, a patient-centered approach is applied in order to gain an improved understanding of a more holistic experience for patients (Figure 1.1). The authors analyzed the experience and well-being of patients at specific focal points of the patient journey: From arrival to patient diagnosis and the actual treatment in a hospital. Section 1.2 introduces the topics and the main research questions that are discussed in this thesis.

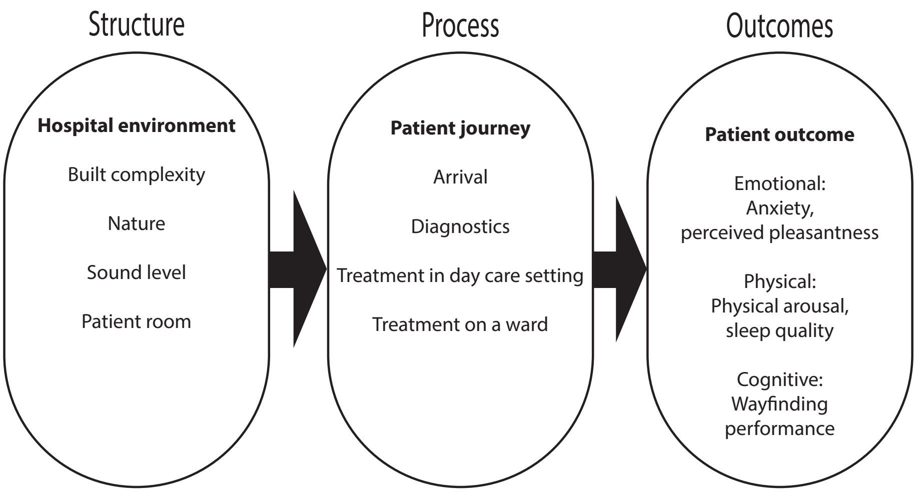

Figure 1.1 Framework used to understand the experience of the patient journey

1.2 The patient journey in a hospital environment – from arrival to treatment

The process that a patient is exposed to in a hospital can be considered as a chain of actions (Fitzsimmons & Fitzsimmons, 2006). In service literature, the map of all of the actions in the service delivery process (e.g., activities, interventions) is also referred to as the service blueprint. Blueprinting is an important technique to understand the customer-centric journey (Bitner, Ostrom, Carey, & Morgan, 2007). This can also be applied to health care. The steps that a patient goes through in a hospital environment is called the patient journey. This patient journey can differ between patients as different patients may encounter different health care services during a hospital visit.

To understand how patients experience a hospital visit, it is important to understand their entire journey from the patient's perspective. Most patients arrive at the hospital by some form of transportation (e.g., car, bus, taxi, bike, walking, or ambulance) and enter the hospital. After entering the hospital, they must find their way to their appointment for diagnosis or treatment. Currently, an illness is often diagnosed by imaging techniques and, consequently, treatment will be initiated. Patients receive treatment in a day care setting or on a ward for multi-day treatments. During this journey, patients are exposed to physical surroundings (e.g., hospital exterior, interior, uniforms) and also interact with other people (e.g., registration staff, nursing staff, doctors, fellow patients, etc.) (Fitzsimmons & Fitzsimmons, 2006).

A common patient journey in a hospital may involve visiting several clinics such as a diagnostic, outpatient, or inpatient clinic. This part of the introductory section introduces the topics and main research questions from the perspective of the patient journey and defines what a patient may experience during a hospital visit (Figure 1.2).

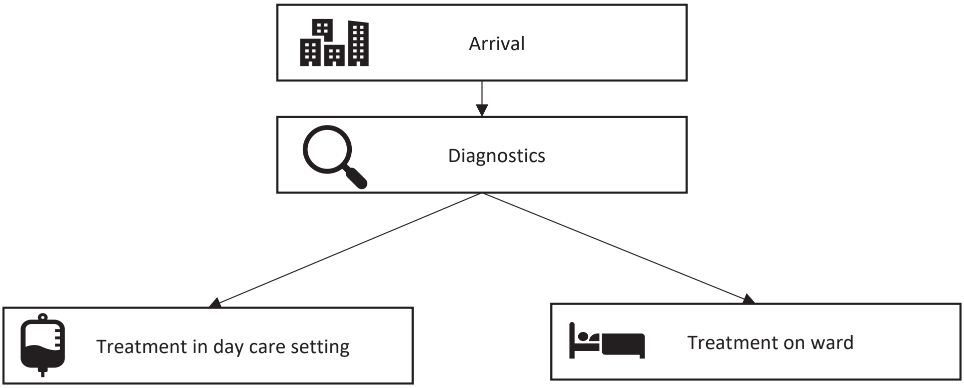

Figure 1.2 Patient journey in a hospital environment

1.2.1 Arrival

The patient journey in a hospital begins with entering the building and following a route to find the way in the built environment to the destination of the patient's appointment. This destination can be a diagnostic, outpatient, or inpatient clinic.

Currently, most hospitals are spacious in size due to the increasing demand for health care services. Hospitals include many areas for patients and staff. In addition, university hospitals also contain areas for education and research. Wayfinding in such complex building settings might be particularly difficult for vulnerable people such as the older population.

Wayfinding is a dual-task performance that requires cognitive and sensorimotor skills (Li, Lindenberger, Freund, & Baltes, 2001). Memorizing the destination and actually moving through the building can be considered as a divided attention task. Older people experience even basic movements such as walking as challenging (Davis, 2012). Patients may become (overly) stressed when becoming lost during a hospital visit. A better design may prevent such problems. Therefore, support from the built environment to find the way in a hospital may be important, especially for older persons.

The built environment, like multi-level buildings or multi-building settings, affects the type of wayfinding strategy that people use. For example, in multi-level buildings, it seemed to be most efficient to first move to the correct floor to locate the destination while, in multi-building settings, it appeared to be better to initially move to the correct building to find the destination prior to finding the correct floor (Hölscher, Büchner, Meilinger, & Strube, 2009; Hölscher, Meilinger, Vrachliotis, Brösamle, & Knauff, 2006). In a wider context, a well-designed building can be seen as a system of nudges (Thaler & Sunstein, 2008) that can stimulate non-mandatory but efficient wayfinding decisions in buildings. Similarly, facilities such as signage can help people in wayfinding, but can also hinder when not done appropriately (Rousek & Hallbeck, 2011).

It is unknown whether the effect of route complexity (i.e., number of building and floor changes) on wayfinding differs for older people with ageing-related physical impairments in both sensory and motor skills.

1.2.2 Diagnostics

Diagnostic scans play a critically important role in the diagnosis and treatment of diseases and are often anxious events for patients because they are usually concerned and worried that they have a serious disease (Munn & Jordan, 2011); not to mention that patients can become overwhelmed by unknown technological innovations. The medical technological development of medical devices and equipment continues to advance and, consequently, the hospital environment is becoming more unhuman from the patient's perspective (Dantendorfer et al., 1997).

Several studies have shown that patients experience elevated levels of anxiety before a scan is taken (Carlsson & Carlsson, 2013; Heyer et al., 2015; Katz, Wilson, & Frazer, 1994). A considerable number of patients (37%) reported moderate to high levels of anxiety for a magnetic resonance imaging (MRI) scan. Even though the prevalence of anxiety for a CT scan is similar compared to an MRI (Heyer et al., 2015), anxiety for an MRI is a recognized problem while anxiety for a CT has received less attention. High levels of anxiety for a CT scan can become a major problem, because it may potentially influence the quality of images due to motion artifacts and may also increase health risks due to an increase in radiation exposure (Bischoff et al., 2009; Gerber, Kantor, & McCollough, 2010).

The physical surroundings and facilities of a diagnostic room may influence the patient experience. An increasing body of evidence showed that views of nature can have a positive impact on people's psychophysiological stress (Malenbaum, Keefe, Williams, Ulrich, & Somers, 2008; Monti et al., 2012; Tanja-Dijkstra et al., 2014; Ulrich, 1984; Vincent, Battisto, Grimes, & Mccubbin, 2010). However, it is yet unknown whether a projection of nature in an imaging room can mitigate psychological and physiological anxiety.

1.2.3 Treatment in day care setting

After diagnosis, a growing number of patients receive treatments for cancer or chronic diseases such as muscle or vascular diseases in outpatient infusion centers. The number of day care treatments has increased over five times in the last 20 years, and the group of patients with the diagnosis of cancer has grown the quickest (Dutch Hospital Association (NVZ), 2016). This increasing demand for day care treatments (to replace inpatient treatments) can be explained by financial considerations as day care treatments are less expensive than hospital admissions. Therefore, hospital stays should be as short as possible, and it is preferable that patients do not stay overnight.

Patients may cope differently with this stressful situation. During these treatments, some may prefer a treatment environment that allows them to contemplate and rest (i.e., minimal noise) whereas others may opt for a treatment environment that distracts them and provides them with the opportunity to converse with fellow patients and visitors

(Browall, Koinberg, Falk, & Wijk, 2013). According to the WHO, the critical health effect for patients in a hospital treatment room is the disturbance of rest and recovery (Berglund, Lindvall, & Schwela, 2000). Since hospitals are currently being designed with an increasing number of single rooms or cubicles, the individual preference of patients with respect to social contact is of great interest.

Studies showed that patients reported human-related sounds the most, like talking, laughing, and coughing (Mackrill, Cain, & Jennings, 2013; Park et al., 2014). Some may not be disturbed by these human-related sounds and feel safe and secure when they hear others while others may experience it as annoying and feel helpless because they cannot escape from the noise (Cohen, Evans, Stokols, & Krantz, 1986; Johansson, Bergbom, Waye, Ryherd, & Lindahl, 2012).

Quiet-time interventions may control the actual sound level by encouraging patients to rest and relax (Lower, Bonsack, & Guion, 2003). Previous intervention studies manipulated multiple variables such as a restriction of visitors and staff movements, promotion of closing doors, reduced light intensity, and lowered volume of technical equipment. However, it is still unknown which individual element of quiet-time interventions effectively reduced the sound level. Therefore, it is important to study a single element.

In addition to studying the effect on actual sound levels, it is important to understand the perception of patients. The physical environment can support the psychosocial aspects and can promote social contact among fellow patients (Browall et al., 2013; Larsen, Larsen, & Birkelund, 2014). Many hospitalized oncology patients need to meet fellow patients because they understand each other's situation and can share experiences and information (Steen Isaksen & Gjengedal, 2000). Several studies discussed that a balance is required between the social and privacy aspects in treatment environments (Edvardsson, Sandman, & Rasmussen, 2006; Ulrich, 1991). However, it is currently unknown how patients experience the physical, social, and privacy aspects and how to design an infusion center respecting individual preferences.

1.2.4 Treatment on a ward

Oncology patients undergo surgeries, radiation, and chemo- or immunotherapies as treatments for cancer. Besides treatment in a day care setting, many patients are hospitalized in oncology wards during these treatments. Patients in a day care setting mentioned that they benefitted from going home after treatment (McIlfatrick, Sullivan, McKenna, & Parahoo, 2007), however, in an oncology ward, they are surrounded by the treatment environment for a longer period of time.

The Dutch Federation of University Medical Centers reports that patients become more critical and assertive as well as demanding a higher quality of care. Additionally, ward design is receiving increasing attention in order to decrease hospital-acquired infection rates during hospitalization (King, Noakes, & Sleigh, 2015; Taylor, Card, & Piatkowski, 2018a; Ulrich et al., 2008). Consequently, new hospital designs have an increased number of single rooms. However, what do oncology patients actually prefer?

Socially, the majority of oncology patients prefer multi-bed rooms in order to avoid isolation and appreciate the company of others (Pease & Finlay, 2002; Rowlands & Noble, 2008; Williams & Gardiner, 2015). The experience during hospitalization may also depend on the individual characteristics of a patient. People who score high on the extroversion scale generally experience lower levels of arousal and seek outside stimulation while people high on the introversion scale generally experience high levels of arousal and are more likely to seek quiet environments/activities (Eysenck, 1967).

Several studies have shown the advantages and disadvantages that patients experience regarding room types and compared single rooms versus multi-bed rooms (Chaudhury, 2005; Maben et al., 2016; van de Glind, de Roode, & Goossensen, 2007). However, until now, it has not been clear whether there are differences in patients' perceptions between multi-bed rooms with two and four beds and how individual characteristics may affect this experience.

1.3 Outline of the thesis

The current thesis aims to investigate the influence of the physical environment (built complexity, nature, sound level, and patient room) on patients' well-being during the different aspects in a patient journey.

To do so, the second chapter of this thesis addresses the influence of the built environment and simulated physical ageing on wayfinding performance during arrival. The focus is to gain understanding about the relation between the growing ageing population and the growing size of hospitals' built environments. The third chapter investigates the influence of the natural environment on patients' well-being during diagnostics. The aim is to study how a motion nature projection affects the psycho-physiological anxiety of patients. The fourth chapter examines the influence of the sound level on the experience of patients during treatment in an outpatient infusion center. The focus is on the influence of a non-talking behavior rule on both the objective sound level as the perceived sound environment. Chapter 5 provides a broader perspective of the patients' experience of the physical, social, and privacy aspects in the outpatient infusion center. The aim is to gain a better understanding of the patients' experience there and also to answer the question of how to design the spaces and organization of an infusion center. In Chapter 6, the experience of patients during treatment in an oncology ward will be examined. This study addresses the effects of the physical (i.e., room type) and psychosocial (i.e., kindness of roommates and extraversion) aspects on the patients' experience in an oncology ward. Most hospitals are now designed with an increased number of single rooms in order to reduce hospital-acquired infection rates while, from a social perspective, the majority of oncology patients prefer multi-bed rooms. Therefore, it is important to examine the differences between different types of multi-bed rooms to understand how hospitals could take into account the social needs of patients. In Chapter 7, the five studies are summarized. Finally, in Chapter 8 the general findings of this thesis and the implications of these findings are discussed.

Emma Zijlstra
Mariët Hagedoorn
Wim P. Krijnen
Cees P. van der Schans
Mark Mobach

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Chapter 2

Route complexity and simulated physical ageing negatively influence wayfinding

Abstract

The aim of this age-simulation field experiment was to assess the influence of route complexity and physical ageing on wayfinding. Seventy-five people (aged 18-28) performed a total of 108 wayfinding tasks (i.e., 42 participants performed two wayfinding tasks and 33 performed one wayfinding task), of which 59 tasks were performed wearing gerontologic ageing suits. Outcome variables were wayfinding performance (i.e., efficiency and walking speed) and physiological outcomes (i.e., heart and respiratory rates). Analysis of covariance showed that persons on more complex routes (i.e., more floor and building changes) walked less efficiently than persons on less complex routes. In addition, simulated elderly participants perform worse in wayfinding than young participants in terms of speed ($p < 0.001$). Moreover, a linear mixed model showed that simulated elderly persons had higher heart rates and respiratory rates compared to young people during a wayfinding task, suggesting that simulated elderly consumed more energy during this task.

2.1 Introduction

Wayfinding – that is, "determining and following a path or route between an origin and a destination" (Golledge, 1999, p. 6) - in complex building settings can be a difficult and stressful task, particularly in anxious and uncertain situations like a hospital visit. Route complexity is a growing problem in hospitals because hospitals are expanding in size due to the increasing demand for health care, more specialized care, and more diagnostic techniques. Consequently, hospital environments comprise more floor levels and multiple buildings, which make routes towards destinations more complex. A wayfinding technique, such as signage, is used in buildings to compensate for complex settings (O'Neill, 1991). Furthermore, wayfinding strategies differ when persons find their way in a multi-level building or a multi-level multi-building setting which effects wayfinding performance in terms of wayfinding time and efficiency (Hölscher et al., 2009, 2006). Floor strategies (firstly moving to the correct floor) have found to be more effective in multi-level settings while in multi-level multi-building settings people find their way more efficient when they firstly move to the correct building during a route. In addition, the majority of wayfinders choose to turn left when they arrive at a T-intersection (Tang, Wu, Lin, & Lin, 2009). Strategies that people use to find their way efficiently depends mostly on route complexity, that is depending on whether building or floor changes were required during a route (Hölsher et al., 2009).

Wayfinding in complex building settings might be particularly difficult and challenging for elderly people. The memory of elderly is not as good as that of younger people (Belsky, 2013) and their physical capacity is reduced. Therefore, especially elderly people may experience problems with dual-task-performance, which requires cognitive and sensorimotor skills (Li et al., 2001). Wayfinding can be seen as a divided-attention-task: people need to memorize the address of their destination while they are actually moving through the environment in order to reach the destination. A navigational study showed that elderly people perform worse than young people in cognitive navigational skills like route learning, route drawing, and especially in photo and video location (i.e., locate a photo or video on a map after a tour through a hospital) (Cushman, Stein, & Duffy, 2008). Knowledge about the impact of physical impairments on wayfinding, however, is lacking. Several studies have shown that few elderly people take the shortest route during virtual wayfinding tasks (Harris & Wolbers, 2014) and real-world wayfinding tasks (Borst et al., 2009), which suggests that most elderly people find their way less efficiently than young people do, but it remains unclear whether this is due to physical or cognitive impairments. We believe this justifies the stance of the study in understanding exclusively potential physical effects through simulated ageing.

Elderly people experience several physical challenges, for example, visual impairments, hearing loss, and limitations in motor skills, and therefore, elderly people fear losing their independence and experience even basic movements, such as walking, as challenging (Davis, 2012). Consequently, walking speed decreases 7% per decade of age (Bendall, Bassey, & Pearson, 1989). However, the energy expenditure of elderly people is not significantly different during walking compared to young people, because elderly people walk slower and their stride length is shorter (Abadi, Muhamad, & Salamuddin, 2010). It is known that high color contrasts can help and complex pictograms in signage can hinder wayfinding in participants wearing glasses that simulate visual impairments (Rousek & Hallbeck, 2011) and in blind and partially sighted people (Chandler & Worsfold, 2013). Elderly people spent more time following signs due to poor visual searching ability, decreased motor skills and longer information processing times (Hashim, Alkaabi, &

Bharwani, 2014; Liu & Ho, 2012). Therefore, wayfinding involves both sensory and motor skills such as following signs, searching for the destination, and walking to reach the destination. If the wayfinding process cannot be completed successfully, persons may become distressed and disoriented in the building and, consequently, they may get lost. Therefore, support from the environment is important for elderly persons to be able to function at their best (Belsky, 2013). Consequently, involving patients can be considered of major importance in studying and designing a built environment (Hignett & Lu, 2009).

The aim of this study is to assess the influence of route complexity and physical ageing on wayfinding (i.e., efficiency and walking speed) in a hospital setting. It is unknown whether the effect of route complexity (i.e., number of building and floor changes) on wayfinding differs for elderly people with ageing-related physical impairments in both sensory and motor skills. To assess exclusively physical ageing, participants for this study were young people wearing gerontologic suits that simulate the physical limitations of elderly people.

2.2 Methods

2.2.1 Participants

Seventy-five bachelor students, studying Facility Management at the Hanze University of Applied Sciences in Groningen The Netherlands, were recruited for this study. In total, 42 of these participants fulfilled one wayfinding task and 33 of these participants fulfilled two wayfinding tasks in order to have at least 10 participants walking each of the nine wayfinding routes (Table 2.1). Participants were randomly assigned to a bundle of three wayfinding tasks in order to start each route from a different origin towards a different destination and, consequently, maximize systematic variation. Data from four participants (i.e., six wayfinding tasks) were excluded because these participants suffered from heart disorders, asthma, or a chronic fatigue syndrome. Participants were aged between 18 and 28 years (M = 20, SD = 1.8). More than half of the sample was female (67%). The mean body mass index (BMI) of the participants was calculated before wearing the gerontologic suits and was 23.3 (SD = 3.4).

2.2.2 Procedure

The University Medical Center Groningen contains multiple buildings and floor levels. The design of the main building is composed of multiple blocks where the destinations are numbered, and all sub-buildings have a different name. Nine routes were selected for this study with different levels of complexity (Table 2.1). A route was defined as the most efficient pedestrian route of a person from origin to destination.

Figure 2.1 shows the map of the study site including origins and destinations. Participants were free to decide on their route, only origin (parking lot or bus stop) and destination (outpatient clinic) were given. The different routes were potentially challenging based on the practical experiences and expectations of the department Facilities & Estates about people getting lost in the building. Moreover, routes were practically selected based on the willingness of the destination clinic to participate in this study.

Participants walked in randomly selected pairs. One participant was the wayfinder and walked the route (randomly selected with or without a gerontologic suit) and the other participant was assigned the role of observer and made assessments, specifically measuring the walking distance and wayfinding time (Figure 2.2). The data was collected

Table 2.1 Characteristics of routes and participants

Route characteristics				Route complexity		Number of participants	
Route number	Origin	Destination	Route distance (m)	No. of building changes required	No. of floor changes required	Simulated Elderly	Young
1	Sub parking	University Center Geriatric Medicine (GM)	243	0	2	6	6
2	Sub parking	Psychiatrics (P)	424	1	1	7	6
3	Sub parking	Diabetic Center (DC)	319	1	2	6	5
4	Main parking	Endoscopy Center (EC)	267	0	2	6	5
5	Main parking	Children's Hospital (CH)	249	0	2	7	6
6	Main parking	Outpatient Internal Medicine (IM)	315	0	1	7	4
7	Bus stop	Endoscopy Center (EC)	351	0	1	8	5
8	Bus stop	Children's Hospital (CH)	333	0	0	5	5
9	Bus stop	Outpatient Internal Medicine (IM)	399	0	0	7	7

during six days and the pairs were evenly distributed over these dates. A random sample of the wayfinding tasks (54.6%) per route was selected to be completed by participants wearing a gerontologic suit (Table 2.1). Prior to the start of the study, the medical ethical committee of UMCG decided that ethical approval was not required. In order to prevent accidents such as stumbling and falling, e.g. on stairways, the observer was also instructed to keep an eye on the wayfinder by walking behind him/her.

The pairs were asked to walk three separate routes per pair during one day with each route starting from a different origin. When the first route was completed the participants were required to walk to the next origin outside the building and take a 15-minute break at this origin in order to start the wayfinding task with a heart rate at rest. The wayfinder that started the first route was randomly selected and also walked the third route. These routes were assigned in such a way that all routes were walked approximately the same number of times. Per pair there was a time difference between starts of about 45-60 minutes because there was limited measuring equipment and in order to avoid pairs crossing each other. During wayfinding tasks, the wayfinder and observers were not allowed to speak to each other to ensure that wayfinders perform their task independently. The wayfinder was able to ask for wayfinding information at service points (Figure 2.1) in order to improve their wayfinding performance and make use of existing wayfinding signage (Figure 2.3).

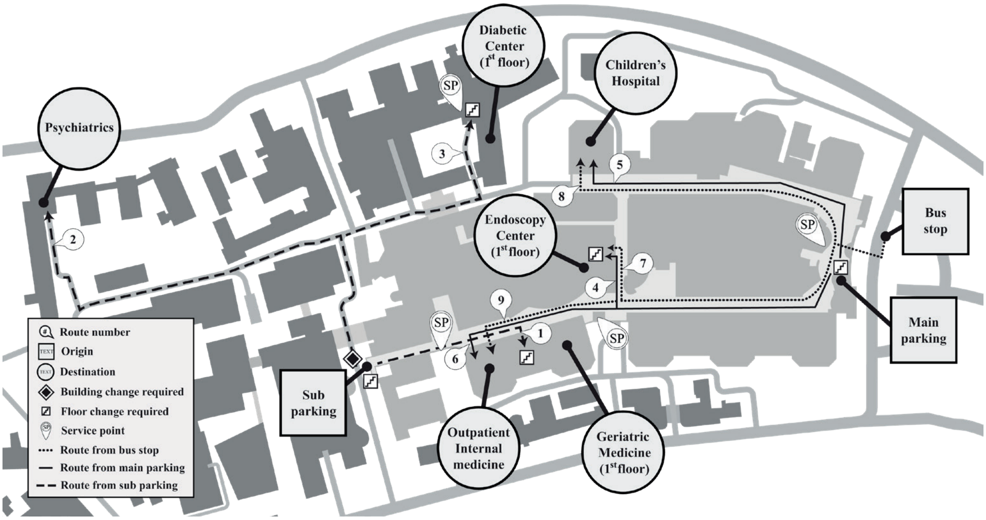

Figure 2.1 Map including origins and destinations

2.2.3 Measures and instruments

2.2.3.1 Independent variables

Route complexity – Route complexity was defined as the number of building or floor changes that were required during the route. Building changes were counted each time a route required the person to leave one building in order to enter another building. In addition, floor changes were counted each time when the use of stairs or elevators was required during the route.

Simulated physical ageing (SPA) – The gerontologic suits allowed young people to experience the typical physical limitations of elderly people. Physical ageing was simulated by different components. The references in the description of the different components validate the relevance of the different components of the gerontologic suit that simulate physical ageing. Participants wore special polycarbonate glasses (weight: 0.14 kg). Such glasses were worn to cause changes in color perception, blurred sight, glare sensitivity and a restricted visual field (Bouwhuis, 1992; Füsgen & Summa, 1984). Hearing protectors (weight: 0.26 kg) were worn to reduce hearing of high frequency tones and hearing loss increases with increased noise (Saup, 1993). Elderly people experience limited mobility of the whole body through difficulties when stooping, bending, and stretching (Saup, 1993). A neck collar and bandages (weight in total: 0.30 kg) around elbows and knees were used to simulate these mobility limitations. Weight cuffs around the wrists (weight: 2 x 1.50 kg) and ankles (weight: 2 x 2.30 kg) were used to simulate the decrease in muscle strength and changed coordination (Platt, 1991). The weight cuffs around the ankle also simulated an insecure shuffling walk. Another component of the gerontologic suit was a weight vest (weight: 10.10 kg) which was worn around the torso. This vest simulated a curvature of the spine, tilting of the pelvis, bad posture, declined power, increased energy expenditure, and a decreased equilibrium sense (Lang & Arnold, 1991). Special gloves (weight: 0.12 kg) and shoes (weight: 2 x 0.25kg) were also worn. The gloves simulated limited hand mobility, limited grip, and a slowed tactile feeling (Saup, 1993). The additional softer sole of the shoes gave a spongy feeling and reduced the sensation of floor contact. This simulated the insecure feeling elderly people often feel when they are walking.

In conjunction, these components simulated the typical physical limitations of elderly people. Exact years of ageing of the simulation suits are yet unknown and preliminary findings are non-conclusive.

Figure 2.2 A typical setting in the wayfinding experiment (Photography: Marieke Kijk in de Vegte)

2.2.3.2 Dependent variables

Wayfinding performance – Wayfinding performance was distinguished in two outcomes: (1) route efficiency and (2) walking speed. A stopwatch was used in order to measure wayfinding time. Wayfinding time was the time interval between origin of walking (T0) till the time arrived at the end destination (T1). In addition, a measuring wheel was used to measure the actual walked distance in meters. The route efficiency ratio was calculated by dividing the distance of the route (actual walked route) by the route distance (most efficient pedestrian route). A route efficiency ratio larger than 1 indicates that participants walked more meters than strictly necessary. Walking speed was calculated by dividing route distance by wayfinding time and was displayed in kilometers per hour (km/h).

Physiological outcomes – Heart rate and respiratory rate were repeatedly measured every second with the Zephyr Bioharness chest belt in order to measure differences in energy expenditure between young and SPA during a wayfinding task. The latter has been validated in measuring respiratory rate per minute (Hailstone & Kilding, 2011) and heart rate per minute (Kim, Roberge, Powell, Shafer, & Williams, 2013).

2.2.4 Analyses

Analysis of covariance (ANCOVA) was used to estimate the main as well as interaction effects of route complexity (i.e., 0 or 1 building changes; 0, 1, or 2 floor changes) and SPA (gerontologic suit versus no suit) on wayfinding performance (i.e., route efficiency and walking speed) during wayfinding tasks (separate analyses for each dependent variable). Sex, BMI, service points, route distance, and number of routes a participant walked were included as covariates as these variables might be related to wayfinding performance and physiological outcomes. As mentioned earlier, some participants walked two routes. This covariate was included to control for familiarity with the hospital and possible fatigue.

Figure 2.3 Existing wayfinding signage in hospital building

The main and interaction effects of route complexity and SPA on the physiological outcomes, that is heart rate and respiratory rate, measured during a wayfinding task were examined in a linear-mixed model (separate analyses for each dependent variable). A linear-mixed-model was chosen to account for possible random effects of individual participants. The mixed-model included the participants as random effects, and number of building changes, number of floor changes, ageing, sex, BMI, number of service points, route distance, and number of walked routes as fixed effects. Standard errors were calculated using a restricted maximum likelihood approach.

2.3 Results

2.3.1 Wayfinding performance

In total 108 wayfinding tasks were studied. Descriptive statistics for the study variables are shown in Table 2.2. The results of the ANCOVA presented in Table 2.3 show significant effects of the number of building changes during the route on wayfinding performance. Table 2.3 shows that routes that required a building change were significantly less efficient (+0.72, $p < 0.001$). No significant effects were shown in speed.

In addition, the results in Table 2.3 showed that participants wearing a gerontologic suit perform worse in wayfinding compared to participants not wearing a suit with respect to speed ($p < 0.001$). Participants who wore the gerontologic suit walked significantly slower (-0.69 km/h). No significant effects were shown in route efficiency, which means that participants wearing a gerontologic suit did not walk significantly less efficiently than participants not wearing a gerontologic suit. No significant interaction effects were shown between route complexity and SPA on wayfinding outcomes (not shown in table).

Table 2.2 Means, and standard deviations per route of the wayfinding performance variables

Route number	Mean wayfinding time (hh:mm:ss)		Actual walked distance (m)		Route efficiency (ratio)		Speed (km/h)	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
1	00:07:42	00:02:25	289	53	1.19	0.22	2.5	1.0
2	00:14:25	00:06:12	733	323	1.73	0.76	3.1	0.9
3	00:12:03	00:03:53	574	271	1.80	0.85	2.9	1.0
4	00:07:28	00:02:43	284	24	1.06	0.09	2.5	0.7
5	00:06:33	00:01:21	266	8	1.07	0.03	2.5	0.5
6	00:06:31	00:01:30	326	24	1.04	0.08	3.1	0.6
7	00:06:52	00:02:22	356	115	1.02	0.33	3.2	0.6
8	00:06:11	00:02:26	311	48	0.93	0.14	3.3	1.1
9	00:07:18	00:01:47	399	46	1.00	0.12	3.4	0.9

2.3.2 Physiological outcomes

Table 2.3 also shows the results of the linear-mixed-model predicting the physiological outcomes. Results of the mixed model showed no significant effects of the complexity of the route on heart rate and respiratory rate. Moreover, no significant interaction effects were found between route complexity and SPA on physiological outcomes.

Results of this study showed significant effects of SPA on heart rate ($p < .001$) and respiratory rate ($p < .001$). Participants who found their way in a gerontologic suit had higher heart rates (+14.31 BPM) and higher respiratory rates (+3.89 BPM).

Table 2.3 Analysis of covariance on wayfinding outcomes (route efficiency and speed) and analysis of linear-mixed-model on physiological outcomes (heart rate and respiratory rate)

	Wayfinding outcomes						Physiological outcomes					
	Route efficiency (ratio)			Speed (km/h)			Heart rate (BPM)			Respiratory rate (BPM)		
	Coef.	SE	P	Coef.	SE	P	Coef.	SE	P	Coef.	SE	P
(Intercept)	0.76	0.75	0.316	3.44	1.28	0.009	110.33	33.34	<0.001	-8.69	15.92	0.585
No. of building changes	0.72	0.27	0.008#	0.26	0.47	0.586	14.83	10.62	0.167	-5.26	3.67	0.156
No. of floor changes	0.09	0.15	0.546	-0.40	0.25	0.110	-9.18	6.57	0.166	5.77	3.13	0.06#
Young person* Simulated Elderly person	0.08	0.09	0.361#	-0.69	0.15	<0.001#	14.31	3.46	<0.001#	3.89	1.04	<0.001#
Male* Female	-0.01	-0.11	0.909	-0.25	0.16	0.115	14.92	3.60	0.000	1.20	1.09	0.276
Body Mass Index	0.02	0.01	0.111	-0.05	0.02	0.054	1.36	0.53	0.012	0.35	0.16	0.030
No. of service points	-0.02	0.10	0.797	0.10	0.17	0.556	4.09	3.74	0.278	0.86	0.75	0.456
Route distance	0.00	0.00	0.768	0.00	0.00	0.705	-0.04	0.09	0.639	0.07	0.04	0.065
No. of walked routes	-0.02	0.11	0.896	-0.17	0.19	0.377	-7.82	4.20	0.067	-0.20	1.28	0.874

Notes: As none of the interactions with SPA was significant, we removed them from the final analyses presented in this table.
Coef. = Coefficient.
* Marks the reference category.
\# Marks the key elements from the written results.

2.4 Discussion

The results of this study showed that participants on more complex routes showed lower wayfinding performance when compared to participants on less complex routes. Moreover, the findings indicate that participants wearing a gerontologic suit walked slower, and had higher heart rates and respiratory rates, and therefore consumed more energy during a wayfinding task compared to participants not wearing a gerontologic suit.

This study showed that a required building change during a route negatively influenced wayfinding performance. The more building changes were required during a wayfinding task, the less efficient routes were walked. This might imply that participants have an incomplete representation of the spatial setting, and therefore rely on the central point wayfinding strategy, meaning that they first walk towards a central point like the main entry hall or main corridors (Hölsher et al., 2009). A complete representation of the multiple building setting should immediately be made clear to visitors when entering the building using wayfinding design, like well-located service points or wayfinding signage. Unexpectedly, the present study shows no significant effects of floor changes on wayfinding performance in this hospital setting.

The results showed that the number of service points had no significant effect on wayfinding performance. Route efficiency was not optimal for the complex routes which implies that participants did not effectively use service points. However, the primary task of the service points is to support patients with wayfinding information, to enroll new patients for the hospital, and to offer other supporting services like a taxi. This ineffective use may be due to incorrectly located service points. According to O'Neill (1991) and

Golledge (1999), wayfinding signage needs to be located at decision points. Some service points in the current hospital setting were not located at decision points. However, it also might be due to the fear not hearing the service employees as a result of the simulated hearing loss, or the desired independence of the participants. Further research is necessary to assess under which wayfinding conditions, like the number of building changes and location of wayfinding signage per route, service points can be effective. For instance, by moving service points to decision points and measuring the effects on wayfinding performance.

Young participants wore gerontologic suits to experience the physical limitations of elderly people. This study did show that simulated elderly participants walked slower than their controls. According to Davis (2012), elderly people become slower in body and mind, and the results of this study confirm that simulated elderly participants walk slower and therefore take more time to complete the route. In contradiction to other studies with actual elderly people (Harris & Wolbers, 2013; Borst et al., 2009), this study showed that SPA had no influence on route efficiency. Besides, this study also showed no significant interaction effects between SPA and route complexity on wayfinding. This implies that route efficiency is not influenced by SPA but in all likelihood is the result of the level of cognitive impairments in elderly people.

However, this study showed that the aspects related to SPA had an effect on all physiological outcomes during wayfinding tasks. In contrast to another study (Abadi et al., 2010) about age differences during walking, this study showed that simulated elderly participants had higher heart rates and respiratory rates, and therefore consumed more energy in comparison to participants not wearing a suit during a wayfinding task. Consequently, simulated elderly people experience a wayfinding task physiological more challenging just as elderly people (Davis, 2012) which also might explain the decreased walking speed in simulated elderly participants. Therefore, hospitals should consider moving clinics that are often visited by elderly people nearby origin, like parking lots, bus stops or taxi pick-up areas, in order to make clinics more accessible by foot for elderly people.

2.5 Future research

The aim of this study was to understand the role of route complexity and physical ageing (by means of simulation) on wayfinding. The influence of physical ageing on wayfinding performance and physiological outcomes was examined by using gerontologic suits worn by young participants that simulated the physical limitations of elderly people in order to exclude cognitive limitations. This study showed no effects of ageing on route efficiency. Because other studies showed effects of ageing on route efficiency, it is more likely that cognitive limitations may play an important role in wayfinding performance. A replication of this study to compare real elderly people without impairments, real elderly with only physical or cognitive impairments, and real elderly with both physical and cognitive impairments is necessary to find evidence for the implication that cognitive limitations play a greater role in affecting wayfinding performance. Moreover, further research is necessary in order to understand the difference in wayfinding time and speed between young and simulated elderly people. For example, whether elderly people make more errors or chose certain directions during the wayfinding task compared to young people. Gaining a greater understanding of the physical limitations of elderly people in hospital buildings in a wayfinding task is a valuable contribution to the science of built environments and the autonomy of elderly people.

Furthermore, participants had no hospital appointment and therefore no time-pressure for an appointment. It is expected that patients with real hospital appointments are more likely to feel stressed because of the risk of being late, to feel nervous for interaction with care providers, or to feel anxious and uncertain for bad news. Further research is necessary to examine whether the level of stress of patients with real hospital appointments actually influences wayfinding performance (i.e., getting lost and walking inefficiency and speed).

Finally, the findings showed that route complexity negatively influenced wayfinding performance in this particular hospital built environment. This study was conducted in the built environment of one hospital, which potentially had consequences on the results. In addition, each route was walked on average 12 times by various participants, which is a limited number. Nevertheless, we believe this study contributes to a better understanding of the influence of route complexity and physical ageing on wayfinding performance. Further studies are needed to determine whether results are generalizable to other hospital buildings. Understanding the influence of building complexity on wayfinding performance will facilitate the development of effective interventions in complex built environments.

Emma Zijlstra
Mariët Hagedoorn
Wim P. Krijnen
Cees P. van der Schans
Mark Mobach

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Chapter 3

Motion nature projection reduces patient's pscyho-physiological anxiety during CT imaging

Abstract

A growing body of evidence indicates that natural environments can positively influence people. This study investigated whether the use of motion nature projection in computed tomography (CT) imaging rooms is effective in mitigating psycho-physiological anxiety (vs. no intervention) using a quasi-randomized experiment (N = 97). Perceived anxiety and pleasantness of the room were measured using a questionnaire, and physiological arousal was measured using a patient monitor system. A mediation analysis showed that motion nature projection had a negative indirect effect on perceived anxiety through a higher level of perceived pleasantness of the room. A linear-mixed-model showed that heart rate and diastolic blood pressure were lower when motion nature was projected. In conclusion, by creating a more pleasant imaging room through motion nature projection, hospitals can indirectly reduce patient's psycho-physiological anxiety (vs. no image projection) during a CT scan.

3.1 Introduction

Physical environmental stimuli (e.g., ambient features, architectural features, interior design features) in hospitals can influence the well-being of patients, both positively and negatively (Dijkstra et al., 2006). One procedure these stimuli may influence involve diagnostic scans, which play a critically important role in the diagnosis and treatment of diseases. Patients undergoing a diagnostic procedure are usually concerned and anxious that they have a serious disease, and feel frustrated when the scan cannot be successfully completed (Munn & Jordan, 2011). In hospital settings, the influence of natural environments is receiving growing attention and seems to have the potential to mitigate anxiety. Understanding the influence of nature during a diagnostic scan will allow us to create imaging rooms that positively affect the well-being of patients.

Several studies have shown that patients experience elevated levels of anxiety before a scan is taken in comparison to after the scan is completed (Carlsson & Carlsson, 2013; Heyer et al., 2015; Katz et al., 1994). In a sample of 297 patients undergoing magnetic resonance imaging (MRI), a considerable number of patients (37%) reported moderate to high levels of anxiety before the scan, and females usually report higher levels of anxiety than males (Dantendorfer et al., 1997). Anxiety for computed tomography (CT) scan is an underestimated problem, although the level of anxiety is similar compared to MRI (Heyer et al., 2015). A CT scan is a non-invasive examination that uses X-ray to make three-dimensional images of a body structure. Anxiety for diagnostic scans can be caused by concerns about the disease that might be detected, radiation exposure, administration of contrast agents, fear of the unknown, fear of pain, and claustrophobia (Heyer et al., 2015; Katz et al., 1994). Furthermore, patients perceive it as important to complete a diagnostic scan successfully (Munn & Jordan, 2011), and might get overwhelmed by the corresponding technical equipment (Dantendorfer et al., 1997).

High levels of anxiety during diagnostic scans can become a major problem. High levels of psychological anxiety during diagnostic scans may increase the need for sedation (Munn & Jordan, 2013). In addition, specifically for coronary CT scans, high levels of physiological arousal (i.e. heart rates) may negatively influence the quality of images due to motion artifacts and may also potentially increase health risks due to an increase in radiation exposure (Bischoff et al., 2009; Gerber et al., 2010). Therefore, reducing anxiety is desirable to enhance the patient experience and well-being.

Coping with anxiety during a scan can be difficult for patients. Some studies focused on understanding the coping process during scans have investigated patient-driven strategies. For example, most patients report that they keep their eyes closed during a scan and try to place the focus elsewhere to relax (Carlsson & Carlsson, 2013). Another study showed that 35% of the patients undergoing an MRI use a strategy of "imaginative visualization" to reduce anxiety, and, for example, imagine that they are lying on the beach instead of lying on the scan table (Quirk, Letendre, Ciottone, & Lingley, 1989).

Other studies have focused on environmental interventions. For example, one review showed that technical interventions (e.g. an open MRI, a shorter bore, a quieter machine, or organizational interventions such as detailed information, and team training) can reduce anxiety, distress, and the need for sedation (Munn & Jordan, 2013). Another small literature review has also shown that environmental interventions (e.g. prism glasses, lighting, or music) can possibly reduce anxiety (Phillips & Deary, 1995). Finally, one study reported that patients perceived an imaging room as more pleasant when the imaging room contained multiple elements of positive distraction during imaging, like nature projection and lighting (Quan, Joseph, & Ensign, 2012). However, no effect was found of this intervention on anxiety of patients. Moreover, this study failed to control for the study site and compared the impact of distraction in different imaging rooms, and for this reason other environmental influences could not be excluded from the results.

In summary, there has been growing interest in identifying interventions to reduce anxiety during a diagnostic scan, but much remains to be learned from more carefully controlled experimental designs. In the present study, we focus on the impact of motion nature projection (i.e., images of nature which move across a screen). Indeed, a growing body of evidence indicates that nature sights can positively influence people (Malenbaum et al., 2008; Monti et al., 2012; Tanja-Dijkstra et al., 2014; Vincent et al., 2010). The psycho-evolutionary theory (Ulrich, 1983) indicates that the visual perception of natural environments depends on the initial affective state of a person and can reduce psycho-physiological stress and negative feelings directly by the affective response or (in)directly by cognition. Persons may like or dislike the natural environment (i.e., initial affective reaction), or appraise it as beneficial or harmful (i.e., cognitive reaction). Ulrich (1983) states that most processes evolve directly via the initial affective reaction towards the post-cognitive affective state. A recent Cochrane review described the effect of positive distraction interventions on patients outcomes, such as anxiety and pain (Drahota et al., 2012). Positive distraction can be defined as "elements of the sensory environment; that is, aspects of the hospital surroundings that can be seen, touched, smelled, or heard" (Drahota et al, 2012, p. 3). This review included five nature-based visual distraction intervention studies that offered static natural scenery or motion natural scenery in hospitals. The authors discussed that natural audiovisual distractions can reduce anxiety; however, no strong evidence was found. For example, one study offered distraction therapy by showing patients a mural photographic natural scene with corresponding sounds before, during, and after a flexible bronchoscopy (Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003). They showed that patients reported more pain control in the intervention group, but did not find any difference in anxiety. One intervention study made use of virtual reality, and showed that patients perceived less anxiety during screening flexible sigmoidoscopy when they were exposed to an ocean shoreline with corresponding sounds (Lembo et al., 1998). The study of Barnason, Zimmerman, and Nieveen (1995) assessed the influence of a natural setting on a television screen on the level of anxiety after heart surgery. They found no differences in anxiety. Nevertheless, they did find evidence for physiologic relaxation, in terms of lower heart rates and blood pressures.

A pleasant imaging room could mitigate anxiety for patients, and thereby improve patients' experiences. The aim of this study was to assess whether patients experience less psycho-physiological anxiety in an imaging room when motion nature was projected as compared to no projection. Specifically, it was hypothesized that, compared to patients in a room without nature motion projection, patients in an imaging room with motion nature projection perceive less psychological anxiety during a CT scan (Hypothesis 1), and would rate the pleasantness of the imaging room higher (Hypothesis 2). Assuming that the pleasantness of the room would be inversely related to reported anxiety, we further hypothesized a negative indirect effect of the intervention on reported anxiety via ratings of the pleasantness of the room (Hypothesis 3). Finally, complementing our self-report measures, we hypothesized that patients in an imaging room with motion nature projection would experience less physiological arousal, in terms of lower heart rates and blood pressures compared to patients in a room without projection (Hypothesis 4).

3.2 Method

3.2.1 Participants

Data for this study were collected between June 2016 and August 2016 in a field experiment in the University Medical Center of Groningen, The Netherlands. Eligible patients were 18 years or older and underwent a cardiac Computed Tomography (CT) scan. Cardiac CT scans can help to detect or evaluate problems with heart function and valves, like coronary heart disease, or calcium in the coronary arteries. Patients were excluded if they were not able to read Dutch, were not able to fill in a questionnaire on a tablet, or were impaired mentally (i.e., Down syndrome) or visually (i.e., blindness or forgotten glasses).

According to the Dutch law for medical research involving human subjects (WMO), a waiver for ethical assessment was provided by the Medical Ethical Committee of the Medical University of Groningen. The study was conducted according to the declaration of Helsinki.

Figure 3.1 Photo of the imaging room with nature projection on the gantry and wall

3.2.2 Design and Interventions

A quasi-randomized experiment had a between-subjects design with participants assigned to one of two conditions, namely a motion nature projection condition versus a no projection condition. Wednesdays between June and August 2016 were designated as measurement days, because these were scheduled for cardiac scans (approximately 12 patients per day, 30 minutes per scan). The assignment to either one of the conditions was based on the scheduled appointments for a cardiac CT scan. During the first four weeks, a group of 49 patients was assessed without motion nature projection during a CT scan. During the next seven weeks, a group of 48 patients was assessed with motion nature projection during a CT scan.

In the experimental condition a motion nature image was projected on the gantry and the wall of the imaging room, before the patient entered the room (Figure 3.1). Figure 3.2 shows the map of the study site. The projection on both objects reflected a time-lapse of a hill landscape, dominated by a hill with grass, trees, and slowly moving clouds with the corresponding shadows (Figure 3.3). In the control condition, no images were displayed.

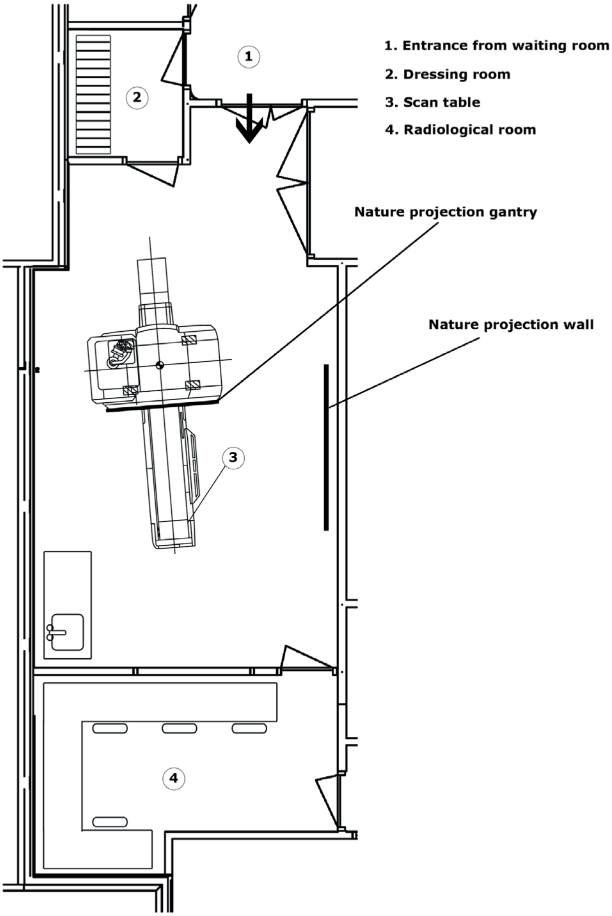

Figure 3.2 Map of the study site

This motion nature image scene was repeated on a loop of 20 seconds. This loop was slightly visible since only the position of clouds changed. In the control condition, the wall and gantry projection were turned off. The researcher assured that other environmental influences such as intensity of lighting in the imaging room and in the radiological laboratory room, and the lighting color in the gantry (color green) were stable. Two radiographers worked simultaneously during the scanning procedure of the patients. In total, six different radiographers conducted the cardiac scans during this study. Since radiographers were always present in the scanning room, it was impossible to conduct the experiment with double blindness. The radiographers were informed about the main research question concerning the effect of motion nature projection on the experience of patients and were explicitly requested to behave in the usual way. The scanning procedure remained completely according to standards, except the nature projection in the experimental condition. All CT scans were performed on an open bore Siemens SOMATOM Force system.

Figure 3.3 Static image of nature projection

3.2.3 Procedure

Patients who underwent a cardiac CT scan arrived at the reception desk of the radiology department, and first took a place in the waiting room. A radiographer invited the patient to enter the imaging room (see arrow, Figure 3.2). In this imaging room the patients received verbal information about the CT procedure from the radiographer. During this conversation, patients were exposed to the motion nature projection on the gantry and wall in the intervention condition (Figures 3.1 and 3.2). The patients were also asked in the dressing room to remove clothing containing metal elements around the chest (see 2, Figure 3.2). Next, the patients were positioned lying on their back on the scan table with the arms above the head. The patients were moved with their head going first into the gantry. As soon as patients took their place on the scan table, they could see the nature projection on the wall in the experimental setting when lying on and looking toward their left side. Before scanning, the radiographer measured heart rate and blood pressures (systolic, diastolic, and average). Moreover, a small needle was placed into a vein in the hand or arm of the patients in order to administer iodine contrast to highlight blood vessels. When the needle was placed, the vein got flushed. When the vein was flushed, the radiographer requested the patients to minimize body movement by remaining as still as possible. Then the radiographer started the scan from the radiological control room. During the scan, the table moved several times slowly in and out of the gantry. Each time the scan table was outside the gantry, it was possible for the patients to see the nature projection on the wall on their left side.

According to protocol, to deliver high quality CT images, heart rates should be less than 70 beats per minute (BPM) for the scan. When the patients' heart rate exceeded this number during the first scan, the radiographer consulted a radiologist. The radiologist examined whether beta-blockers could be administered via the intravenous line to reduce the heart rate before the next scan could be continued. After finishing the CT scan, the radiographer measured heart rates and blood pressures and removed the needle. Finally, the patients left the imaging room and re-entered the waiting room.

3.2.4 Data collection

From the radiological control room the researcher observed the patients and registered data of each individual patient that underwent a cardiac CT scan. Radiographers were strictly instructed to provide no information about the motion nature intervention to patients. Hence, patients had no knowledge of the study until they left the imaging room. Before patients left the imaging room, the radiographer was instructed to ask all eligible patients whether they were willing to fill in a questionnaire about their experiences during the CT scan. In addition, the radiographer was instructed to hand out an instruction card when patients expressed their willingness to participate. Patients were asked directly after the scanning procedure was finished, making selection bias unlikely.

3.2.5 Outcomes

3.2.5.1 Perceived anxiety

Perceived anxiety in the CT imaging room was assessed by the short State-Trait Anxiety Inventory (Marteau & Bekker, 1992) of the Spielberger State-Trait Anxiety Inventory (STAI) immediately after the scanning procedure (this was after the measures of actual physiological arousal). This six-item short-form (STAI-6) measured the level of anxiety of an individual at the specific moment while they were present in the CT imaging room. One sample item reads "I felt calm in the CT imaging room", which was measured from 1 "not at all" to 4 "very much". The positive items were reversed and a sum of all items (total score of 6 tot 24) was calculated; a higher score reflects more perceived anxiety. There were no missing values on any of the self-reported items, because the tablet procedure required an answer to all questions to complete the questionnaire.

3.2.5.2 Pleasantness room

Patients were asked to rate the pleasantness of the imaging room on a 10-point bipolar scale ranging from (1) 'not pleasant' to (10) 'very pleasant'.

3.2.5.3 Physiological arousal

The radiographer measured heart rate and blood pressure directly before and after finishing the scan using a Criticare Comfort Cuff monitor system. There were 13 missing values in physiological measures before the scan, and 17 missing values after the scan.

3.2.5.4 Perceived contact with radiographer

Patients were asked to rate the contact with the radiographer on a 10-point bipolar scale ranging from (1) 'very poor' to (10) 'excellent'. This item was included in order to control for the potential influence of contact with the radiographer on the perceived anxiety and physiological arousal, and the perceived pleasantness of the room.

3.2.5.5 Administration of medication

Patients underwent different types of cardiac scans, namely calcium scans, coronary scans, trans catheter aortic valve implementation (TAVI) scans, and pre-ablation cardiac scan. Patients undergoing the most common cardiac CT scan (coronary scan) received nitroglycerin spray under the tongue. Use of the medicine was registered because this nitrate dilates blood vessels, which may lower blood pressures and may cause headaches. In addition, when the heart rate of patients exceeds 70 BPM, radiographers consult radiologists to administer beta-blockers (Metoprolol) to lower heart rates below 70 BPM. The researcher registered these data to assess whether perceived anxiety correlates with administered medication.

3.2.5.6 Patient characteristics

Patients were asked to report their age and gender. These data enabled the researcher to link the data of the patients' questionnaire (i.e., perception of patients) with the data that the researcher observed (i.e., physiological arousal, and administration of medication) for analysis. In addition, patients were asked whether they were claustrophobic (yes/no), whether they visited the CT scan for the first time (yes/no), and whether they used a sedative in advance at home (yes/no).

3.2.6 Data analyses

Two linear regression analysis were conducted to test the effect of the nature projection on perceived anxiety, and the rating of the pleasantness of the room. A number of variables that may be related to perceived anxiety were included to control for potential effects, including gender, age, sedation before the scan, familiarity with the scanning procedure (i.e., first time or not), the perceived contact with the radiographer, the use of nitroglycerin, and the use of beta-blockers. Minimum Bayesion Information Criterion (BIC) was used to identify significant explanatory variables for perceived anxiety.

It was expected that patients perceive less anxiety when they perceive the room as more pleasant. Therefore, we tested for the indirect effect of nature projection on anxiety through pleasantness of the room. This analysis included nature projection as treatment, pleasantness of the room as mediator, and perceived anxiety as outcome. The average causal mediation effect (AFME) was estimated using R and performing 5,000 bootstrap samples.

A linear-mixed-model analysis conducted to explore for main and interaction effects of nature projection and time (before and after the scan) on physiological outcome measures heart rate, systolic blood pressure, diastolic blood pressure, and average blood pressure. We tested for the effect of gender, age, time by beta-blocker interaction, group by time interaction, group by beta-blocker interaction, and group by time by beta-blocker interaction. The interaction effect between time (after the scan) and beta-blocker was included as its effect seems evident from medical evidence (Pichler et al., 2012). It was expected that heart and blood pressure rates would be lower before and after the scan when nature was projected compared to the control situation of no projection at all.

3.3 Results

During the experiment, 126 patients met the inclusion criteria. Among these 97, patients completed the questionnaire (77%). From this group, 48 patients filled in the questionnaire in the intervention condition, and 49 patients filled in the questionnaire in the control condition. The independent T-Test (ratio variables) and chi-square test (nominal variables) were used to explore for differences between groups. No significant differences between the intervention group and control group were found. The characteristics of participants are presented in Table 3.1.

Table 3.1 Comparison of sample characteristics between the two groups (N = 97)

		Intervention group (n = 48)	Control group (n = 49)	*p*
Age; M (SD)		55.2 (14.2)	55.0 (13.7)	0.947
Gender; N (%)				0.920
	Male	24 (50.0)	25 (51.0)	
	Female	24 (50.0)	24 (49.0)	
Claustrophobic; N (%)				0.076
	Yes	10 (20.8)	4 (8.2)	
	No	38 (79.2)	45 (91.8)	
First time for CT; N (%)				0.481
	Yes	24 (50.0)	21 (42.9)	
	No	24 (50.0)	28 (57.1)	
Sedation before CT; N (%)				0.629
	Yes	3 (6.3)	2 (4.1)	
	No	45 (93.7)	47 (95.9)	
Beta-blocker during CT; N (%)				0.159
	Yes	17 (35.4)	11 (22.4)	
	No	31 (64.6)	38 (77.6)	

Table 3.2 Descriptive statistics of perceived anxiety and pleasantness of the room (intervention group vs control group)

Dependent variable	Intervention group Mean (SD)	Control group Mean (SD)
Perceived anxiety	10.1 (3.3)	9.6 (2.9)
Pleasantness of room	8.7 (1.2)	8.1 (1.0)

Table 3.3 Results linear regression analyses on perceived anxiety and pleasantness of the room

	Perceived anxiety			Perceived anxiety (minimum BIC[1])			Pleasantness of the room		
	Coeffcient	SE	*p*	Coeffcient	SE	*p*	Coeffcient	SE	*p*
(intercept)	21.62	3.17	<0.001	16.91	1.90	<0.001	8.08	0.17	<0.001
Intervention group	0.60	0.53	0.256	0.70	0.53	0.188	0.56	0.23	0.017
Pleasantness of the room	-0.75	0.26	0.006	-1.00	0.23	<0.001			
Gender; male	-1.10	0.55	0.047						
Age	-0.03	0.02	0.070						
Sedation before the scan; yes	2.54	1.22	0.040	2.73	1.19	0.025	0.04	0.54	0.943
First time for CT; yes	0.68	0.51	0.185						
Claustrophobia; yes	0.41	0.79	0.610						
Perceived contact with radiographer	-0.48	0.36	0.184						
Use of nitroglycerine	-0.21	0.66	0.748						
Beta-blocker; yes	2.49	0.62	<.001	2.89	0.59	<0.001	0.18	0.26	0.498

Note:[1] Results Bayesian Information Criterion (BIC) minimizing model

3.3.1 Effect on perceived anxiety and pleasantness of the room

Table 3.2 shows the descriptive statistics of the level of perceived anxiety and the ratings of the pleasantness of the rooms (intervention group vs control group). Two linear regression analyses (Table 3.3) were conducted to test the hypotheses that motion nature projection (intervention group) effects the level of perceived anxiety (Hypothesis 1), and the rating of the pleasantness of the room (Hypothesis 2). The BIC minimizing model identified pleasantness of the room, sedation before the scan, and usage of beta-blockers as explanatory variables. Results showed that the intervention had no direct effect on perceived anxiety ($\beta = 0.70$, $p = 0.188$). There was, however, a significant positive effect ($\beta = 0.56$, $p = 0.017$) of the intervention on the rating of the pleasantness of the room (Table 3.3).

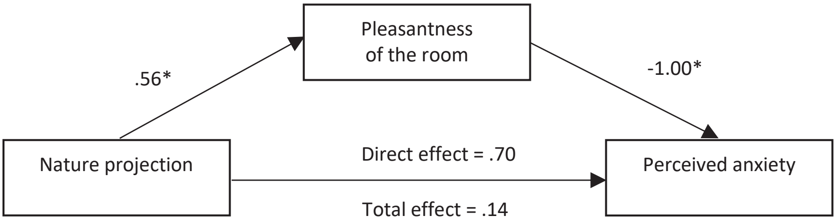

Figure 3.4 Unstandardized coefficients (B) of indirect effect of nature projection on perceived anxiety through pleasantness of the room
Note: * $p < 0.05$

3.3.2 Indirect effect on perceived anxiety

Next, we conducted a mediation analysis to test for the indirect effect of intervention on anxiety through ratings of the room's pleasantness (Hypothesis 3). Although the nature motion projection intervention had no simple (total) effect on perceived anxiety (as reported in Table 3.3), nature projection did have a significant decreasing indirect effect on perceived anxiety through the rating of pleasantness of the room, as the 95% bootstrapped confidence interval did not include zero (B = -0.56, CI = -1.17 to -0.09). As Figure 3.4 illustrates, the group of patients who were exposed to motion nature rated the imaging room as more pleasant (B = 0.56, $p = 0.017$), and the more pleasant patients perceived the room, the less anxiety they reported (B = -1.00, $p <0 .001$). On the one hand, the existence of this significant (negative) indirect effect may seem counterintuitive, given the lack of an overall effect of the intervention on anxiety. However, consistent with our reasoning, there is a significant negative indirect effect (ab = 0.56*-1 = -0.56). This pattern of results (where the sign of c' and ab are opposite) is sometimes referred to as inconsistent mediation (MacKinnon et al., 2007), which suggests that the mediator (pleasantness of the room) is suppressing the effect of the nature motion projection intervention on perceived anxiety.

3.3.3 Effect on physiological outcomes

We now turn to the effect of the intervention on the physiological measures (Hypothesis 4). Table 3.4 shows the results of the final linear mixed model for the outcome physiological arousal. After controlling for various effects (age, gender, beta-blocker), a significant decreasing effect was found of motion nature projection on heart rate and diastolic blood pressure. Heart rates (B = -7.07, $p = 0.042$) and diastolic blood pressures (B = -5.61, $p = 0.040$) of patients were significantly lower, overall, when nature was projected compared to when no nature was projected. No significant interaction effect was found

Table 3.4 Linear-mixed-model results for physiological outcomes (heart rate and blood pressure)

	Heart rate			Systolic blood pressure			Diastolic blood pressure			Average blood pressure		
	Coef.	SE	*p*	Coef.	SE	*p*	Coef.	SE	*p*	Coef.	SE	*p*
(intercept)	73.28	2.87	<0.001	142.70	3.35	<0.001	87.63	2.24	<0.001	116.29	2.95	<0.001
Intervention	-7.07	3.42	0.042	-2.07	4.03	0.609	-5.61	2.70	0.040	-5.82	3.56	0.105
Time; after the scan	2.31	1.43	0.111	-11.28	2.16	<0.001	-7.38	1.43	<0.001	-11.03	1.98	<0.001
Age	0.02	0.10	0.814	0.60	0.12	<0.001	0.28	0.08	<0.001	0.43	0.10	<0.001
Gender	-3.02	2.75	0.276	-1.45	3.14	0.646	1.90	2.10	0.368	-1.43	2.75	0.606
Beta-blocker; Yes	5.36	4.60	0.247	0.09	5.41	0.986	0.33	3.62	0.928	-0.83	4.78	0.863
Time * beta-blocker	-10.02	2.82	<0.001	3.53	4.25	0.409	0.33	2.81	0.906	3.16	3.89	0.420
Intervention * time	-1.59	2.12	0.454	-0.80	3.20	0.804	0.81	2.12	0.703	1.56	2.93	0.597
Intervention * beta-blocker	11.24	6.02	0.065	9.96	7.09	0.163	8.77	4.74	0.067	9.91	6.26	0.116
Intervention * time * beta-blocker	0.31	3.73	0.934	-4.75	5.62	0.401	-1.88	3.72	0.614	-4.97	5.15	0.337

between intervention and time on heart rate or blood pressures. A significant decreasing interaction effect (B = -10.02, p < 0.001) was found between time and the use of beta-blocker on heart rate (Figure 3.5). As expected, patients who received beta-blockers had significantly lower heart rates after the scan compared to before the scan. Results also showed an interaction between intervention and beta-blockers interaction on heart rate (Figure 3.6) and diastolic blood pressure (Figure 3.7) which approached significance. We conducted additional simple effects tests to probe the nature of these interactions. Results showed that, among patients who did not receive beta-blockers, those in the intervention condition had lower heart rates (B = -7.16, p = 0.074) and lower diastolic blood pressures (B = -5.45, p = 0.053) than those in the control group, though the p-values did not reach traditional levels of 0.05 significance (Figure 3.6 and 3.7). By comparison, among those who did receive beta-blockers, the intervention and control conditions did not differ on either heart rate (B = 4.11, p = 0.182) or diastolic blood pressure (B = 3.30, p = 0.379).

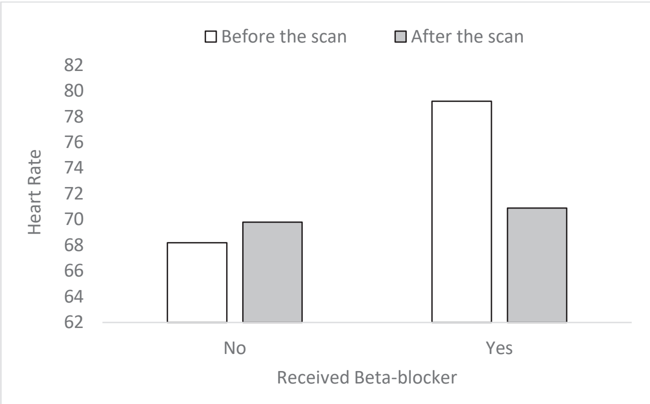

Figure 3.5 Interaction effect of time (before the scan versus after the scan) and beta-blocker (no versus yes) on heart rate

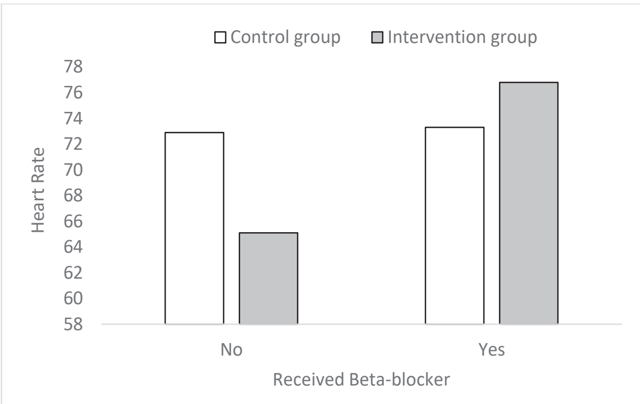

Figure 3.6 Interaction effect of intervention (control group versus intervention group) and beta-blocker (no versus yes) on heart rate

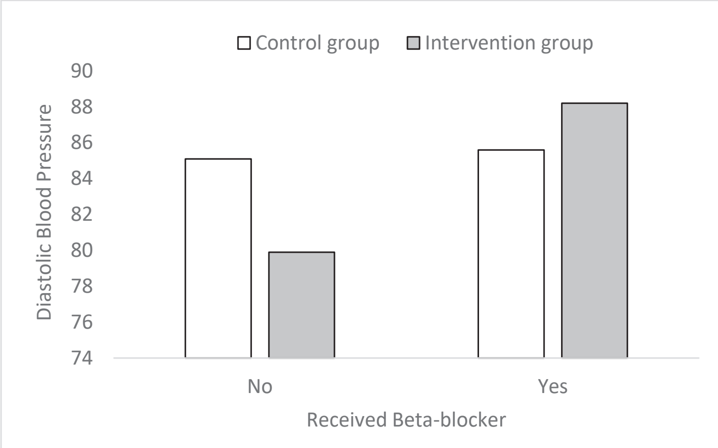

Figure 3.7 Interaction effect of intervention (control group versus intervention group) and beta-blocker (no versus yes) on diastolic blood pressure

3.4 Discussion

The aim of this study was to investigate whether patients experienced less psycho-physiological anxiety in a CT imaging room when motion nature was projected as compared to no projection. This study showed that patients perceived the room as more pleasant when motion nature was projected in the imaging room. This is consistent with the theory of Ulrich (1983) that the visual perception of a landscape may cause a positive affective reaction (i.e., interest or like). Hence, this result implies that natural scenes positively influence patients during CT imaging.

However, this study showed no significant main effect of motion nature projection on perceived anxiety. Patients do not directly perceive less anxiety when motion nature was projected, which confirms the results of an earlier study of Quan et al. (2012).

The results of the mediation analysis showed that nature projection had an indirect effect on perceived anxiety through the rating of pleasantness of the room. Our study implicates that patients perceived the room as pleasant when motion nature was projected, which in turn reduced the level of perceived anxiety. This indirect effect is in accordance with the psycho-evolutionary theory of Ulrich (1983) which posits that the influence of natural environments is a psychological process as a result of visual perception. Ulrich (1983) states that the visual perception of nature can reduce psychological stress directly by the initial affective response (i.e., like or dislike). This study showed that the initial affective response of the participants was a higher rate of the pleasantness of the imaging room when nature was projected, and as a consequence lower levels of perceived anxiety. Our study showed a small but significant indirect effect of nature projection. This small effect can be explained by the limited exposure to nature; patients could only see the nature projection during the conversation with the radiographer, and when they were lying at the scan table and looking toward their left side. In addition, this small indirect effect can be explained by the influence of the initial affective state of patients. According to Ulrich (1983), the visual perception of nature depends on the initial affective state of persons which may influence the selection of the scene that is perceived. For instance, it is widely known that one function of anxiety is the detection of threat (Rinck, Becker, Kellermann, & Roth, 2003). Therefore, it can be explained that patients who perceive high levels of anxiety might not benefit from the nature projection. These patients might be more distracted by threatening stimuli (e.g., technical equipment, white coats) compared to positive distraction (i.e., motion nature projection). In addition, the small indirect effect can also be explained by a variety of patient conditions that might have influenced their initial affective state. Further research is necessary to understand the influence of the initial affective state of patients on the visual perception of patients during a CT scan. Nevertheless, this study showed that when patients did perceive the imaging room as more pleasant as this was associated with lower levels of perceived anxiety.

The existence of the significant negative indirect effect of nature projection may seem counterintuitive, given the lack of an overall effect of the intervention on anxiety. The significant negative indirect effect suggests that the mediator (pleasantness of the room) is suppressing the effect of the nature motion projection intervention on perceived anxiety. That is, patients perceived the room as more pleasant when nature was projected, which in turn reduced the level of perceived anxiety. This may further suggest that motion nature projection may have an effect on an unmeasured (competing) mediator which (alongside pleasantness of the room) leads to an increase in anxiety (rather than a decrease in anxiety). As just one example, it is possible that while motion nature projection can reduce anxiety through improved pleasantness of the room, motion nature projection may simultaneously be distracting or arousing in its own right (e.g., and thus overstimulating), and/or may send a subtle signal to the patient that "this environment is so stressful we need to use nature motion projection to reduce your anxiety." Whatever the correct interpretation, it seems likely that motion nature projection had a more complex (mixed) effect on perceived anxiety than was hypothesized.

We also measured the effect of the intervention on physiological arousal. This study showed that motion nature projection had a positive influence on heart rate and diastolic blood pressure. This suggests that patients experienced less physiological arousal when motion nature was projected compared to no projection. These results are in line with previous studies in the sense that natural scenes lead to physiological relaxation and extend these in the sense that natural scenes also lead to physiological relaxation during diagnostic scans (Barnason, Zimmerman, & Nieveen, 1995; Hartig et al., 2003; Ulrich, 1991). Specifically, the average heart rate of patients' in the intervention group was 66 BPM, compared to an average of 73 BPM in the control group. These results are potentially important because, according to the coronary imaging protocols, patients with heart rates below 70 BPM can be scanned immediately without administration of beta-blockers. In sum, the present results suggest nature motion projection could result in a reduced need for administration of beta-blockers. This may have a positive influence on the work efficiency of radiographers. In addition, lower heart rates during cardiac scans allows a reduction in radiation exposure which may reduce biological hazards (Bischoff et al., 2009; Gerber et al., 2010). However, this study did show an interaction effect on the borderline of statistical significance between intervention and the use of beta-blockers during the CT scan on heart rate. These results imply that patients with high levels of physiological arousal did not physiologically benefit from the motion nature projection. This might be due to variables we did not control, such as medical physiological reasons, other individual psychological coping strategies (e.g., imaginative visualization), or not seeing the motion nature projection as a result of anxiety. On the other hand, as mentioned earlier, the presence of motion nature projection may send a subtle signal to the patient that "this environment is so stressful we need to use nature motion projection to reduce your anxiety," which may even lead to an increase in physiological arousal.

In conclusion, the present study showed that patients undergoing a diagnostic CT scan perceive less psycho-physiological anxiety when motion nature was projected. This suggests that even a relatively simple and quick intervention positively influences the perception of patients during a diagnostic scan. Furthermore, patients exposed to motion nature projection perceived less physiological anxiety, such as lower heart rate and blood pressure. This work contributes to environmental psychology by providing evidence that exposure to nature can also positively influence patients in imaging rooms. Therefore, it is important that hospitals should consider designing pleasant imaging rooms by including positive distraction in the imaging room to reduce psycho-physiological anxiety. By providing pleasant imaging rooms, the well-being of patients can be significantly improved.

3.5 Limitations and future directions

There are some limitations to be considered in this study. We studied the influence of motion nature, because it is known that nature can positively influence patients (Hartig, Evans, Jamner, Davis, & Arling, 2003; Kaplan, 1995; Nanda, Eisen, Zadeh, & Owen, 2011; Ulrich et al., 1991) and motion stimuli attracts more attention compared to still images (Livingstone & Hubel, 1988). However, a limitation of this study is that we did not compare the effect of motion nature projection to other motion images, or still nature images during diagnostic scans. Further research should clarify whether patients actually benefit from motion nature projection compared to other motion images, or still nature images during diagnostic scans.

Moreover, due to practical constraints, the location of the nature projection on the wall and gantry were fixed. It is expected that an increased exposure to positive distraction will expand the positive effects on patients (Andrade & Devlin, 2015). Further research is necessary to show whether other locations of nature projection in the imaging room would have a larger effect on psycho-physiological anxiety of patients during diagnostic scans. For instance, by moving the nature projection at the wall that patients see immediately when entering the room and when lying at the scan table, or moving the nature projection at the inside of the gantry of the scan. In addition, patients may experience greater benefits when they are exposed to nature through virtual reality glasses (Depledge, Stone, & Bird, 2011), or when, in addition to the imaging room, nature projection is also incorporated into the waiting room, before entering the imaging room.

Due to another practical constraint (i.e., presence of radiographers in the scanning room), it was impossible to blind radiographers during the experiment. Therefore, another limitation is that this study was not double-blind and radiographers were informed about the main research question concerning the effect of motion nature projection on the experience of patients. However, the instructions to keep the scanning procedure according to the standard did not indicate any known sign of bias with respect to the outcome in the conditions under which the CT scans were conducted, and additional analyses (not reported in the interests of space) indicated that perceived pleasantness of contact with the radiographer did not mediate the effect of the intervention on the outcomes of interest, further reducing concerns over experimenter demand characteristics.

Another limitation is that in the current study we did not register the type of cardiac CT scan, did not measure radiation exposure, and did not register motion artifacts. Considering coronary imaging protocols, patients with heart rates below 70 BPM during coronary scans can be scanned directly, without the administration of beta-blockers, and allows a reduction in radiation dose and may reduce motion artifacts. Our study showed that motion nature projection can significantly lower heart rates below 70 BPM. Therefore, it is expected that motion nature projection can reduce the administration of beta-blockers, radiation exposure, and motion artifacts for patients undergoing coronary scans. However, we also failed to register the severity of the patient's condition which might influence the administration of beta-blockers. For example, some patients with a certain disease or condition may not receive beta-blockers because this might be harmful. Therefore, further research is required to provide evidence for the influence of motion nature projection on administration of beta-blockers, radiation exposure, and motion artifacts. Potentially this can reduce health risks, save medication costs, reduce time of radiographers to reassure patients before scanning, improve the quality of images, and, therefore, the system potentially requires less time in scheduling patients.

Finally, all patients underwent a CT scan for cardiac diseases. Further research is required to show whether the findings are generalizable to other types of diagnostics scans and other patient groups. Further research is required to determine how this intervention contributes to other patient groups. Nevertheless, the current study contributes to a better understanding of the positive influence of nature scenes on patients during diagnostic scans. Understanding the influence of nature on psycho-physiological anxiety will contribute to further development of effective interventions during diagnostic scans.

Emma Zijlstra
Mariët Hagedoorn
Wim P. Krijnen
Cees P. van der Schans
Mark Mobach

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Chapter 4

The effect of a non-talking rule on the sound level and perception of patients in an outpatient infusion center

Abstract

Noise is a common problem in hospitals, and it is known that social behavior can influence sound levels. The aim of this naturally-occurring field experiment was to assess the influence of a non-talking rule on the actual sound level and perception of patients in an outpatient infusion center. In a quasi-randomized trial two conditions were compared in real life. In the control condition, patients (n = 137) were allowed to talk to fellow patients and visitors during the treatment. In the intervention condition patients (n = 126) were requested not to talk to fellow patients and visitors during their treatment. This study measured the actual sound levels in dB(A) as well as patients' preferences regarding sound and their perceptions of the physical environment, anxiety, and quality of health care. A linear-mixed-model showed a statistically significant, but rather small reduction of the non-talking rule on the actual sound level with an average of 1.1 dB(A). Half of the patients preferred a talking condition (57%), around one-third of the patients had no preference (36%), and 7% of the patients preferred a non-talking condition. Our results suggest that patients who preferred non-talking, perceived the environment more negatively compared to the majority of patients and perceived higher levels of anxiety. Results showed no significant effect of the experimental conditions on patient perceptions. In conclusion, a non-talking rule of conduct only minimally reduced the actual sound level and did not influence the perception of patients.

4.1 Introduction

Patients visit an outpatient infusion center for treatments of various diseases, like cancer, vascular diseases, or muscle diseases. During therapy, some patients prefer a treatment environment to rest, whereas others prefer a social treatment environment with the opportunity to interact with fellow patients and visitors (Browall et al., 2013). The social behavior of people in hospitals can influence the actual sound level and perception of patients (Mackrill et al., 2013).

Many studies showed that sound levels often exceed the WHO guideline of 35 dB(A) in a patient room (Blomkvist, Eriksen, Theorell, Ulrich, & Rasmanis, 2005; Konkani & Oakley, 2012; MacKenzie & Galbrun, 2007; Park et al., 2014). High sound levels can cause noise-induced awakening, sleeplessness, and increased heart rates (Baker, Garvin, Kennedy, & Polivka, 1993; Joseph, 2009). Noise can be defined as the presence of unwanted sound (Berglund et al., 2000). According to the WHO, the critical health effect for patients in a hospital treatment room is disturbance of rest and recovery (Berglund et al., 2000). A study at an intensive coronary ward showed that bad acoustics can even increase the hospital readmission rate and the need for additional intravenous beta-blockers (Hagerman et al., 2005).

In a hospital ward the most negatively perceived sounds were unnecessary sounds, for instance, cleaning machines, paging announcements, phones ringing, trolleys, and loud talking (W. Liu, Manias, & Gerdtz, 2014; Mackrill et al., 2013). Nevertheless, patients reported human-related sounds most, like talking, laughing, and coughing (Mackrill et al., 2013; Park et al., 2014). The study of Baker et al. (1993) showed that the maximum sound level was highest during conversation in a patient room (i.e., 67 dBA), with an average increase of 18 dB(A) during conversations.

Some patients may not be disturbed by these human-related sounds, while others may experience it as annoying (Cohen et al., 1986). According to Mackrill et al. (2013) this difference in perception might depend on the individual coping method; some patients may become familiar with the sounds and they accept and habituate to sounds, while others may not be able to habituate to sounds and perceive it as disturbing. The perception of the sound of talking may also depend on the actual well-being of patients. Studies have shown that patients in oncology wards prefer to have the opportunity to choose between private and shared rooms (Browall et al., 2013; Rowlands & Noble, 2008), but when patients were able to interact they preferred shared rooms (Rowlands & Noble, 2008). Sometimes patients may feel safe and secure when they hear others, while at other times they may be disturbed by these sounds and feel helpless because they cannot escape from the noise (Johansson, Bergbom, Persson Waye, Ryherd, & Lindahl, 2012). Therefore, in an outpatient infusion center the preferences of patients regarding sound may influence the individual perception of sound.

Quiet-time interventions may control the actual sound level by encouraging patients to rest and relax (Lower et al., 2003). For example, quiet-time interventions in the afternoon (1.5 to 2 hours) reduced the sound levels with an average of 10 dB(A) in wards, and the mean sound level was correlated with the number of patients asleep and awake (Dennis, Lee, Woodard, Szalaj, & Walker, 2010; Gardner, Collins, Osborne, Henderson, & Eastwood, 2009). In contrast, an increase of 10 dB(A) is generally perceived as twice as loud (Kryter, 1985). However, these intervention studies manipulated multiple variables, such as a restriction of visitors, restriction of staff movements, promotion of closing doors, reduced light intensity, and lowered volume of technical equipment. Although relevant, for this reason, it is still unknown which individual element effectively reduced the sound level.

Therefore, it is important to study specifically the influence of the sound of talking on the actual and perceived sound levels in a single intervention study.

Based on the ideas outlined above, we expect that a rule of conduct (i.e., a non-talking rule) reduces the actual sound level (hypothesis 1). Additionally, we expect an association between a rule of conduct and the patients' perception, and it is expected that this association depends on the patients' preferences (i.e., non-talking versus talking preference). Finally, we expect that the rule of conduct has more influence on patients with a clear preference as compared to patients with no preference. We hypothesize that patients with a preference for non-talking perceive less anxiety, proximity, crowdedness, and noise, and perceive more environmental satisfaction, privacy, pleasantness of the room, and satisfaction with healthcare treatment when there is a rule of conduct not to talk than when there is no rule of conduct (hypothesis 2). Conversely, patients with a preference for talking perceive less anxiety, proximity, crowdedness, and noise, and perceive more environmental satisfaction, privacy, pleasantness of the room, and satisfaction with healthcare treatment when there is no rule of conduct than when there is a rule of conduct not to talk.

4.2 Methods

4.2.1 Participants

Participants were recruited at the University Medical Center of Groningen (UMCG) between January 2015 and October 2015. Participants were outpatient adults visiting the outpatient infusion center, mostly for cancer treatments but also for treatments of chronic illnesses like Multiple Sclerosis, rheumatic disease, and Raynaud's disease. Patients received different infusion treatments such as chemotherapy or other medicines, and bloodletting or blood transfusions. Eligible patients were 18 years or older, had visited the outpatient infusion center at least one time before, and had a minimum treatment duration of 30 minutes. Patients were excluded when they were not able to read and write Dutch.

A waiver for ethical assessment was provided by the Medical Ethical Committee of the Medical University of Groningen. The study was conducted according to the declaration of Helsinki. Written informed consent was obtained from participants during their visit at the outpatient infusion center.

4.2.2 Study design

In a quasi-randomized trial, participants were assigned to one of the two conditions, namely no rule of conduct (i.e., talking condition) versus a rule of conduct (i.e., non-talking condition). Both conditions were carried out in the same treatment environment. Between January and October 2015 nine weeks were determined as measurement weeks. Patients who were scheduled to receive treatments during these weeks were included in the study. Be reminded that the study was room-based and included all patients in the treatment area in the described periods. The assignment to one of the two behavioral conditions occurred based on the scheduled appointments for a treatment. During three weeks, we assessed a group of 126 patients in the experimental weeks in which the non-talking rule was introduced. During six weeks, we assessed a group of 137 patients in the talking condition.

4.2.3 Procedure

Before patients underwent their treatment at the outpatient infusion center, they received an appointment letter at their home address. Patients with an appointment in the experimental weeks received an additional information letter explaining the rule of conduct, one week before their appointment. By means of this letter, they were prepared for the rule of conduct not to talk to fellow patients and visitors during their treatment in order to respect the preferences of other patients, and also for the purpose of a sound environment test. At the day of the treatment, patients arrived at the reception and first took place in the waiting room. At the day of arrival in the experimental week, all patients were verbally reminded of the rule of conduct by the reception staff at the registration desk. A nurse picked up each patient from the waiting area and entered the treatment area (arrow, Figure 4.1). To test the effect of a non-talking rule and the applicability in a real-life setting, all patients in the treatment area were requested but not forced to comply with the rule. In this treatment area, patients received administration of medication via an injection or an intravenous line, or a blood treatment/bloodletting via an intravenous line. Therefore, an injection or needle was placed into the arm or hand of the patient. During the treatment patients took place on a treatment bed or chair (Figure 4.1). After 30 minutes of treatment, all eligible patients were asked by research assistants and nurses to fill in a questionnaire. The questionnaires were completed and handed in by patients during treatment at the outpatient infusion center.

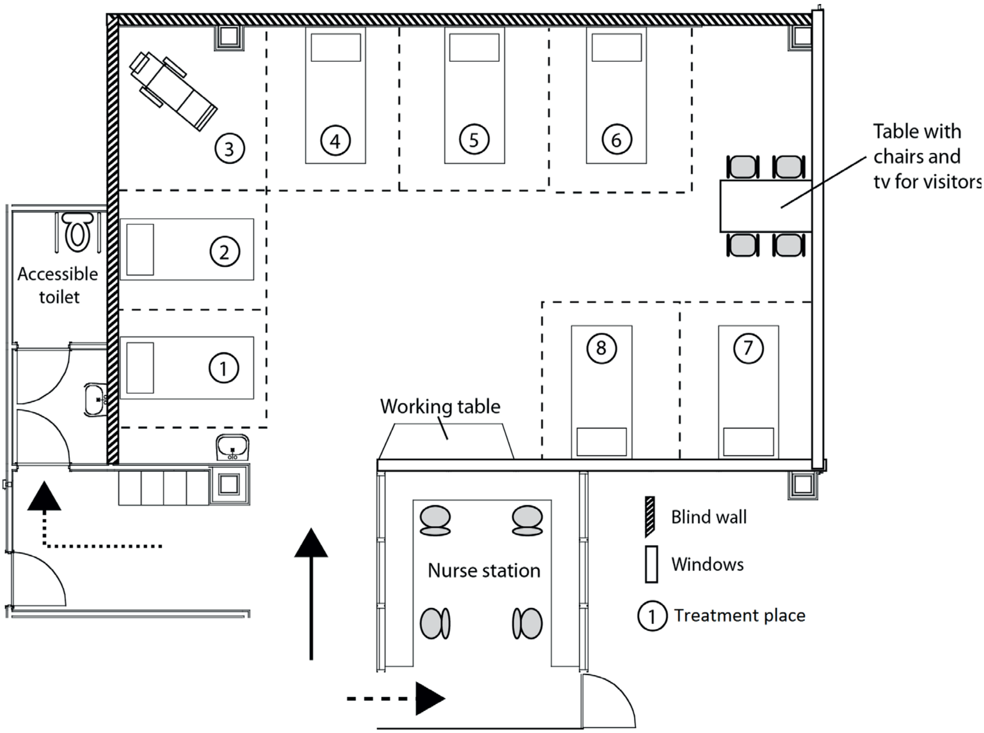

Figure 4.1 Map of the study site

4.2.4 Study site

4.2.4.1 Architectural features

This study was carried out in a treatment area (94m2), which was secluded from other treatment rooms and areas. Consequently, patients were minimally disturbed by other patients or staff. Two sides of the area had blind walls and two sides of the area had windows (Figure 4.1). At one side of the area there were windows overlooking the main corridor of the hospital and perpendicular to this side there were windows with a view of the nurse station. This treatment area had a passage (no doors, arrow, Figure 4.1) to the corridor towards the waiting room. The entrance of the toilet for disabled patients was located in this corridor (dotted arrow, Figure 4.1) and the entrance of the nurse station (no doors, striped arrow, Figure 4.1).

4.2.4.2 Interior design features

An impression of the interior design features is shown in Figure 4.2. The treatment area included seven treatment beds and one treatment chair. A total of eight patients can be treated in this environment at the same time. A table with chairs was available for visitors (Figure 4.1). Moreover, a TV was placed on the ceiling (turned off in both conditions). For nursing staff a working table was placed against the wall of the nurse station. A clock was present above the window and working table, visible for some patients (places 1-6).

Figure 4.2 Impression outpatient infusion center

4.2.5 Outcomes

4.2.5.1 Sound environment

The actual sound level in dB(A) in the treatment area was measured to assess actual differences in sound levels between the two study conditions. A-weighted decibels are a logarithmic unit to express the loudness of sound perceived by the human ear (Kryter, 1985). A sound level meter (Bruel & Kjaer 2250) was placed on the ceiling in the middle of the treatment area and measured the A-weighted equivalent levels (LAeq), minimum levels (LAFmin), and maximum levels (LAFmax) every minute during four days in each condition (Tuesday till Friday). In the non-talking condition, sound levels were measured between 13th and 16th of January, and in the talking condition between 20th and 23rd of January. Sound levels were measured between 10AM and 5PM representing the average sound level. During night time no treatment-related sounds were present at the outpatient infusion center, like patients, staff or alarm systems. To understand the sound levels that were generated by sources during the treatment, the average background sound level was measured during night between 12AM and 5AM as baseline.

4.2.5.2 Perceived anxiety

Perceived anxiety was measured by the Dutch version of the State-Trait Anxiety Inventory (STAI) of Spielberger (van der Ploeg, 1980). On a 4-point Likert scale participants rate whether they felt calm, tense, upset, relaxed, content, or worried (1, not at all; 2, somewhat; 3, moderately; 4, very much). The sum of the 20-item state scale represents the level of state anxiety (i.e., how a person feels at that specific moment); higher scores indicate higher levels of anxiety (total score of 20 to 80). Cronbach's alpha for the state-anxiety scale was .91.

4.2.5.3 Perceived environment

On a 7-point bipolar scale the perception of different environmental variables were measured based on five dimensions (Sundstrom, Town, Brown, Forman, & McGee, 1982). Each dimension consisted of one item and reflected (1) the satisfaction with the room (very dissatisfied versus very satisfied), (2) perceived privacy (not private versus private), (3) perceived proximity (too close to others versus too far from others), (4) perceived crowdedness (not crowded versus crowded), and (5) perceived noise (quiet versus noisy).

4.2.5.4 Perceived pleasantness of room

On a 7-point bipolar scale, participants rated the pleasantness of the room based on four dimensions (i.e., the environment seems: uncomfortable versus comfortable, drab versus colorful, boring versus interesting, and unattractive versus attractive) (Sundstrom et al., 1982). The scores of the four items were summed up, with higher scores reflecting a higher perception of pleasantness of the room. The range of scores is between 4 and 28. The scale showed high internal consistency with a Cronbach's alpha .91.

4.2.5.5 Satisfaction with healthcare

Hawthorne et al. (2014) developed a short questionnaire (7 items) to measure patient satisfaction with healthcare treatment based on seven dimensions (i.e., effectiveness, information, technical skill, participation, relationship, access and facilities, satisfaction general). The participants used a 5-point Likert scale ranging from (0) very dissatisfied to (4) very satisfied. The scores of the seven items were summed up; higher scores reflecting higher levels of satisfaction. The range of scores is between 0 and 28. Cronbach's alpha for the satisfaction with healthcare scale was .67.

4.2.5.6 Patient preferences

Participants were asked (1 item) about their preferences for one of two types of treatment areas. Namely the non-talking room or the talking room. The non-talking room was defined as a treatment area where talking was not allowed, except with healthcare staff. The talking room was defined as a treatment area where it was allowed to speak to healthcare staff, but also, for instance, to fellow patients and visitors. The participants indicated a preference for either room or indicated that they had no preference for one or the other room.

4.2.6 Data analysis

The main and interaction effects of a non-talking rule on the sound levels were examined by linear-mixed-modelling as it accounts for possible random effects during the day. The mixed-model included the minutes during the day as random effects, the measurement day as a fixed effect, and the fixed interaction effect between non-talking condition and measurement day. Standard errors were calculated using a restricted maximum likelihood approach.

To examine the perception of patients, two analyses were conducted. Firstly, a one-way MANOVA was conducted to examine the influence of a non-talking condition on the perceived anxiety, environmental satisfaction, privacy, proximity, crowdedness, noise, pleasantness of the room, and satisfaction with health care. A number of variables that may be related to the dependent variables were included to control for confounding effects, including gender, age, and diagnosis (i.e., cancer versus chronic illness). Secondly, a moderation analysis was conducted to test whether the relation between a non-talking condition and the dependent variables depends on the patients' preference. The moderation analysis included the condition (talking versus non-talking condition) as independent variable and preference (talking preference versus non-talking preference versus no preference) as a moderator. We performed separate analyses for the dependent variables, namely, perceived anxiety, environmental satisfaction, privacy, proximity, crowdedness, noise, pleasantness of the room, and satisfaction with health care. Again, included confounding variables were gender, age, and diagnosis.

4.3 Results

4.3.1 Participants

In total, 263 patients participated in this study with a mean age of 53 years (SD = 14.33). From this group, 126 patients received their treatment in the non-talking condition and 137 patients in the talking condition. Half of the patients had a preference for talking (57%), 7% of the patients had a preference for non-talking, and 36% of the patients had no preference. The characteristics of the sample are presented in Table 4.1. Independent T-tests (ratio variables) and chi-square tests (nominal variables) were used to explore for differences between non-talking condition and talking condition.

Table 4.1 Study sample characteristics (N = 263)

	Non-talking condition (n = 126)	Talking condition (n = 137)	*p*
Male gender; N (%)	51 (41%)	55 (42%)	0.847
Age; M (SD)	52.9 (14.7)	53.5 (14.1)	0.747
Diagnosis; N (%)			0.092
Cancer	84 (67%)	77 (57%)	
Chronic illness	41 (33%)	58 (43%)	
Preferences; N (%)			0.192
Talking preference	73 (58%)	68 (56%)	
Non-talking preference	5 (4%)	12 (10%)	
No preference	47 (38%)	42 (34%)	

Table 4.2 Descriptive statistics sound levels in dB(A) during measurement days (non-talking condition versus talking condition)

	Non-talking condition				Talking condition			
	Number of patients	Cumulative duration treatments (in hours)	Occupancy rate	Sound level dB(A)	Number of patients	Cumulative duration treatments (in hours)	Occupancy rate	Sound level dB(A)
Tuesday	20	44.75	80%	53.3	18	41.50	74%	54.3
Wednesday	21	41.50	74%	52.1	20	43.00	77%	55.4
Thursday	13	43.25	77%	50.2	18	44.00	79%	52.3
Friday	18	36.00	64%	51.9	19	35.00	63%	56.2
Total week (mean)	18	41.38	74%	51.9	19	40.88	73%	54.6

Note: Be reminded that, during the data collection of nine weeks, the sound levels were measured during eight days equally divided over two weeks.

Table 4.3 Results of the linear-mixed-model predicting the average sound levels in dB(A)

	Coefficient	SE	T-value	*p*
Main effects				
(Intercept)	54.324	0.228	238.627	*<0.001*
Non-talking rule	-1.054	0.313	-3.3650	*<0.001*
Tuesday[a]				
Wednesday	1.091	0.313	3.485	*<0.001*
Thursday	-2.058	0.313	-6.572	*<0.001*
Friday	1.897	0.313	6.058	*<0.001*
Interaction effects				
Non-talking rule * Wednesday	-2.246	0.443	-5.073	*<0.001*
Non-talking rule * Thursday	-1.013	0.443	-2.289	*0.022*
Non-talking rule * Friday	-3.227	0.443	-7.289	*<0.001*

[a] Marks the reference category

4.3.2 Rule of conduct and sound level

First, night measurements which were used as a base line showed that the average sound level was 39.7 dB(A). Presented sound levels above 39.7 dB(A) were generated by sound sources during the treatment (e.g., sound of talking, sound of alarms). In the talking condition the mean sound level (LAeq) was 54.6 dB(A) (SD = 5.0) and in the non-talking condition the mean sound level was 51.9 dB(A) (SD = 4.7). The range of sound (LAFmin to LAFmax) in the talking condition was between 41 dB(A) and 69 dB(A), and in the non-talking condition between 40 dB(A) and 67 dB(A).

Figure 4.3 shows that sound levels varied over days (Tuesday till Friday). Descriptive statistics of these measurement days (Table 4.2) showed fluctuations in the number of patients, treatment duration and occupancy rate. Since these variables (i.e., number of patients, treatment duration, and occupancy rate) were not independent they were excluded in the linear-mixed-model, but we controlled for measurement days. Results

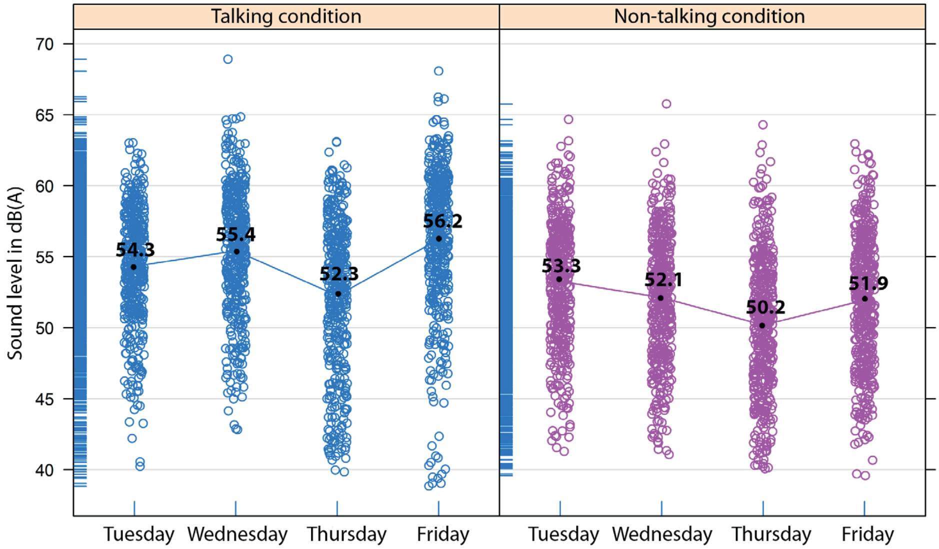

Figure 4.3 Average sound levels in dB(A) during four measurement days in each condition. Dots represent the sound level per minute

of linear-mixed-model (Table 4.3) confirmed our first hypothesis and showed a significant difference of 1.1 dB(A) in the mean sound level between the talking and non-talking condition, taken into account the effect of measurement days. The results of the linear-mixed-model showed a significant effect of measurement day on the average sound level. Moreover, results showed a significant interaction effect between the non-talking rule and measurement day. Therefore, also per day the average sound level (LAeq) in the non-talking condition was lower compared to the talking condition.

4.3.3 Rule of conduct and patient perception

The results of a one-way MANOVA (Table 4.4) showed that there was no significant main effect of the non-talking condition on the dependent variables level of perceived anxiety, environmental satisfaction, perceived privacy, perceived proximity, perceived crowdedness, perceived noise, perceived pleasantness of the room, and satisfaction with healthcare. In addition, results showed some significant effects of the covariates. Gender had a significant effect on pleasantness of the room, and age on environmental satisfaction, privacy, and pleasantness of the room. The covariate diagnosis showed a significant effect on satisfaction with healthcare.

According to our second hypothesis we expected an interaction between condition and preference. However, our descriptive results (Table 4.1) showed that the number of participants who preferred non-talking was too small to test meaningful statistical differences. Therefore, only a moderation analysis was conducted for the patients who preferred talking and had no preference (Table 4.5). The results of the moderation analysis showed no significant interaction effect. Hence, the relation between the condition (talking versus non-talking) and the dependent variables did not depend on the patients' preferences (talking versus no preference). However, results did show a significant effect of preference on how patients rated the pleasantness of the room ($p = 0.038$). Patients

Table 4.4 Results of one-way MANOVA of rule of conduct (non-talking versus talking) on perceived anxiety, environmental satisfaction, privacy, proximity, crowdedness, noise, pleasantness of room, and satisfaction with health care

Independent variable	Dependent variable	F	*p*	Talking condition mean ± SD	Non-talking condition mean ± SD
Rule of conduct	Anxiety	0.087	0.768	32.3 ± 7.7	32.1 ± 8.9
	Environmental satisfaction	1.101	0.296	6.1 ± 1.1	6.2 ± 0.9
	Privacy	2.024	0.157	4.2 ± 1.6	4.5 ± 1.6
	Proximity	0.804	0.371	4.0 ± 1.1	4.7 ± 5.9
	Crowdedness	0.733	0.393	4.3 ± 0.9	4.1 ± 0.8
	Noise	0.000	0.990	4.2 ± 1.2	4.2 ± 4.7
	Pleasantness of room	1.149	0.285	16.5 ± 5.4	16.8 ± 5.5
	Satisfaction with healthcare	0.463	0.497	29.8 ± 2.9	29.7 ± 2.5
Covariates					
Gender[a]	Anxiety	1.292	0.257		
	Environmental satisfaction	0.121	0.728		
	Privacy	2.507	0.115		
	Proximity	0.113	0.737		
	Crowdedness	0.735	0.392		
	Noise	1.519	0.220		
	Pleasantness of room	4.972	*0.027*		
	Satisfaction with healthcare	1.795	0.182		
Age	Anxiety	2.277	0.133		
	Environmental satisfaction	10.082	*0.002*		
	Privacy	7.871	*0.006*		
	Proximity	0.754	0.387		
	Crowdedness	0.007	0.932		
	Noise	0.004	0.952		
	Pleasantness of room	23.357	*0.000*		
	Satisfaction with healthcare	0.066	0.797		
Diagnosis[b]	Anxiety	3.087	0.081		
	Environmental satisfaction	0.634	0.427		
	Privacy	0.032	0.858		
	Proximity	0.444	0.506		
	Crowdedness	0.327	0.568		
	Noise	0.030	0.863		
	Pleasantness of room	1.503	0.222		
	Satisfaction with healthcare	3.973	0.048		

Note: a Female versus male (male is reference category)
b Chronic illness versus cancer (cancer is reference category)

Table 4.5 Results interaction analysis between condition (talking versus non-talking) and patient preference (no preference versus talking preference)

	Condition[a]				Preference[b]				Condition * preference			
	B	SE	t	*p*	*B*	SE	t	*p*	*B*	SE	t	*p*
Anxiety	-0.91	1.25	-0.72	0.470	-0.73	1.30	-.056	0.576	1.28	2.55	0.50	0.616
Environmental satisfaction	0.17	0.13	1.32	0.188	-0.07	0.14	-0.48	0.629	0.32	0.27	1.19	0.237
Privacy	0.33	0.22	1.51	0.134	0.34	0.23	1.49	0.138	0.82	0.45	1.84	0.067
Proximity	0.56	0.52	1.07	0.285	0.31	0.54	0.57	0.568	1.29	1.06	1.22	0.225
Crowding	-0.14	0.12	-1.15	0.251	-0.12	0.13	-0.92	0.359	0.25	0.25	1.01	0.312
Noise	-0.07	0.43	-0.16	0.872	-0.12	0.45	-0.45	0.656	0.84	0.87	0.96	0.338
Pleasantness of room	0.27	0.68	0.39	0.350	-1.49	0.72	-2.08	*0.038*	1.31	1.40	0.94	0.350
Satisfaction with healthcare	0.02	0.39	0.05	0.961	0.01	0.41	0.01	0.996	0.70	0.80	0.87	0.386

Included covariates: gender, age and diagnosis
a Talking condition versus non-talking condition (non-talking condition is reference category)
b Talking preference versus no preference (no preference is reference category)
Note: Non-talking preference sample was too small to test statistical analyses.

Table 4.6 Mean and standard deviations of dependent variables per preference

Dependent variable	Non-talking preference (n = 17)	Talking preference (n = 141)	No preference (n = 89)
Anxiety	37.9 ± 7.9	31.8 ± 16.4	32.1 ± 18.0
Environmental satisfaction	5.4 ± 1.4	6.2 ± 1.0	6.3 ± 0.9
Privacy	2.8 ± 1.8	4.5 ± 1.6	4.2 ± 1.7
Proximity	3.3 ± 1.9	4.4 ± 4.6	4.0 ± 3.6
Crowdedness	5.0 ± 1.2	4.2 ± 0.8	4.3 ± 0.9
Noise	4.8 ± 1.7	4.2 ± 3.7	4.2 ± 2.9
Pleasantness of room	13.5 ± 4.0	16.4 ± 5.3	18.0 ± 5.1
Satisfaction with healthcare	29.6 ± 2.6	29.9 ± 2.6	29.9 ± 2.8

Note: Number of patients who preferred a non-talking condition was too small to test statistical differences. There were 16 missing values in preference, because these patients did not indicate their preference.

who preferred talking rated the room as less pleasant compared to patients without a preference, regardless of the condition.

In addition, the differences in descriptive means were explored to gain additional insight in the three different preferences of patients (i.e., non-talking preference, talking preference, no preference). Results showed that patients with a non-talking preference revealed higher levels of perceived anxiety compared to patients with a talking preference and no preference (Table 4.6). In addition, results of patients that preferred non-talking showed the lowest score on environmental satisfaction, perceived privacy (i.e. not private), and perceived proximity (i.e. too close to others), and perceived the room as less pleasant compared to patients who preferred talking or had no preference. In addition, patients with non-talking preference perceived more crowding and noise compared to patients with a talking preference and no preference. Scores of satisfaction with healthcare did not differ considerably between the groups.

4.4 Discussion

The results of this study showed that a rule of conduct (i.e., request for patients not to talk to fellow patients and visitors) reduced the sound level in an outpatient infusion center. The observed differences were very small, but statistically significant. In addition, the rule of conduct did not significantly influence the perception of patients, neither positive nor negative. The minority of patients preferred a non-talking condition in the outpatient infusion center, and the results showed that this group of patients perceived higher levels of anxiety and perceived the outpatient infusion center as less positive, compared to patients who preferred talking or had no preference. However, due to limitations in the sample size the relevant and exciting findings at the non-talking preference group need further investigation in future research to allow more robust conclusions.

First, in this study, the average sound level was 52 dB(A) in the non-talking condition and 55 dB(A) in the talking condition, with a maximum sound level of 69 dB(A). The average sound level in the control condition was 19.6 dB(A) higher than the recommended level of 35 dB(A) in hospital treatment rooms stated in the WHO guideline. Furthermore, in the non-talking condition the minimum sound level was 40 dB(A) and still exceeded the recommended level. This minimum sound level of 40 dB(A) can be compared with the sound of whispering (Harris, 1979). People can speak with a relaxed voice when sound levels are below 50 dB(A), sound level of 57 dB(A) can be compared with a with a normal voice, 65 dB(A) with a raised voice, 74 dB(A) with a very loud voice, and 82 dB(A) with a shouting voice (Harris, 1979). Therefore, in the current outpatient infusion center, with a maximum sound level 69 dB(A), people may need to raise their voice in conversations (Harris, 1979).

Second, this study showed a statistically significant, but rather small effect of a non-talking rule on the actual sound level with an average of 1.1 dB(A). Results showed a significant interaction effect between the non-talking condition and measurement day, and showed a reduction in sound level up to 3.3 dB(A) on Wednesday, up to 2.1 dB(A) on Thursday, and up to 4.2 dB(A) on Friday. A reduction of 3 dB(A) is a halving of sound sources (i.e., acoustic power). Other studies (Dennis et al., 2010; Gardner et al., 2009) showed a reduction of 10 dB(A) through a quiet-time intervention. So, the observed differences in this current study were rather small. However, the other studies included multiple manipulations (patient behavior, staff behavior, technical equipment). Be reminded that our intervention study only manipulated patient behavior by means of a rule of conduct, namely non-talking. According to the focus theory of normative conduct (Cialdini, Reno, & Kallgren, 1990), humans behave according to descriptive norms (typical or normal behavior) and injunctive norms (rules or beliefs). The reduced sound level suggests that the typical behavior of talking in the outpatient infusion center (descriptive norm) can be changed by setting a non-talking rule of conduct (injunctive norm).

Third, in contrast with the results of other studies (Gardner et al., 2009; Lower et al., 2003), our intervention study showed no influence of the non-talking rule on the perception of patients. Previous studies were conducted in wards where patients stayed overnight. This may be explained by the relatively small average reduction of 1 dB(A) in our study compared to an average reduction of 10 dB(A) in the quiet-time intervention study including multiple manipulations (Gardner et al., 2009). On the other hand, patients in outpatient infusion centers may experience their visit differently compared to inpatients, because they perceive the benefit of leaving after the treatment is finished (McIlfatrick, Sullivan, McKenna, & Parahoo, 2007). Therefore, patients may accept the sound as a part of being in a hospital (Mackrill et al., 2013), and may adapt to the current situation and pay less attention to the noise (Cohen et al., 1986).

Fourth, one of our concerns was that the noise not related to talking was quite high, and therefore the non-talking rule didn't have such an impact on overall noise reduction. This can be explained by sounds due to conversations between nurses and patients about the patients' health and treatment. In addition, other studies also showed that the effect of technical related sounds were mentioned by patients (Mackrill et al., 2013). Studies showed that the increasing use of medical device alarms cause noise (Konkani, Oakley, & Bauld, 2012). At this outpatient infusion center acoustic alarms were used as a warning system for nurses. Since most patients underwent infusion therapy and received medication via an intravenous line, each individual patient had a medical alarm system standing next to their bed or chair which can be explained as a reason that the overall sound level was pretty high.

Fifth, this study showed that more than half of the patients preferred a talking condition, around one-third of the patients had no preference, and only a minority preferred a non-talking condition. Despite the small group of patients who preferred a non-talking condition, results suggest that they had different perceptions compared to other preferences. This group of patients perceived more anxiety, lower satisfaction levels, perceived the room as less pleasant, perceived less privacy, and felt close proximity (too close to others). Dijkstra et al. (2006) suggested that the perception of a stimulus (e.g., sound) depends on the characteristics of the patient population. Our results suggest that it may specifically depend on the individual preference of patients and that patients who prefer non-talking perceive the current outpatient infusion center (non-talking or talking condition) more negative compared to patients who prefer talking or had no preference. However, due to a small group who preferred a non-talking condition, further research in a larger sample is necessary to test whether the differences in percentages also reflects a true statistically significant difference.

In conclusion, our study showed that a rule of conduct seems to influence patient behaviors in a field-setting, but by doing so, only slightly reduces the actual sound level, however not to an impactful level in an outpatient infusion center. The well-being and perception of patients was not influenced by the rule of conduct. However, our results suggest that patients who preferred non-talking (although having limitations due to a small sample size and related statistical power), perceived the environment more negatively compared to the majority of patients and perceived higher levels of anxiety. The results indicate that a rule of conduct is not sufficient to reduce sound level and improve the perceptions of patients in an outpatient infusion center. Patients in an outpatient infusion center might potentially benefit from a patient-centered spatial design where they have the opportunity to choose whether to rest in silence or to communicate with others.

4.5 Further research and limitations

This study has some limitations. First, patients with different preferences were assigned to a non-talking and talking condition. It is expected that the average sound level will decrease more when exclusively patients with a non-talking preference receive their treatment in a non-talking condition. Therefore, it is expected that the opportunity to choose between a non-talking and talking condition may potentially influence the perception of patients positively. Further research should clarify whether the opportunity to choose between conditions, for instance, with a spatially-targeted planning system, shows a larger influence on the sound level and, in addition, a positive influence on the perception of patients.

Second, our results showed a significant interaction effect between the non-talking rule and measurement days on sound levels. However, due to the complexity of the naturally occurring field experiment and to financial limitations, the sound measurements were limited to eight days and we did not measure sound sources and sound levels of treatment equipment separately. Results of the descriptive statistics of the measurement days showed fluctuations in the number of patients, occupancy rate and sound levels (e.g., lower occupancy rate on Friday but an increase in sound level). These fluctuations cannot be explained with the data of the current study design. Further research is necessary to distinguish and unravel the causes (sound sources) of the sound levels.

Third, patients were only included in this study when they visited the outpatient infusion center at least for the second time. Therefore, patients in the talking condition (control condition) may have adapted to the current situation and were used to the sound level. It is expected that patients visiting the outpatient infusion center for the first time may have different preferences and perceive the sound environment more negative compared to recurring patients. Further research is necessary to examine whether the preferences and perceptions differ between recurring patients and patients who visit an outpatient infusion center for the first time.

Finally, the results of this study showed a difference between preferences and the perception of patients. However, we cannot generalize the results because the group of patients who preferred non-talking was a relatively small group. Further qualitative research is necessary to provide a rich understanding of the experiences of patients with different preferences. Gaining a greater understanding of the underlying feelings and reasons of patients visiting an outpatient infusion center and how this would contribute to a better understanding of how to improve the experiences and well-being of patients in an outpatient infusion center.

Emma Zijlstra
Mariët Hagedoorn
Stefan C.M. Lechner
Cees P. van der Schans
Mark Mobach

Facilities 2020

Chapter 5

The experience of patients in an ouptatient infusion center: A qualitative study

Abstract

Purpose: Since hospitals are now being designed with an increasing number of single rooms or cubicles, the individual preference of patients with respect to social contact is of great interest. The purpose of this study was to gain a better understanding of the experience of patients in an outpatient infusion facility.

Methodology: A total of 29 semi-structured interviews were conducted, transcribed, and analyzed by using direct content analysis.

Findings: Findings showed that patients perceived a lack of acoustic privacy and therefore tried to emotionally isolate themselves or withheld information from staff. In addition, patients complained about the sounds of infusion pumps, but they were neutral about the interior features. Patients who preferred non-talking desired enclosed private rooms and perceived negative distraction due to spatial crowding. In contrast, patients who preferred talking, or had no preference, desired shared rooms and perceived positive distraction due to spatial crowding.

Research implications: In conclusion, results showed a relation between physical aspects (i.e., physical enclosure) and the social environment.

Practical implications: The findings allow facility managers to better understand the patients' experiences in an outpatient infusion facility and to make better-informed decisions. Patients with different preferences desired different physical aspects. Therefore, nursing staff of outpatient infusion facilities should assess the preferences of patients. Moreover, architects should integrate different types of treatment places (i.e., enclosed private rooms and shared rooms) in new outpatient infusion facilities to fulfill different preferences and patients should have the opportunity to discuss issues in private with nursing staff.

Originality/value: This study emphasizes the importance of a mix of treatment rooms, while new hospital designs mainly include single rooms or cubicles.

5.1 Background

Hospitals aim to provide optimal health care and the facility manager in a hospital supports the delivery of health care services with the right built environment and support services. The facility design can positively influence patients' experiences and well-being (Becker and Parsons, 2007; Ulrich et al., 2010; Tanja-Dijkstra and Pieterse, 2011; Rashid, 2015). However, many hospitals lack knowledge about how patients experience their spaces and facility services. If we do not know people's needs in a specific context - not even in a potentially life-threatening situation - how can we make buildings that work for people? This can only be done by asking users. Therefore, knowledge regarding the patients' experiences of the facility design is essential for facilitating the quality of health care.

A growing number of patients receive treatments for cancer or chronic diseases, such as muscle or vascular diseases, in outpatient infusion facilities. Although these treatments may take up to eight hours, the advantage is that patients do not need to stay overnight and can leave after the treatment is finished (McIlfatrick et al., 2007). Nevertheless, the high diversity in treatments and the different needs of patients may reveal different experiences during treatments. Patients may cope differently with these stressful situations. Some patients may prefer a treatment environment that allows them to contemplate and rest (i.e., little noise), whereas others may prefer a treatment environment that distracts them and provides them with the opportunity to talk to fellow patients and visitors (Browall et al., 2013). Since hospitals are now being designed with an increasing number of single rooms or cubicles, the individual preference of patients with respect to social contact is of great interest. However, it is currently unknown how outpatients visiting an infusion facility experience the treatment environment and how to design an infusion facility respecting individual preferences.

Patients perceive a treatment environment as an entity that contains physical and psychosocial aspects, where the primary psychosocial desire of patients is supported by the physical environment (Browall et al., 2013). In the context of this study, the social environment was defined as the (opportunity) to interact between people in and around the treatment environment (Mobach, 2009). The physical environment contains different aspects, such as architectural features (e.g., windows, spatial layout), interior features (e.g., seating arrangements, television, flowers), and ambient features (e.g., light, sound, odor), and these aspects can influence patients both positively and negatively (Dijkstra et al., 2006; Harris et al., 2002).

The visual impression of the physical environment can be perceived as important by patients and can support a feeling of well-being (Browall et al., 2013). Physical environments can potentially reduce anxiety and increase satisfaction (Campos Andrade, Lima, Pereira, Fornara, & Bonaiuto, 2013; Ulrich et al., 2004). It is known that perceived pleasantness of a healthcare setting can have a mediating role in reducing stress (Dijkstra, Pieterse, & Pruyn, 2008b; Zijlstra, Hagedoorn, Krijnen, van der Schans, & Mobach, 2017). Therefore, the pleasantness of the physical environment might be critical to patients who receive chemotherapy (Sitzia & Wood, 1998).

In addition to the pleasantness of the room, sound is also an important ambient feature of the physical environment, which can influence patients positively and negatively (Mackrill et al., 2013). For example, low levels of sound at night can be associated with the ability to rest at night, but natural background sounds (e.g., people talking, music, kitchen) during the day can be associated with amusement (Browall et al., 2013). Many studies emphasize on the effect of actual sound levels. However, sometimes patients may feel safe and secure when they hear others, while at other times they may be disturbed by these sounds and feel helpless because they cannot escape from the noise (Johansson, Bergbom, Waye, et al., 2012). Therefore, it is important to understand the underlying feelings of patients in an outpatient infusion facility regarding sounds.

The physical environment can support the psychosocial aspects and can promote social contact among fellow patients (Browall et al., 2013; Larsen et al., 2014). Many hospitalized oncology patients have the need to meet fellow patients, because they understand each other's situation and can share experiences and information (Steen Isaksen & Gjengedal, 2000). According to Ulrich's theory (1991) physical healthcare environments can reduce anxiety when fostering access to social support. For example, people perceive less anxiety when health settings provide access to social support during hospitalization (e.g., space and chairs for family, internet, bedside phone, sleeper sofa for family) (Andrade & Devlin, 2015). Nevertheless, patients cope differently when they are confronted with fellow patients, patients can have a response of fighting, keeping hope, non-acceptance or capitulation (Andersen, Larsen, & Birkelund, 2015). It is unknown how the physical environment can affect the social aspects in an outpatient infusion facility.

Several studies discussed that in treatment environments a balance is needed between the social and privacy aspects (Alalouch, Aspinall, & Smith, 2009; Edvardsson et al., 2006; R. Ulrich, 1991). A study in office settings showed that the degree of physical enclosure is related to perceived privacy (Sundstrom et al., 1982); the more enclosed spaces are by walls or partitions, the more privacy is perceived by persons. In a reversed analogy, reduced degree of enclosure in hospital settings can mean that patients feel less privacy in being involuntary exposed to information of fellow patients; it may even cause feelings of helplessness and fearfulness (Johansson, Bergbom, Waye, et al., 2012), while patients also may feel involved when seeing something happening in the environment, but simultaneously desire privacy (Edvardsson et al., 2006). However, it is still unknown how patients perceive privacy in an outpatient infusion facility.

Based on the knowledge outlined above, we investigated how patients experienced the physical aspects (i.e., pleasantness of the room, sound), social aspects (i.e., proximity and crowding), and privacy aspects in the treatment environment of an outpatient infusion facility with a qualitative data analysis. It is expected that patients, with different preferences with respect to talking (i.e., no talking preference, talking preference, no preference), may experience an outpatient infusion facility differently. Therefore, this study examined two research questions: (1) How do patients experience the physical, social, and privacy aspects in the treatment environment of an outpatient infusion facility?; (2) How do patients, with different preferences, experience the physical, social, and privacy aspects in the treatment environment of an outpatient infusion facility?

5.2 Methods

The aim of this study was to gain a better understanding of how patients, with different preferences, experience the physical, social and privacy aspects in the treatment environment of an outpatient infusion facility. A descriptive qualitative study of semi-structured interviews with three groups of patients was employed.

5.2.1 Setting

The outpatient infusion facility was located in the University Medical Center of Groningen in the Netherlands. In the outpatient infusion facility of the University Medical

Center of Groningen, around 70 patients receive treatments each day. Patients visiting the outpatient infusion center arrived at the waiting area after registering at the reception desk (see arrow, Figure 5.1). A nurse met the patients in the waiting room and showed them the scheduled treatment place. The treatment environment contained three shared patient areas with multiple treatment beds and/or chairs (blue), and four private rooms with a treatment bed (green). In total the patient areas contained 17 treatment beds and five treatment chairs. The environment contained two storage rooms, one biopsy room, and five staff areas where nurses were able to do computer work, discuss patient information, prepare medication, or have a break.

Figure 5.1 Map outpatient infusion facility

5.2.2 Participants

A purposive sampling method was used to select participants. Participants were selected based on the preference with respect to talking, namely (1) non-talking preference (2) talking preference, or (3) no preference.

Patients visiting the outpatient infusion facility were approached for a qualitative interview. These participants (N = 163) received an information letter, including a reply form to sign up for the interview and indicate their preference. Forty-three patients signed up for the interview (26% response rate). After calling, two patients dropped out of the study for personal reasons (i.e., too sick and need for rest after illness).

5.2.3 Data collection

Participants were interviewed face-to-face by using an interview guideline (Table

5.1) based on five perceptions (i.e., pleasantness of room, sound, proximity, crowding, privacy) of an environment (Sundstrom, Burt, & Kamp, 1980). Semi-structured interviews were held at participants' homes between October 2015 and March 2016. The researcher asked the participants beforehand whether it was possible to conduct the interview in a room without the presence of others. All participants agreed to this. With permission of the participants, all interviews were audiotaped. The participants were informed about the goal of this study that was to improve the experience of patients and future patients of the outpatient infusion facility. To validate the way of questioning and framing for cancer patients, an expert of the Dutch Federation of Cancer Organizations evaluated the audiotape of the first interview. Field notes of statements of participants were made during the interviews to be able to ask follow-up questions. Further questions to understand the topics were based on what the participants said and consisted mainly of requests for clarification, details, and examples. Interview duration ranged from 40 to 90 minutes with an average of 59 minutes. Data collection was completed after 29 interviews, since we reached data saturation during the last interviews (i.e., new themes did not occur).

Table 5.1 Interview guideline

Aspects (topics)	Questions
Physical aspects (i.e., pleasantness of the room, sound)	- How would you describe the treatment environment? - How comfortable do/did you perceive the treatment environment? - How colorful do/did you perceive the treatment environment? - How interesting do/did you perceive the treatment environment? - How attractive do/did you perceive the treatment environment? - Can you describe the sounds you hear(d) during treatment? - How do/did you perceive the sound level during treatment?
Social aspects (i.e., proximity, crowding)	- How do/did you perceive the distance between you and other patients? - How do/did you experience the number of other patients?
Privacy aspects (i.e., privacy)	- What does privacy mean to you at an outpatient infusion center? - How do/did you perceive privacy in the treatment environment? - How do/did you experience the visual privacy? - How do/did you experience the acoustic privacy?

5.2.4 Data analyses

Audiotapes of the interviews were transcribed verbatim in Dutch. All interview transcripts were coded using directed content analysis (Hsieh & Shannon, 2005).

According the directed content method, existing theory was used to start identifying variables as initial coding categories. The analysis started with the key variables as initial coding categories using the theory of Sundstrom et al. (1980), namely sound, pleasantness of the treatment environment, proximity, crowdedness, and privacy. Two coders coded the interviews separately and it was carried out by hand. In addition, each transcript was briefly summarized in a few sentences describing the findings regarding codes.

After coding five interviews, the codes were entered in the software package ATLAS. ti. Both coders categorized all codes in predefined categories and new categories and subcategories that were derived from the data. After agreement of the initial coding framework the remaining interviews were coded. Consequently, after two coded interviews the coders critically assessed the codes mutually in order to check and reach agreement before continuing.

Both coders continued by making a conceptual model of the categories that were coded to identify relationships between categories. The relations between categories (i.e. causal network) were developed through a logical interpretation of the relationship between codes in the participants' quotation (Miles & Huberman, 1994).

Next, the final themes were defined. Three themes were derived from a causal network, namely:

(1) effect of acoustic privacy on patient behavior,
(2) effect of physical enclosure on perceived social environment; and
(3) effect of spatial layout on perceived distraction.

Two themes were derived from clustered categories, namely:

(1) perception of interior features; and
(2) perception of sound environment.

5.2.5 Ethical considerations

According to the Dutch law for medical research involving human subjects (WMO), the medical ethical committee of the Medical University of Groningen provided a waiver for ethical assessment. The study was conducted according to the declaration of Helsinki. Participants were fully informed by means of an information letter, a phone call, and verbally at the beginning of the interview. Participants gave verbal permission for audiotaping the interview, and signed an informed consent that they were willing to participate.

5.3 Findings

A total of 29 out of 43 participants were interviewed until saturation was achieved. The background of these participants is shown in Table 5.2. The findings are presented according to the themes. First, three themes show the experiences of patients in general. Followed by two themes presenting the findings of the experiences of patients with different preferences. The themes are illustrated with quotations of participants. Words that are not part of the original quotations are stated in square brackets [interpretation authors].

Table 5.2 Demographic- and treatment information participants

Preferences	Total participants	Gender (female/ male)	Disease (cancer/ chronic)	Average treatment period (year)		Average duration per treatment (hour)	
				Mean	SD	Mean	SD
Talking preference	14	10/4	8/6	3.4	3.9	3.4	1.9
Non-talking preference	9	9/0	4/5	7.6	7.8	5.1	2.2
No preference	6	5/1	4/2	3.3	3.7	3.6	2.6

5.3.1 Experience of the treatment environment in general

The analysis revealed that the majority of participants experienced a lack of acoustic privacy, perceived technical-related sounds negative, and perceived the interior features neither negative nor positive. The themes, categories, and sub-categories are presented in Table 5.3.

Table 5.3 Themes, categories, and sub-categories of experiences of the treatment environment in general

Themes	*Categories* (subcategories)
Perception of relation between acoustic privacy and patient behavior	*Acoustic privacy* (Acoustic privacy medical information, acoustic privacy non-medical information)
	Patient behavior (Attempting emotional isolation, withholding information from staff)
Perception of interior features	*Interior features* (Ambience, interior condition, television, furniture, lighting)
Perception of sound environment	*Sound environment* (Human-related sounds, technical-related sounds, sound level)

5.3.1.1 Perception of relation between acoustic privacy and patient behavior

Experiences of a lack of acoustic privacy were central in many narratives (n = 25). These patients mentioned that confidential conversations could be overheard and described dissatisfaction with the lack of acoustic privacy in the shared treatment areas. One patient described that nurses ask with genuine interest how the patient is feeling, while walking toward a treatment bed. She described how she did not want to honestly answer this question in front of all people. In addition, patients did not feel the urge to hear the stories of fellow patients:

"I think others do not have to know who I am, and I don't have to know who others are."

As a consequence of the lack of acoustic privacy, some patients (n = 8) tried to cope with this by emotionally isolating themselves from hearing these conversations either by reading, hiding under the sheets, listening to music and turning up the volume, or even by leaving the clinic temporarily. Nevertheless, they often heard the stories of patients against their own will:

"You can literally hear it. Then I try to read something […] you really do not have any privacy. Actually, it is not possible [it is not right] [...]"

Another way of coping with this lack of acoustic privacy was that several patients (n = 9) intentionally withheld information from nursing staff. By using this strategy, patients tried to prevent private issues from being overheard by others. As a consequence of withholding information, one patient felt she needed to suppress her feelings, which made her feel lonely:

"I myself noticed that when one realizes everyone or anyone, a lot of people can hear, you [realize] it is not normal, normal? Then I am self-conscious [of what I am saying] and that is not good because I need to be able to speak freely, what I'm thinking, should I say that? When I know others can hear it also, or should I keep things superficial?"

5.3.1.2 Perception of sound environment

Patients described how they could hear technical-related sounds and human-related sounds, but only few patients (n = 2) complained about the sound levels. These patients mentioned that they suffered from an increased sensitivity to sound as a side-effect to their medication:

"Every, every sound makes the headache worse."

Although most patients did not complain about the levels of sound in general, most patients (n = 21) did complain about the source of the sounds, namely technical equipment. Patients described especially the sounds of beeps of infusion pumps as irritating, annoying, unpleasant, stupid, horrible, and sharp and terrible:

"Beep, beep, beep, beep, a lot of beeping. It drives you crazy, [all those] beeps."

Patients reported a negative association with the alarm of infusion pumps, for instance, an association with their disease when hearing similar beeps at home such as the sound of a dishwashing machine when finished, or an association with the new administration of a medication that causes nausea:

"Sometimes I have three medication bags at the same time, and the more often they beeped, the more nauseous I became."

In contrast to the technical sounds, most patients found the sound of talking not to be disturbing (n = 18). As mentioned before, patients did not want to hear the content of the conversations of others, but they described the sound of talking as unavoidable, as long as people did not talk the entire time or too loudly. However, when fellow patients talked a lot and loudly, or brought more than one visitor, they sometimes found the talking annoying. Therefore, some patients suggested restricting the number of visitors allowed:

"It's not a café where you sit down with your family to drink some coffee."

5.3.1.3 Perception of interior features

Most patients were neither positive nor negative about the interior design features (n = 22). Some patients (n = 4) described the environment as a typical hospital environment and explained that the ambience will never be pleasant in a hospital. However, the majority of patients mentioned the treatment environment as professional, functional, sterile, and clean:

"It is a reasonably sterile environment, but I have no problems with that. Obviously, you are there for a treatment, you don't come for a fun package, and so I think it is fine."

Some patients described the treatment environment as unpleasant, gray, and, cold (n = 6) and would appreciate a more homelike ambience. Some patients perceived an outdated interior (n = 6) and some of these patients associated this with a lack of perceived cleanliness. Patients described how they missed some form of decoration suggesting the addition of plants, flowers, or paintings. They described a feeling of home could potentially benefit their mood, for example, creating a sense of security or feeling more relaxed:

"No, it does not give you a warm feeling, or I find that it does not give you the feeling that you can easily relax."

Most patients were satisfied with the furniture and described the treatment beds and chairs as comfortable (n = 10). Some patients (n = 8) were amazed by the availability of only one television in the shared rooms. They described that one television was not sufficient to be able to watch television properly (unable to see the screen properly), and, therefore, the patients were satisfied that it usually was turned off.

A few patients complained about the lighting (n = 3), because they could not control it themselves. Therefore, one patient experienced reading difficulties due to a lack of light, while two others experienced sleeping difficulties because the light was too bright:

"I'm going to hide under the covers, because when I'm lying there, I always want, then I want to be in the dark."

5.3.2 Experiences of the treatment environment with different preferences

The analysis revealed that patients with different preferences experienced the physical enclosure and spatial layout of the treatment environment differently. The themes, categories, and sub-categories are presented in Table 5.4.

Table 5.4 Themes, categories, and sub-categories of experiences of the treatment environment with different preferences

Themes	*Categories* (subcategories)
Perception of relation between physical enclosure and social environment	*Physical enclosure* **(**Private rooms, shared rooms, enclosed sides)
	Social environment (Proximity fellow patients, visibility fellow patients)
	Perceived social environment (Social interaction, social connection, social isolation)
Perception of relation between spatial layout and distraction	*Spatial layout* (Layout, spaciousness, windows & doors)
	Crowding (Occupancy, patient flow, people walk along)
	Perceived distraction (Perceived positive distraction, perceived negative distraction)

5.3.2.1Perception of relation between physical enclosure and perceived social environment

Patients with different preferences desired different types of physical enclosure. Most patients who preferred a non-talking area wished an enclosed private room to socially withdraw (n = 8), as they did not want to interact with fellow patients. Patients described that a few minutes of interaction were fine, but that they did not feel the urge to talk or desire to listen to someone else's talking:

"I'm very happy when I'm assigned to a private room, nice to be alone, peaceful."

One patient mentioned that other patients felt the urge to tell their story, and she felt obliged to listen to those stories. Another patient described that it caused panic to be confronted with seeing other sick patients. One way of coping with this involuntary exposure to others is by hiding under the sheets pretending to be asleep (n = 2):

"I do not want 'blah blah blah' the entire time, I just don't like that. I'm quite calm myself, and I usually lie still, and I pull the covers up over me and then they think I'm sleeping, but I do not sleep at all."

Most patients with the preference for talking desired to receive treatments in shared rooms. Patients mentioned that being in proximity of fellow patients made it easier to make small talk with others. They liked to be able to make small talk with visitors or other patients, because they perceived it as a positive distraction and often described it as a feeling of social connection. For that reason, some patients even described how they did not want to receive treatment in enclosed private rooms, because then they felt secluded and lonely. One patient even described that she would not accept being locked up.

Patients without any preference described that sharing a room is part of being in a hospital, and therefore, they did not feel detached. These patients (n = 6) described that, due to the proximity of other patients, they sometimes made small talk, most of the time based on the initiatives of other patients:

"You don't like to be alone lying in a room. You share things with each other, right?"

5.3.2.2 Perception of relation between spatial layout and perceived distraction

Patients related the spatial layout to perceived crowding, and patients with different preferences perceived this crowding differently. Patients defined crowding as full occupancy of treatment places, patient flow, and people walking around. Some patients perceived this crowdedness as a negative distraction, while others perceived it as a positive distraction.

On the one hand, patients with the preference for non-talking experienced the treatment center as crowded (n = 9). Most patients experienced restlessness due to people constantly walking around. One patient described that it felt like she was being treated on a main shopping street. Therefore, most patients found certain places in the shared area to avoid this, such as a bed in one of the corners. The findings revealed that most patients found especially the high patient flow to be a negative experience and sometimes even found it to be exhausting. Patients described that this negative association was mainly caused by a mix of short-term treatment patients and long-term treatment patients in the same area. Therefore, patients who received a multiple-hour treatment were exposed to many different patient changes during a day:

"And all these changes between various beds cause a lot of unrest. When you place short-term [patients] between long-term patients, you cannot just do that [it does not work]!"

One patient was frightened by seeing the high number of patients visiting an outpatient infusion center and wondered whether there were still people healthy in this world.

On the other hand, patients that preferred a talking area or had no preference experienced the crowding as a positive distraction during the treatment. They experienced it as a positive distraction when seeing fellow patients arrive, walk around, and leave the outpatient infusion center. Patients described that then 'things began to happen', 'the place came alive', and that 'time flies'.

Patients without preference mainly 'surrendered', adapted to the current situation, and accepted that the situation was only temporary. This group of patients found positive distraction in seeing others. They amused themselves throughout the day by looking around, talking, reading, knitting, and when they got tired they would sleep for a while:

"I prefer crowding because more happens. There is more commotion in the room because the nurses have to walk back and forth. I think that is fine, it distracts"

5.4 Discussion

The aim of this study was to gain a better understanding of how patients, with different preferences, experience the physical, social, and privacy aspects of the treatment environment of an outpatient infusion facility. The findings showed that most patients perceived a lack of acoustic privacy. In addition, patients complained about the sounds of infusion pumps, but they were neutral about the interior features. Patients perceived a relation between physical aspects (i.e., physical enclosure) and the social environment. Patients who preferred non-talking had a preference for enclosed private rooms and perceived negative distraction due to spatially crowding. In contrast, patients who preferred talking or had no preference had a preference for shared rooms and perceived positive distraction due to spatially crowding.

The findings revealed that patients perceived a lack of acoustic privacy. Patients did not complain about the sound of talking, but patients did not want to hear all conversations of others. These findings are in line with the study of Edvardsson et al. (2006) showing that patients in an oncology ward desire privacy. Extending this to an outpatient setting, our findings showed that some patients in our study also intentionally withheld information from nursing staff, which may have implications for the quality of care. These findings suggest that patients should have the opportunity to discuss issues in private, but also have the opportunity to shield themselves from stories of other patients.

Although most patients did not complain about the sound of talking or the sound level, many patients complained about the sound of infusion pumps. Sounds of infusion pumps occur to alert healthcare staff for safety reasons, such as a notification that the pump is empty intending to activate healthcare staff. However, previous studies showed that only 5.5% of the alarms are clinically significant (Lawless, 1994). Previous studies also showed that patients perceive unnecessary sounds, such as cleaning machines, pagers, phones, or trolleys most negatively (Liu et al., 2014; Mackrill et al., 2013). In line with these studies, our findings indicate that patients found the sound of infusion pumps (i.e., beeps) annoying and extend the earlier findings in the sense that some patients perceived their stay in the outpatient infusion facility even as traumatic owing to the sounds of these infusion pumps. This can be explained because regularly eight patients received treatments in the same room and infusion pumps alarmed simultaneously. Therefore, it is likely that alarm sounds should be avoided in an outpatient infusion facility. For instance, by replacing it with a vibration function for nurses or eliminating redundant beeps. Some patients suggested visual alarms instead of acoustic alarms.

Most patients expressed neither positive nor negative opinions about the interior features. Some patients preferred a homelike ambience. Although it is known that pleasantness of the room can indirectly reduce patients' stress (Dijkstra et al., 2008b; Zijlstra et al., 2017), patients did not describe this relationship and may not be aware of the effects of interior features. An explanation may be that patients are in stressful periods of their life and are focused on receiving a treatment. Some patients also described that the treatment environment remains a hospital environment and it would never have a pleasant ambience. Nevertheless, this aspect should not be underestimated because empirical research provides evidence for the influence of interior features, such as nature, art, light, and television (Dijkstra, Pieterse, & Pruyn, 2008a; Harris et al., 2002; Ulrich et al., 2004). A few patients complained about the lack of control such as the presence of only one television in a shared room. These findings are in line with the study of Ulrich, Simons, & Miles (2003) who found that patients experienced less stress when there was no television during blood donation compared to a television. These results suggest that the presence of a television should only be considered in treatment settings when the individual patient can control it.

This study showed that patients perceived a relation between physical aspects (i.e., physical enclosure) and the social environment. Patients with different preferences (i.e., talking preference, non-talking preference, no preference) experienced the treatment environment differently and desired different physical aspects in the treatment environment. The first aspect was that patients desired different degrees of physical enclosure; some patients have a desire for single rooms, while others desire shared treatment environments. This knowledge is important since the existing design of our study provides single and shared treatment environments while new hospital facility designs mainly include single rooms or cubicles. Patients who preferred non-talking desired physical enclosure and did not have the need to interact with others but want to isolate themselves from others. By comparison, among those patients who preferred talking and desired shared treatment environments with multiple patients, these patients did have the need to see others and interact. These findings are in line with the study of Browall et al. (2013) that patients in an oncology ward desire both, a psychosocial environment and a place to withdraw and rest. According to the definition of health of Huber et al. (2011), patients should have the ability to self-manage. These results suggest that patients should have the freedom of choice to select their treatment place, since this may depend on their severity of condition and ability to interact (Rowlands & Noble, 2008). Airlines already provide this check-in service technology on a large scale, however, the potential benefits of this technology for vulnerable patients may be even greater (e.g., comfort and convenience). Other studies mentioned that patients like to share experiences and information (Steen Isaksen & Gjengedal, 2000). However, the participants in our study did not explicitly express the need for sharing, but expressed either the need for solitude or the need for small talk during treatment. This need for small talk can be explained because patients in outpatient infusion facility go home after treatment and desire a sense of normality (McIlfatrick et al., 2007).

The second physical aspect in which experiences differ is regarding the facility layout. Patients perceived a relation between the facility layout and distraction. Patients who preferred a non-talking room experienced negative distraction, due to crowding, people walking around, and a high patient flow. Patients felt restlessness and compared the treatment environment with a main shopping street. By comparison, among those who preferred talking, patients experienced positive distraction due to crowding, people walking, and a high patient flow. On one hand, these findings suggest that designers are challenged to come up with solutions that are satisfactory for all patients. We believe that this can be done with sufficient diversity in design and smarter planning tools. On the other hand, these findings also suggest that there was a lack of positive distraction and patients tried to find distraction in seeing others. Offering additional positive distraction, such as nature, artwork, decoration, or audiovisual distractions could complement this need for positive distraction and may reduce anxiety (Drahota et al., 2012).

5.4.1 Limitations and further research

There are some limitations to be considered in this study. We studied the experiences of patients in an outpatient infusion facility. These findings are highly relevant for the advancement of FM.

First, the findings showed that different patients experience their hospital visit differently. These differences in experiences between individual patients emphasize that one size does not fit all in a hospital environment. However, in this specific hospital setting patients did not have the opportunity to select a treatment place. It is expected that the opportunity to choose between different types of treatment places positively influence patients' experiences and well-being. Further research should clarify whether different options and the opportunity to choose positively influences the patients' well-being.

Second, results described the impact of the physical, social, and privacy aspects on patients. This study highlights the relevance for a more integrated perspective on practice in FM research. Tying together data on of the built environment (e.g., functionality, comfort, efficiency), process (e.g., inquiry of patient's preferences and technology (e.g., silent infusion pumps, planning systems, needs inquire) helps to improve the patients' well-being.

Third, participants were selected based on the patients' willingness to participate. Therefore, participants may have been biased toward patients who were unwilling to participate, e.g. being more positive regarding the treatment environment. However, due to our selection criteria the different preferences were equally represented, and findings were consistent within these groups.

Finally, this study was conducted before the pandemic in 2020 (i.e., COVID-19) which has shown the importance of physical isolation to avoid infection risks, but also the extremely distressing situations emerging from social isolation in hospitals (van Verschuer, 2020; Yardley & Rolph, 2020). It is expected that this may influence the preferences of patients. Further research is necessary to clarify this impact on patient experiences and preferences. Moreover, further research is necessary to understand which potential alternative opportunities enhance socialization, as for instance shared social rooms, connected areas, technology, or activities (e.g., meal together, playing games).

5.5 Conclusions

The treatment environment has an important role in the well-being of patients. A treatment at an outpatient infusion facility can be experienced as a social activity. Nevertheless, not all patients wished to be part of this social activity or participate in this social activity; some preferred to withdraw and rest.

First, facility managers are responsible for the effectiveness of the hospital facilities. To build better hospitals it is important to move from an intuitive design towards an evidence-based design. Understanding the experiences of patients allows facility managers to make better-informed facility design decisions to improve patients' experiences and well-being through an alignment with spaces and services.

Second, architects should integrate different types of treatment areas in the new design to fulfill different preferences. Patients should be offered different types of treatment places (i.e., private and shared rooms) and individual adjustable places (e.g., dynamic glazing solutions) where they have the opportunity to withdraw in rest or socialize with others. In addition, individual positive distraction opportunities (e.g., entertainment systems with noise cancelling headphones) should be offered to meet different patient preferences and patients can isolate themselves from hearing and seeing others.

Third, nursing staff of outpatient infusion facility should assess the preferences of patients. Patients should have the knowledge and opportunity to indicate their preference for each treatment, because their preference might depend on their actual mood and health condition. Vulnerable, sick, and anxious patients who prefer a non-talking room could benefit from a treatment environment where they can easily isolate themselves from others. In contrast, patients who prefer talking benefit when they have the opportunity to connect to others and experience positive distraction in seeing others. Patients should be informed in advance about the advantages and disadvantages of private and shared rooms. The planning department can take these preferences into account while scheduling patients or offer the patients the service to choose their own treatment place (e.g., when entering the front office or through a system to allow for self-service check-in at home).

Fourth, the planning department should take into account the duration of the treatment in the new planning system. To optimize acoustic privacy, long-term treatments (i.e., multiple hours) and short-term treatments (i.e., 1 h or less) should be scheduled clustered; patients who receive treatments for multiple hours should be surrounded by patients who also receive multiple-hour treatments. Patients will be less exposed to stories of a high variety of patients and some patients will be less disrupted in a treatment environment where all patients receive multiple-hour treatments.

Emma Zijlstra
Mariët Hagedoorn
Wim P. Krijnen
Cees P. van der Schans
Mark Mobach

Submitted for publication

Chapter 6

Experiencing the physical and psychosocial aspects in an oncology ward in the Netherlands

Abstract

Under submission

Chapter 7

Summary

The aim of this thesis was to gain an improved understanding about a more holistic experience and well-being of patients at specific focal points of the entire patient journey from the arrival, to the diagnosis, and to the actual treatment in a hospital. The influence of the hospital environment (building complexity, nature, sound environment, and patient room) on the patients' well-being was investigated from different aspects of a patient journey. In this section, the main findings of the studies in this thesis will be summarized regarding these specific focal points of this entire patient journey. First, the influence of building complexity and simulated physical ageing on wayfinding performance was studied during arrival. Second, the influence of nature projection on the patients' well-being during diagnostics was investigated. Third, the influence of the sound level on the well-being of patients in an outpatient infusion center was examined. Fourth, a broader perspective of the patients' experience of the physical, social, and privacy aspects was studied in the outpatient infusion center. Finally, the physical and psychosocial aspects in multi-bedded patient rooms in an oncology ward were investigated.

7.1 Arrival *(Chapter 2)*

The patient journey in a hospital begins with entering the building and following a route in the built environment to find the way to the destination of the patient's appointment. Complexity of the built environment is an increasing problem in hospitals because they are expanding in size due to the increasing demand for health care, more diagnostic techniques, and more specialized care. Wayfinding in complex building settings can be a difficult and stressful task and might be particularly difficult and challenging for older people. The aim of the study in Chapter 2 was to assess the influence of route complexity and physical ageing on wayfinding (i.e., efficiency and walking speed) in a hospital setting. It was unknown whether the effect of route complexity (i.e., number of building and floor changes) on wayfinding differs for older individuals with ageing related physical impairments in both sensory and motor skills.

In an age simulation field experiment, participants performed wayfinding tasks (i.e., participants were randomly assigned to either one or two wayfinding tasks). To exclusively assess physical ageing, participants for this study included young people wearing gerontologic suits that simulated the typical physical limitations of older persons such as changes in muscle strength, sight, and hearing. Participants were also assigned to wayfinding tasks with or without wearing these suits.

Results showed that the complexity of the built environment (i.e., more floor and building changes) influenced the wayfinding performance (i.e., efficiency) of all of the participants. This can be explained by the fact that participants rely on the central point wayfinding strategy, meaning that they first walk towards a central point such as the main entry hall or main corridors (Hölscher et al., 2009). These results are partly in accordance with the conceptual framework for evidence-based design (Ulrich et al., 2010) which argues that the contextual variables of the wayfinding system including the entrance, signage, and floor plan influence patient outcomes. Results also showed that simulated older participants performed less adequately in wayfinding than young participants in terms of speed. According to Davis (2012), individuals that are advanced in age become slower in body and mind, and the results of this study confirm that simulated older participants walk slower and, therefore, take more time to complete the route. In addition, results showed that they had higher heart rates and respiratory rates compared to young people during a wayfinding task and, therefore, consumed more energy in comparison to participants not wearing a suit during a wayfinding task.

In conclusion, a building's complexity and physical ageing influences wayfinding performance. Understanding the influence of building complexity on wayfinding performance will facilitate the development of effective interventions in complex building environments. Hospitals should be aware of the benefits for patients from a simply-built environment during wayfinding and the benefits for older individuals from destinations that are more accessible by foot.

7.2 Diagnostics *(Chapter 3)*

Diagnostic scans play a critically important role in the diagnosis and treatment of diseases. Therefore, after patients have entered the hospital, they must often undergo a diagnostic scan. This often creates anxiety for patients because they are usually concerned and fearful that they have a serious disease (Munn & Jordan, 2011). The influence of natural environments is receiving growing attention and appears to have the potential to mitigate anxiety. Understanding the influence of nature during a diagnostic scan will allow hospitals to create imaging rooms that positively affect the well-being of patients.

In Chapter 3, it was assessed whether the use of motion nature projection in computed tomography (CT) imaging rooms was effective in mitigating psycho-physiological anxiety. Participants underwent a cardiac Computed Tomography (CT) scan. In a quasi-randomized experiment with a between-subjects design, participants were assigned to one of two conditions. In the experimental condition, a motion nature image was projected onto the gantry and the wall of the imaging room. The projection on both objects reflected a time-lapse of a hill landscape dominated by a hill with grass, trees, and slowly moving clouds with the corresponding shadows. In the control condition, no images were displayed.

Results showed that, during diagnostics, the natural environment (i.e., motion nature projection) positively influenced the patient outcomes through the rating of the pleasantness of the room. Patients perceived the room as pleasant when motion nature was projected which consequently reduced perceived anxiety and physiological arousal (i.e., lower heart rate and blood pressure). This confirms Ulrich's (1984) seminal work that a view of nature can positively influence patient outcomes; in this case, even with digital representations of nature. These current results are also potentially important because, according to the coronary imaging protocols, patients with heart rates below 70 BPM can be scanned immediately without administration of beta-blockers. These results suggest that nature motion projection could result in a reduced need for administration of beta-blockers which may have a positive influence on the work efficiency of radiographers. Moreover, lower heart rates during cardiac scans allow a reduction in radiation exposure which may decrease biological hazards.

Results of this study are also in accordance with Bitner's framework (1992) and showed that the perceived pleasantness of the room is an essential mediator in improving the well-being of patients. The results demonstrated that nature projection did not directly reduce anxiety, however, it seemed that pleasantness was suppressing the effect of nature on anxiety. When nature was projected, patients perceived the room as being more pleasant and consequently perceived experiencing less anxiety. This role of perceived pleasantness also demonstrates a strong affinity with the emotional response pleasure, according to the model of Mehrabian & Russell (1974). They distinguished three emotional responses to describe the perception of the physical environment, specifically, pleasure, arousal, and dominance. They describe pleasure as a positive affective state (e.g., happy, pleased, satisfied). According to the psycho-evolutionary theory of Ulrich (1983), the influence of the natural environment is also a psychological process as a result of visual perception. He states that the visual perception of the natural environment can reduce psychological stress by the initial affective reaction (i.e., feelings) or by cognition (i.e., thoughts). In conclusion, it can be argued that pleasantness is one of the mediating variables between the hospital environment and patient outcomes as a result of visual perception. It is most likely that a greater number of affective or cognitive mediating variables play a crucial role in how patients perceive the hospital environment which leads to well-being.

In conclusion, nature influences patient outcomes. By creating a more pleasant imaging room through motion nature projection, hospitals can influence patient's psycho-physiological anxiety during a diagnostic scan. By providing pleasant imaging rooms, the well-being of patients can be significantly improved.

7.3 Treatment in day care setting *(Chapter 4 and 5)*

Following diagnosis, an increasing number and significant variety of patients receive treatments for cancer or chronic diseases, such as muscle or vascular diseases, in outpatient infusion centers. Patients may cope differently with this potentially stressful situation. Noise is a common problem in hospitals, and it is known that social behavior can influence sound levels. During these treatments, some patients may prefer a treatment environment that allows them to contemplate and rest (i.e., minimal noise) whereas others may prefer a treatment environment that distracts them and provides them with the opportunity to talk to fellow patients and visitors (Browall, Koinberg, Falk, & Wijk, 2013). Since hospitals are now being designed with an increasing number of single rooms or cubicles, the individual preference and experience of patients with respect to social contact is of great interest.

In Chapter 4, the influence of the sound of talking on the actual and perceived sound levels was assessed in an outpatient infusion center. In a quasi-randomized trial, participants were assigned to one of the two conditions, specifically, no rule of conduct (i.e., talking condition) versus a rule of conduct (i.e., non-talking condition). Both conditions were performed in the same treatment environment. This study measured the actual sound levels in dB(A) and patients' preferences regarding sound and their perceptions of the physical environment.

The findings showed that the sound environment was only slightly influenced by a non-talking rule of conduct, and no effect of the sound environment on patient outcomes was ascertained. However, results suggest that the preference of patients did influence the perceived level of anxiety. Half of them preferred a talking condition, approximately one-third of the patients had no preference, and the remaining group of the patients preferred a non-talking condition. The results suggest that patients who preferred non-talking perceived the environment more negatively compared to the majority of patients and perceived higher levels of anxiety in both situations.

In conclusion, the results indicate that a non-talking rule is not sufficient for reducing the sound level and improving a patient's well-being. More importantly, patients might potentially benefit from a patient-centered design where they are afforded the opportunity to choose between a mix of treatment places.

An in-depth follow-up study (Chapter 5) was conducted to improve the understanding of the experience of patients and to determine how to better design an infusion center respecting individual preferences. In this qualitative study, it was investigated how patients experienced the physical aspects, social aspects, and privacy aspects in the treatment environment of an outpatient infusion center. Participants were interviewed face-to-face at participants' homes by using an interview guideline based on five perceptions (i.e., pleasantness of room, sound, proximity, crowding, privacy) of an environment (Sundstrom et al., 1980).

Results of this study showed that patients did not complain about the sound of talking, however, patients did not want to hear all of the conversations of others. Especially health-related conversations were found to be disturbing. Patients perceived a lack of acoustic privacy and, therefore, attempted to emotionally isolate themselves or withheld information from staff. According to Donabedian's framework (1988), it can be suggested that the healthcare process is influenced by the non-talking rule (structure) which may have implications for the quality of care. This finding also accords with Bitner's servicescape model in which she argues that environmental dimensions influence social interactions between customers and staff. In this healthcare context, and even more vitally important, the environment influences medical interactions between patients and healthcare staff. For instance, patients in open multi-bed rooms who disliked the acoustic exposure during treatment emotionally withdrew themselves and even withheld medically relevant information from staff. Although most patients did not complain about the sound of talking or the sound level, many patients expressed dissatisfaction about the sound of infusion pumps. Results of the study showed that different patients had different spatial needs. Patients who preferred non-talking desired enclosed private rooms and perceived negative distraction due to spatial crowding. In contrast, patients who preferred talking or had no preference desired shared rooms and perceived positive distraction from the spatial crowding. These individual differences in preferences might be due to personality characteristics (Mehrabian & Russell, 1974) or may depend on the severity of the condition of patients and their ability to interact (Rowlands & Noble, 2008).

In conclusion, the results demonstrated a relation between the physical environment (i.e., physical enclosure) and the social environment. Patients with different preferences desired different physical aspects in the hospital environment. Therefore, it is important that healthcare staff assess the preferences of patients, and new designs should integrate different types of treatment places.

7.4 Treatment on ward *(Chapter 6)*

Under submission

Chapter 8

General discussion

In this thesis, the influence of the hospital environment (i.e., building complexity, nature, sound environment, and patient room) on the patients' physical and psychosocial well-being was investigated considering different aspects in a patient journey. First, the influence of building complexity and simulated physical ageing on wayfinding performance was studied during the arrival at the hospital. Second, the influence of nature projection on the patients' well-being during diagnostics was investigated. Third, the influence of the sound level on the well-being of patients in an outpatient infusion center was examined. Fourth, a broader perspective of the patients' experience of the physical, social, and privacy aspects was studied in the outpatient infusion center. Finally, the physical and psychosocial aspects in multi-bedded patient rooms in an oncology ward were studied.

This final chapter begins with the theoretical implications of the findings (Chapter 8.1), followed by the practical implications of the present research (Chapter 8.2). Moreover, several methodological considerations (Chapter 8.3) and suggestions for future research are discussed (Chapter 8.4). This chapter ends with a brief conclusion (Chapter 8.5).

8.1 Theoretical implications of the findings

This section discusses four theoretical models that are widely used such as quality of health care, services, and spaces. The results of this dissertation are in accordance with these models. However, the results also suggest the unjustified absence of a number of important variables with an impact on patients. The following section discusses the theoretical contribution of this dissertation to the literature on the built environment of hospitals with regard to (1) the role of the hospital environment and (2) the role of individual patient characteristics. This section concludes by discussing the alignment between the hospital environment and individual patient characteristics, resulting in a visual summary of the theoretical implications.

8.1.1 The hospital environment and patients' experiences and well-being

The studies in this thesis contribute to scientific knowledge with regard to the hospital environment and the influence on patients' experiences and well-being. This dissertation showed the influence on patients of building complexity, nature, sound, and the size of patient rooms and also the mediating and moderating effects in the relationship between the hospital environment and patients' physical and psychosocial well-being. To understand the patient's experience, four relevant theoretical concepts on spaces, services, and health care were relevant: Quality of care, environmental psychology, servicescapes, and evidence-based design. Figure 8.1 presents the four theoretical concepts, and the axes divide the concepts into four sections: The x-axis expresses the focus of the theories (i.e., service-oriented versus space-oriented), and the y-axis expresses the generalizability of the theories (i.e., universal versus health care). In the upper right section, the theory of environmental psychology begins with a focus on space, and this theory is applicable in different settings (i.e., universal). In the upper left, the theory of servicescapes stands from service management and, therefore, is service-oriented, and this theory is also applicable in different settings (i.e., universal). The lower left section presents the theory of quality of care, which is service-oriented (i.e., health care processes) and intended for health care settings. Finally, the lower right section presents the evidence-based design theory that is space-oriented and intended for health care settings.

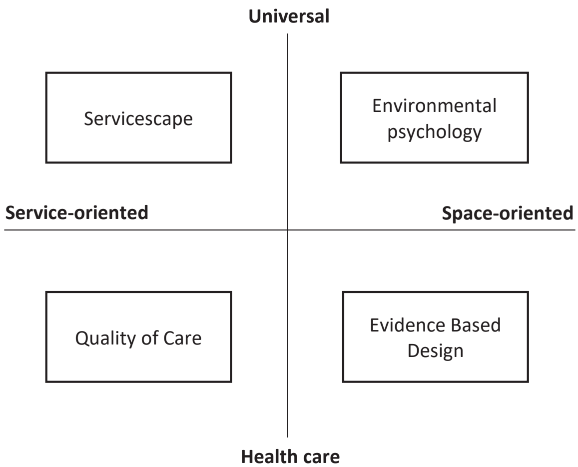

Figure 8.1 Four relevant theories on spaces, services, and health care with, on the x-axis, the focus of the theory (service-oriented versus space-oriented) and, on the y-axis, the generalizability of the theory (universal versus health care setting)

The theory of quality of health care introduced the basic concept of the role of the hospital environment but had not yet emphasize the importance. Donabedian (1966, 1988) argued that structure influences health care processes which may have implications for the quality of care. Donabedian contended that structures involve the setting in which the care occurs. Structure includes material resources (e.g., facilities, equipment, and money), human resources (e.g., number and qualifications of personnel), and organizational structure (e.g., medical staff organization). Even though facilities are a mere sub-attribute of material resources, the model of Donabedian can be confirmed by emphasizing the important role of the hospital environment for improving patients' physical and psychosocial well-being. For instance, patients who received treatments in a shared room where they are exposed to health-related conversations can emotionally isolate themselves and even withhold medically relevant information from staff.

Coherence between the hospital environment and services can positively influence patients' physical and psychosocial well-being. This also accords with Bitner's servicescape model in which she added the connection between spaces and services. She argued that a holistic experience of the physical environment that corresponds with the material resources in Donabedian's model influences responses of staff and customers as well as their social interaction. For instance, the nature of conversations at a reception desk may depend on a(n) (un)successful wayfinding task. Her framework is primarily focused on commercial settings; however, it can be stated that an application in health care also works well. In a health care context, and even more specifically in a hospital, the environment can influence medical interactions between patients and health care staff.

In environmental psychology, it is argued that humans respond emotionally and behaviorally to the environment (Mehrabian & Russell, 1974). For instance, if a room is too noisy, people can become irritated and decide to leave the room. In addition to the direct effect of the hospital environment on patients' well-being, it is important to consider mediating and moderating effects in this relationship. Building on the work of Mehrabian & Russell (1974), Bitner (1992) included the mediating role of the perceived servicescape in the relation between environmental variables and responses of customers and employees. The perceived pleasantness of the hospital environment is an essential mediator in the relationship between the hospital environment and patients' well-being and is in line with other studies (Campos Andrade et al., 2013; Dijkstra et al., 2008b). For instance, nature in a diagnostic room is perceived as pleasant which subsequently reduces the patients' level of anxiety. It is most likely that a greater number of affective or cognitive mediating variables – such as feelings of fear or surprise – may play a crucial role in how patients perceive the hospital environment, which influences well-being.

Beyond emotional and behavioral responses, evidence-based design research argues that the hospital environment can even influence health care outcomes. Evidence-based design is rigorous research linking health care environments to health care outcomes (Ulrich et al., 2008). Studies show that physical surroundings can potentially be transformed into healing environments and can even improve patients' well-being and outcomes (Ulrich et al., 2008; Ulrich et al., 2010). The relevance of physical surroundings on patients' perceptions and experiences such as wayfinding, nature, sound, privacy, and room size can be confirmed.

The conceptual framework of evidence-based design should be extended with the introduction of the social perspective with regard to the hospital environment. Bitner's (1992) servicescape framework also addressed the impact of the physical environment on the quality of social interactions between customers. In a hospital setting, this framework can be extended with the influence of the hospital environment on the social interactions among patients.

To conclude, the hospital environment contains different health care specific design variables that, in coherence with (health care) services, can have a significant impact on patients' physical and psychosocial well-being.

8.1.2 Individual patient characteristics, needs, and preferences

The influence of the hospital environment on patients is complex, and there appear to be differences between individual patients. The theoretical models would better accord with reality when considering (1) the individual characteristics of patients and (2) the patient needs and preferences with regard to the hospital environment. Different patient groups should be defined for each journey step in order to improve patients' well-being in hospitals.

It can be stated that the impact of the hospital environment is, in fact, more complicated than the previous theoretical models supposed (Bitner, 1992; Donabedian, 1988; Mehrabian & Russell, 1974; Ulrich et al., 2010). Coyle and Battles (1999) also argued that the model of Donabedian lacked the inclusion of individual characteristics. They contend that personal characteristics of patients influence the quality of care and, subsequently, the patient outcomes (Coyle & Battles, 1999). In environmental psychology (Mehrabian & Russell, 1974), the individual factor of personality was included but only focused on personality traits that are associated with emotions. In the servicescape model of Bitner (1992), she also adds situational factors such as the plan and purpose for being in the environment, mood state, and expectations of the environment next to personality traits. In the evidence-based design framework, demographics were included as moderators such as age, gender, ethnicity, and diagnosis.

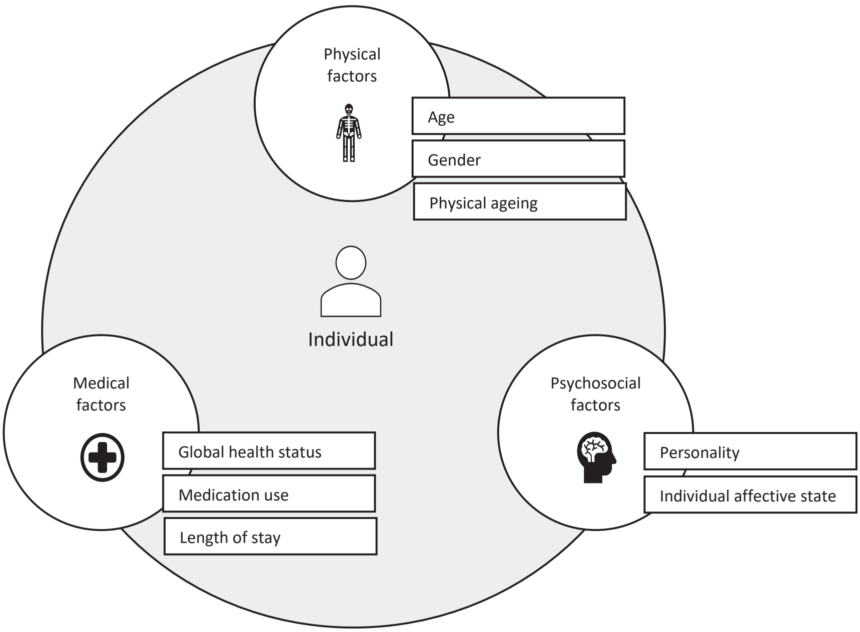

Figure 8.2 Individual factors influencing patients' physical and psychosocial well-being

The theoretical models would better fit with reality when considering the individual characteristics of patients in hospitals, which can be subdivided into three individual main factors: Physical factors (i.e., age, gender, physical ageing), medical factors (i.e., health condition, medication use, length of stay), and psychosocial factors (i.e., personality, individual affective state) (Figure 8.2). For instance, there is an influence of physical ageing. Older people with physical limitations perform less rapidly in terms of speed during a wayfinding task (Chapter 2). From a medical perspective, an example is the impact of medication use. For instance, patients who use sleep medication perceive higher levels of anxiety during hospitalization (Chapter 6). An illustration of a psychosocial factor is, for instance, the initial affective state. It can be suggested that the influence of the individual initial affective state of patients affects the patient's perception of hospital environments. This is in line with the framework of Mehrabian and Russell (1974); they discussed the impact of the internal state of an individual on emotions, such as hunger, sleep, fatigue, pain, or sickness. According to the psycho-evolutionary theory of Ulrich (1983), the individual's affective state that is derived from a person's present and history direct and sustains the person's attention. The findings of the studies in this thesis accord with these two models that the state in which individuals enter the hospital influence the experienced quality of health care.

Moreover, patients' well-being is related to their individual needs and preferences. For example, the study in Chapter 5 showed that patients with different preferences perceived the relation between the physical environment and social environment differently in an outpatient infusion center. Patients desired different degrees of physical enclosure; those who preferred non-talking required physical disclosure in terms of single rooms while those who preferred talking desired shared rooms. Donabedian (1988) argued that it is difficult to include patient preferences in the assessment of quality of care. However, Pine II and Gilmore (1998) contend that the individual needs are essential for the experience of customers (Pine II & Gilmore, 1998). The alignment of spatial structures with patient's needs appears to be essential for their well-being in hospitals. In fact, these individual characteristics may even be part of the structure (Donabedian, 1988) that – together with buildings and organization – define the experienced quality of health care.

8.1.3 Aligning the hospital environment with individual patient characteristics

The theoretical implications above show that the experience and well-being of patients is both context and person specific. The contextual aspects, for instance, building complexity, nature, sound environment, and patient rooms influence patients' well-being (i.e., physical, emotional, and cognitive). Moreover, the findings of these studies indicated that a wide variety of patients visit a hospital and experience their hospital visit very differently. This variety relates to individual patient characteristics such as needs and preferences.

The results of this thesis demonstrated that a combination of the aforementioned theories can provide improved insight into the impact of the hospital environment on patients during the patient journey since universal theories are too generic for a hospital context compared to other types of organizations. A health care oriented model such as that of Donabedian (1988) does support the basic idea that the structure of a building influences hospital processes and outcome but disregards the need to align a hospital environment with patient characteristics. Moreover, the universal framework of Mehrabian and Russell (1974) does combine personal and environmental characteristics but neglects patients' well-being (i.e., physical, emotional, and cognitive) and organization structures.

Similarly, the universal model of Bitner connects the environment with user responses and behaviors in a dominantly commercial context and even includes interaction between customer and staff but also omits the relation with patient outcomes. The best fit may be with the evidence-based design model; however, this lacks the inclusion of interaction between fellow patients and organization structures.

In conclusion, Figure 8.3 presents the most important associations found in this dissertation. The results in this dissertation support the direct influence of the hospital environment on patients' well-being. The well-being of patients in hospitals can be improved by aligning the hospital environment with individual patient characteristics, needs, and preferences. Moreover, the mediating role of the perceived pleasantness of the environment and social interactions between patients and health care staff as well as interactions among patients play an essential role in the relationship between the hospital environment and patients' well-being.

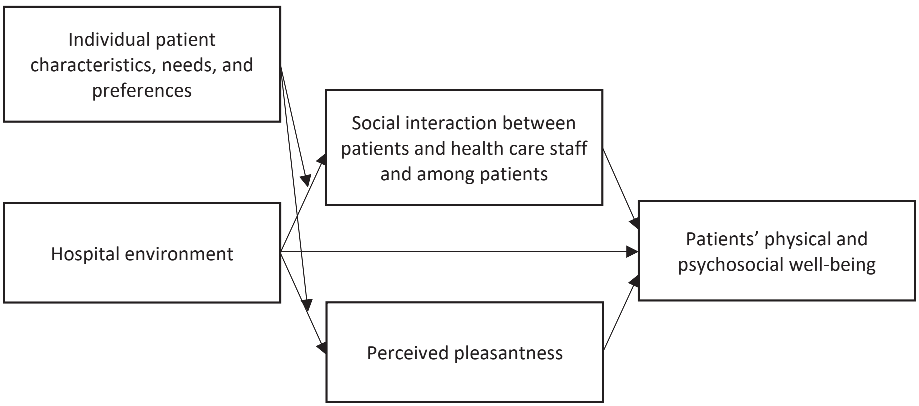

Figure 8.3 Summary of associations between the hospital environment and patients' physical and psychosocial well-being

8.2 Practical implications of the findings

Although it seems obvious that the hospital environment has an important role in improving patients' well-being, the practical challenges for creating hospital buildings with a positive influence on patients are surprisingly ample. First, the practical implications of evidence-based design will be elaborated. Second, the integration of a focus on patients' well-being in the hospital design process will be discussed. Thirdly, the need for an integrated approach among stakeholders will be examined.

8.2.1 Evidence-based design

To build a better hospital environment, it is important to move from an intuitive design towards an evidence-based design. An optimal hospital environment facilitates the patients' physical, mental, and social well-being and can subsequently even improve the organization's financial results (Berry et al., 2004; Ulrich et al., 2010). The findings of this thesis extended this scientific knowledge and confirmed that the hospital environment has an important role in the well-being of patients during the entire patient journey from arrival, diagnosis to treatment. This thesis identified four areas that are within the parameters of the domain of evidence-based design and will be further elaborated: (1) wayfinding system, (2) sound environment, (3) view on nature, and (4) options and choices.

8.2.1.1 Wayfinding system

Existing evidence argued that the wayfinding system can hinder or improve patients' well-being. The findings of this thesis present the importance of better alignment between the building structure, signage, and services to help prevent patients from becoming lost and increasing their autonomy. More specifically, evidence in this thesis showed that the number of building and floor changes during the patient journey should be limited in order to improve wayfinding performance (e.g., fewer errors and delays). Hospital buildings should be easy to 'read' and understand. To make a building easy to understand, two architectural features are important (Passini, 1996):

1. To structure distinctive units
2. To create an identifiable setting
    - apply geometric laws (e.g., symmetry or hierarchy)
    - use simple geometric forms (e.g., T-form or L-form)

The building indirectly influences the choices that patients make, also known as nudging (Thaler & Sunstein, 2008). For example, patients will choose the route that is the most obvious and requires the least effort. However, they will always make mistakes, therefore, it is important to expect errors and to create foolproof designs. Hospitals should include routes that require fewer patient decisions (e.g., whether to go left, right, or straight ahead) which will result in better wayfinding performance (e.g., fewer errors and delays). To create a more patient-centered hospital environment, it is important to identify, group, and link the most common patient journeys (including the different ways that patients arrive, such as by car, bus, taxi, bicycle, or walking). By doing so, hospitals are able to locate departments in an easy and efficient manner around patient needs instead of around doctors, specialties, or medical interventions. Such an approach can increase the logic from a patient's perspective and decrease density by creating a clear vision of the building's logic and structure. This can be accomplished, for example, by locating departments that belong together from a patient's perspective in the same area: outpatient clinics (e.g., consultation rooms for oncologists, oncology nurses, psychologists), diagnostic clinics (e.g., CT-scan, MRI-scan, blood test, biopsy rooms), and inpatient clinics (e.g., chemo treatment rooms) around the patients' medical condition or, for example, by separating the flow of patients, staff, and logistics (e.g., onstage versus backstage). To enable integrated care around the patient journey, hospitals should pay attention to the physical relocation of departments and alignment of location with patient logistics and perspectives.

Moreover, evidence showed that simulated older people consumed more energy during a wayfinding task. Therefore, it is important that hospitals prioritize patient groups by taking into account the physical capabilities (e.g., which patient groups are able to walk the longest distances). For instance, hospitals could move clinics with a focus on older people nearer to the parking lots, bus stops, or taxi pick-up areas in order to make clinics more accessible by foot for them.

Facility managers should employ wayfinding support systems with similar properties. In this context, two implications are of particular importance: signage and services. Signage is important to support patients in wayfinding and can compensate for complex building situations. Important aspects of wayfinding signage are (Mijksenaar, 1997):

- Clarity – the message must be clear;
- Continuity – repeat the information until the destination is reached;
- Conspicuity – signs should be eye catching;
- Consistency – use the same terminology constantly.

For example, when patients and visitors enter a building, a complete representation of a multiple building setting should immediately be made clear by using wayfinding design such as well-located and clearly visible wayfinding signage (Hölscher et al., 2006). Wayfinding signage needs to be located continuously at decision points so patients can proceed from decision point to decision point until the destination is reached (Passini, Pigot, Rainville, & Tétreault, 2000). To make signage conspicuous, it is important to provide high contrast signage, clear color schemes, readable font type and size, sufficient illumination, and clear pictograms (Rousek & Hallbeck, 2011). Moreover, it is important that signs are positioned facing the patient and views on signage are not obstructed. Additionally and last, it is important that the same terms are consistently used in wayfinding signage.

Manned service points and/or reception desks can also support wayfinding, for instance, if patients face difficulties repeatedly at specific locations. It is important that the staff of service points are positioned well and can help patients that are lost or, more optimally, support patients even before they ask for help (Huelat, 2007). Evidence showed that the number of service points did not influence wayfinding performance. However, alignment between service points and decision points is important for facilitating effective use. For instance, patients who enter a hospital building should immediately encounter a service point or employee that can support in making wayfinding decisions to improve wayfinding performance. Therefore, the design of services such as the staffing and staff behavior at receptions should always match with the building design in terms of the location of the reception.

In conclusion, alignment between different wayfinding system variables and individual patient characteristics can improve the wayfinding performance and autonomy of (older) people.

8.2.1.2 Sound environment

Evidence of research shows that noise is an environmental stressor that can cause induced awakening, sleeplessness, and increased heart rates (Baker et al., 1993; Joseph, 2009). The findings of the study in this thesis showed that the sound levels at the outpatient infusion center exceed the WHO guideline of 35 dB(A) in a patient room. Despite a non-talking behavior rule during treatment, sound levels were still too high, and patients specifically complained about the sound of infusion pumps.

This thesis indicated evidence for different patient needs of the sound environment with regard to the sound of talking; some patients preferred the sound of talking while others preferred non-talking or had no preference. Hospitals should always inquire about the patient's preferences and create alignment with the sound environment and the planning system to come up with solutions that work well for all patients. The planning system should take into account the different preferences of patients with regard to the sound of talking. For example, patients with the same preferences for talking should be grouped in treatment rooms, patients with preferences for non-talking should be planned in single-person enclosed rooms, and patients with the same treatment duration should be placed together (e.g., preventing unrest).

The evidence of this thesis demonstrated that hospitals should not merely search for architectural solutions (e.g., layout, sound-absorbing ceilings, walls, or floors) and organizational solutions (e.g. inquiry of patient's preferences, planning systems) but also for technological solutions. It is especially important to find solutions in avoiding unnecessary sounds for patients, such as alarm sounds, to improve patients' well-being in hospital settings, for instance, by replacing sounds with a vibration function for nurses or eliminating redundant beeps. Some patients suggested visual alarms instead of acoustic alarms. Other examples of dominant unnecessary sounds are the sound of footsteps, passing trolleys, or creaking doors. Since sound levels often exceed the WHO guideline, and hospital environments change over time, it is important to continuously monitor the sound environment with, for example, smart systems. This enables hospitals to evaluate the WHO guideline and measure the effect of a single intervention (e.g., behavior rule, visual alarms instead of acoustic alarm, sound-absorbing floor, other footwear, wheels) as well as continuously improve the sound environment.

In conclusion, alignment between architectural, organizational, and technological solutions regarding the sound environment can improve patients' well-being.

8.2.1.3 View on nature

A growing body of evidence indicates that views on nature can positively influence people (Malenbaum et al., 2008; Monti et al., 2012; Tanja-Dijkstra et al., 2014; Vincent et al., 2010). The findings in this thesis confirmed this and showed the positive influence of nature projection on psychological anxiety and physiological arousal.

The study in this thesis at the diagnostic clinic showed that it is beneficial for hospitals to design pleasant imaging rooms by including views on nature - in this case, a beamer - in the imaging room to reduce psycho-physiological anxiety. By providing pleasant imaging rooms, the well-being of patients can be significantly improved. It is expected that an increased exposure to pleasant distraction will increase the positive effects on patients (Andrade & Devlin, 2015). Therefore, it is advisable that hospitals put nature projection on walls in view of patients (e.g. when entering a hospital room or when lying at a scan table). In addition, patients may experience even greater benefits when they are exposed to nature with virtual reality glasses (Depledge et al., 2011).

Views on nature can be considered as universally effective for reducing anxiety. Since many patients experience anxiety during the entire journey in hospitals, other settings such as waiting rooms, treatment rooms, or patient rooms should also include positive distractions such as views on nature. Since different natural environments can elicit various reactions, it is important that hospitals provide appropriate views of nature in the correct places. Those that contain the following visual characteristics are generally perceived as pleasant and, therefore, are important for creating pleasant distraction and reduce anxiety (Ulrich, 1983):

- Complexity: Moderate to high number of elements in the scenery (e.g., trees, plants, flowers)
- Structural properties: Focal point and order of patterning (e.g., grouping or a line of trees)
- Depth: Moderate to high level of depth (e.g., openness in the scenery)
- Ground surface texture: Homogenous ground surface and make it possible to move (e.g., forest landscapes or smooth grass ground)

- Deflected vista: Curved scenery (e.g., curving lines as pathways or rivers)
- Threats: No or minor appraised threats (e.g., no high cliffs or wild sea)
- Water: Low complexity and restricted depth (e.g., calm lake or river)

In conclusion, the evidence of this thesis indicates that even an inexpensive and simple solution such as a beamer that projects nature can mitigate anxiety in spaces where daylight and views of real nature outside are impossible.

8.2.1.4 Options and choices

Evidence also shows that patients in hospitals often experience loss of control of every aspect of their daily lives (Andrade & Devlin, 2015). For instance, patients have limited possibilities to leave patient rooms and are limited in their activities (e.g., what and when to eat, shower, get dressed, and receive visitors). The findings in this thesis showed that various patients experience their hospital visit very differently. These differences in experiences between individual patients emphasize that one size does not fit all in a hospital environment.

The findings in this thesis presented evidence that individual patient characteristics, needs, and preferences require different environmental and organizational solutions. From an environmental perspective, hospitals should inquire and fulfill the different needs of patients. For instance, choice options that respect preferences for talking or non-talking by offering different types of treatment places and patient rooms (i.e., private and shared rooms) and individually adjustable places (e.g., dynamic glazing solutions) where patients have the opportunity to withdraw to rest or socialize with others. From an organizational perspective, to improve patient autonomy, hospitals should offer patients the possibility to choose between different types of treatment places and patient rooms. For instance, patients should have the knowledge and opportunity to indicate their preference for each treatment/hospitalization because their preference might depend on their current mood and health condition. Before patients enter the hospital, at a minimum, nursing staff should determine these patient preferences. Patients should be informed in advance about the advantages and disadvantages of private and shared rooms. Patients could be matched regarding their individual characteristics. However, hospitals could also allow self-selection by patients of places or rooms. Subsequently, planning departments should schedule patients regarding their personal preferences and could take into account the duration of the treatment in the new planning system (i.e., match patients by length of stay). However, self-planning of patients may even be better. By doing this, patients have the opportunity to benefit from the most appropriate place that best fits their personality, current mood, and physical condition which will enhance autonomy and patients' well-being.

From a social perspective, evidence in this thesis and the pandemic in 2020 (i.e., COVID-19) has shown both the importance of physical isolation to avoid infection risks but also the extremely distressing situations emerging from social isolation in hospitals (van Verschuer, 2020; Yardley & Rolph, 2020). To avoid this, hospitals should also and foremost consider creating alternative opportunities to enhance socialization such as, for instance, safe shared social rooms, connected areas, technology, or activities (e.g. meal together, playing games).

In conclusion, the autonomy and well-being of patients can be significantly improved when the hospital environment allows for spatial and organizational flexibility and adaptability by creating options and offering choices. By doing so, hospitals could create an alignment of the hospital environment with different individual patient characteristics and improve well-being.

8.2.1.5 Evidence-based design methodology

Hospital environments change rapidly, and the individual needs of patients are not static and can shift radically, for example, in the presence of other hospital or health care developments. It is of major importance to learn from the design decisions on the level of the hospital as well as on the national and global levels.

The evidence-based design methodology is based on a set of principles to (re)design a better built environment of humans, specifically, (1) the real-world design process, and (2) the design methodology to frame research activities (Mobach, 2019). The real-world design process begins with the current situation and ends with the future situation. The design methodology makes the methodology cyclical and, in each round, the cycle creates a better future design. The continuous process of evidence-based design consists of seven phases and is illustrated in Figure 8.4. The first step of the learning cycle of evidence-based design is to identify the current (undesired) situation. In the second step, it is important to acknowledge the advantages and disadvantages of the current situation and conduct a premeasurement. The third step is the process to re(design) a future situation continued by the fourth step to implement the (re)design. In the fifth step, the future (desired) situation is created. To measure the actual impact of a (re)design of the hospital environment on patients, the cycle continues with the sixth step. In the sixth step, it is important to acknowledge the advantages and disadvantages of the future situation by conducting a post-measurement. In the final step (step 7), it is time to evaluate and compare the performances of the undesired and desired situation. The findings of this evaluation can be used to learn from design decisions and develop new (re)designs, according to Mobach (2019).

Accordingly, the hospital environment is continuously improving and creating extraordinary designs that improve patients' well-being. Hospitals and the construction, real estate, and facility management industries should begin to seriously support such research. It will help them to perform more effectively. Hospital buildings are never finished; their design and redesign must be considered as a continuous learning process.

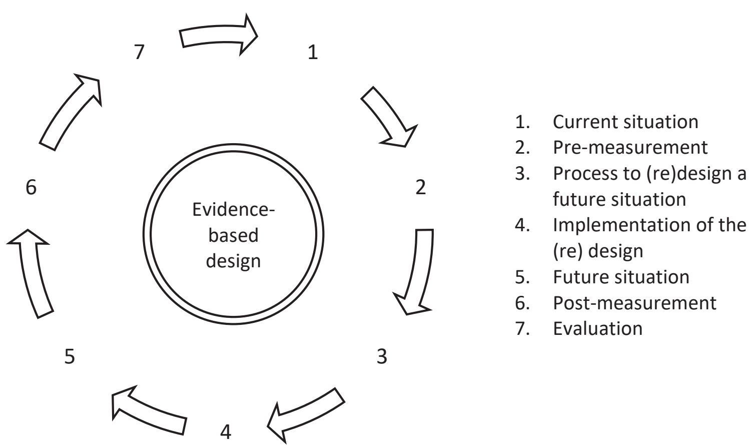

Figure 8.4 Phases in learning cycle of evidence-based design research

8.2.2 Integrate patients' needs in building design process

Despite the current evidence, it is still often unknown how building decisions precisely affect the patients' well-being and outcomes and what patients require. The patients should be the focus in hospitals and, therefore, it is a matter of concern that patients themselves are barely involved in the building design process in hospitals. Hospital employees and managers are often involved as 'users' in the design process, however, the key is to involve a wider range of users. In order to understand patients and provide better healthcare, patients and their perspectives should be integrated into the building design process.

Patients should be involved from the beginning in the decision-making process for new hospital environments or modifications to existing designs. In the initiation phase, the concept for the project is explored and attention should be paid to the patient's needs. It is important to ask and learn from the experience of patients in the current situation. In doing so, it is crucial not only to inquire about their needs because many of them may not able to articulate this question. They may be unaware of possibilities. As Henry Ford, one of great innovators of the world, quoted: "If I had asked people what they wanted, they would have said faster horses." Therefore, asking and measuring patient experiences is of great interest for improving patient outcomes, however, it is not enough. The experiences of patients should be turned into data, and this data should be turned into relevant information for the design process. This means that their experiences and needs must be channeled through other independent stakeholders to bring 'the voice of the patient' into the design process and allow for better-informed decision-making.

During the design process, it is important that patients remain involved as active partners. Design teams create design solutions, moving from rough sketches towards a final design. It is essential that these solutions are presented and discussed with patients. Architects often present floor plans and 3D impressions but, in an optimal situation, patients should have the opportunity to experience potential future designs in advance, for instance, in a virtual environment. A virtual environment provides an optimal spatial experience, and patients can experience the new design more realistically. In this way, patients can better discuss the design and appearance of the hospital environment. For example, they can experience the distance to other patients, the visibility of health care staff, or the exposure to daylight in a virtual environment.

8.2.3 Need for an integrated approach among stakeholders in the design process

It is important that, beyond patients, all relevant stakeholders are involved in the design process and collaborate to successfully improve hospital environments and positively influence patients' well-being and outcomes. At the primary level, the inclusion of patients was discussed in the previous paragraph (8.2.2). Subsequently, an integrated approach among other relevant stakeholders (i.e., internal and external stakeholders) will help to gain a greater understanding of the influence of the hospital environment and can create a valuable contribution to its design in order to improve patient outcomes.

The design process of a hospital should involve a large group of stakeholders, specifically, patients, internal stakeholders, and external stakeholders (see Figure 8.5). In the internal organization, it is essential to build support from the important decision makers in the hospital, to encourage collaboration among the different functions, and to advance the potential positive effect of the hospital environment. The involved stakeholders should be committed to evidence-based design and related enhancement of patients' well-being and outcomes.

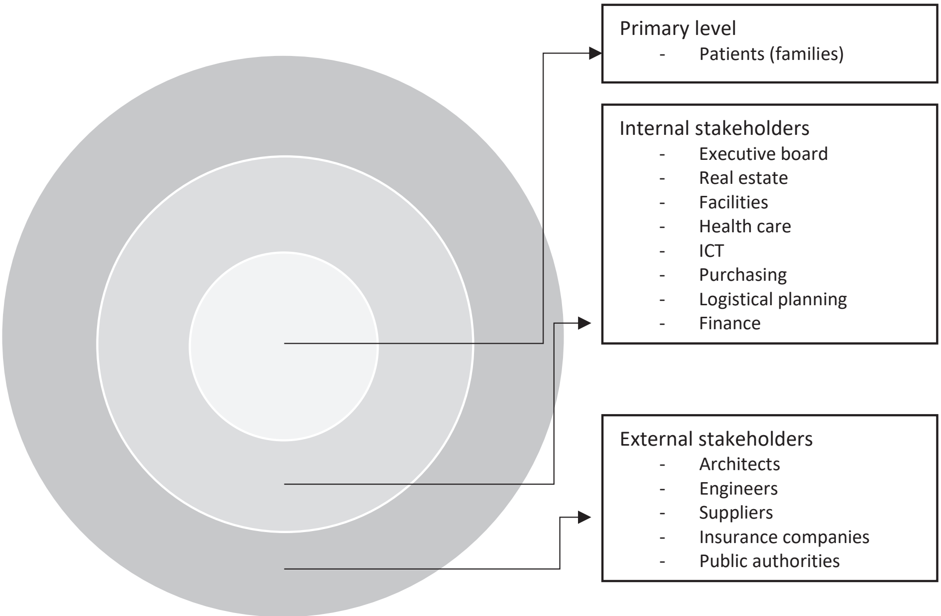

Figure 8.5 Map of stakeholders in hospital design

In the internal organization, the facility manager is responsible for the effectiveness of the hospital facilities and, therefore, should play an essential role in decision-making in the design process. He or she is responsible for the building operations, therefore, these professionals know to what extent the building works or not. So, it is important to involve facility managers and make them prioritize evidence-based design decisions for health care facilities to ensure high quality in hospital designs and improve patients' well-being and outcomes. They are especially useful as a linking pin between the design team and the users (i.e., patients, families, and staff). By facilitating and coordinating multidisciplinary design teams and monitoring decisions, they are able to achieve an effective facility that improves patients' well-being and outcomes.

In addition to patients, health care professionals are another important group of users. To begin with, it is important that they become aware of the effect of the hospital environment on patients' well-being and outcomes. They are experts in the healthcare process and are exceptionally knowledgeable in the medical procedures and patient outcomes. This knowledge of health care professionals can support the health and well-being of both patients and health care professionals. Raising awareness among these professionals is important for the quality of the design process. New knowledge and better designs can be generated by combining the knowledge of health care professionals with existing evidence-based design knowledge. By raising awareness, they can have an active role in continuously improving buildings and healthcare by looking beyond their current expertise. For example, after completing a treatment or patient appointment, it is important that health care professionals should not only ask questions about the patient's health but also ask for the holistic experience of the individual patient. How did the patient perceive their hospital visit? This information leads to a better understanding of the patient needs. Although the time of health care professionals is a critical resource, the input of healthcare professionals is also important for better building designs. Obtaining this information is crucial for fulfilling the needs and improving the well-being of future patients and healthcare professionals of hospitals. In addition, health care professionals usually have better control over the hospital environment than patients because the patients are often vulnerable and out of control due their state of health and dependence on professionals. When health care professionals are aware of this phenomenon, they can enable patients to experience more autonomy by providing, for example, different options for them (e.g., 1-person room or 4-person room, curtains open or closed, lights on or off) and allow patients to make choices (e.g., using verbal communication, self-selection of places/rooms, remote controls for doors or lights).

Moreover, important external stakeholders in the design process are architects and engineers. Therefore, it is important that these professions acknowledge and understand the significant impact of design decisions on patients' well-being and outcomes. Architects and engineers should pay attention to the effects of the hospital environment on patients and cooperate with other stakeholders and researchers to apply evidence-based design knowledge in their design decisions. Moreover, they should return to the buildings they have created, debate its use with user groups, reflect and learn, adopt emerging topics in their subsequent designs, and disseminate these learning experiences within relevant communities.

To create awareness among the future decision makers, an effective solution would be that the role of the physical environment on patients' well-being and outcomes should be integrated in architectural, facility management, medical, nursing, business, and psychological schools of prospective healthcare professionals and practitioners.

8.3 Methodological considerations

The studies were conducted in a real-life hospital setting, and the findings should be interpreted with some strengths and limitations in mind. In this section, these strengths and limitations will be discussed regarding study design and measurements

8.3.1 Study design

The studies in this thesis were field experiments and were not randomized. In randomized control trials (RCTs), participants are randomly allocated to a control or intervention group. An RCT is often not possible in a real hospital setting in which patients depend on clinical diagnosis and treatment.

One of the advantages of a naturally occurring field experiment is that we were able to link research to current healthcare processes and procedures. In the study at the diagnostic clinic, for example, the radiographers already measured some physiological outcomes of patients such as heart rate and blood pressures. By linking this information to the experiment, we took advantage of existing operational processes and avoided unnecessary burdening of healthcare staff or patients.

In our studies, we also faced some difficulties during naturally occurring field experiments. Hospitals face capacity problems and, consequently, we faced limitations in conducting interventions. An example is the limited number of available treatment places or beds. The initial intention in the day care setting was to provide patients the freedom of choice between a non-talking or talking condition based. However, due to capacity problems and the current design, we were forced to allocate patients to treatment places according to the existing procedure.

Health care systems in the Netherlands also face major capacity problems in staffing. Therefore, health care professionals have only limited time, even for their own work processes. Consequently, all additional research activities are a burden for health care staff and should be conducted by researchers or research assistants/students. This can be advantageous because patients can provide answers without considering socially desirable answers (e.g., patients depend on health care professionals and can attempt to answer as 'good' patients do). However, contact with research(ers) (assistants) is also an additional point of contact with patients which is sometimes undesirable or even impossible due to potential risks of infection. Health care professionals, and not merely doctors, should have the opportunity to be more research-oriented to continuously improve their processes and patient outcomes, also beyond their own field of knowledge.

Moreover, a researcher is vulnerable since the individual is highly dependent on unpredictable real-life situations and/or building processes. For example, we faced a considerable amount of time loss in setting up studies that were cancelled at the last moment. Due to changes in management at the last moment and a complex chain of hospital managers, it is not always clear who owns the research process, therefore, in that respect, we faced some unexpected barriers. To prevent this and avoid misunderstandings, future studies should require pre-approvals at the highest levels of the organization. Furthermore, delays in the building process are not uncommon due to the complexity and numerous involved parties. Consequently, this is a great risk for evidence-based design researchers.

In conclusion, despite the different challenges that field experiments provoke, the major strength of this study design is the strong representativeness for hospital settings. The experiments in this dissertation were conducted in a natural setting, and these naturally occurring field experiments are essential for demonstrating that interventions actually work in the field (Leichsenring, 2004).

8.3.2 Combining objective and subjective measurements

The well-being of patients contains objective and subjective aspects, and both have their own advantages and disadvantages to improve the understanding of the patients' experiences and well-being as well as hospital designs.

Some objective patient outcomes are collected during medical procedures in hospitals since health care services are focused on patient outcomes, for instance, simple measurements such as heart rate, blood pressure, and body temperature but also more complicated medical outcomes such as results of diagnostic scans, blood levels, infection occurrence, symptoms, or disease progression. It is a significant advantage for patients, health care professionals, and researchers when no additional measurements on patients are required. Moreover, by linking research to existing measurements, relevant information regarding the patients' well-being can be collected. Nevertheless, in some cases, supplementary objective measurements may also be relevant for improving the understanding of patients' well-being, for instance, being aware of the potentially highly relevant information that can be extracted from blood levels, urine samples, or saliva samples.

In addition to the objectivity of physiological well-being, the subjective psychosocial well-being of patients also determines their health status such as perceived anxiety, quality of life, or sleep quality. These subjective psychosocial measurements are often collected from questionnaires or qualitative interviews. Qualitative studies are essential in a field where limited existing studies are applicable and much is not yet well understood.

The results of qualitative studies enable future studies to focus on the pertinent patient outcomes. A disadvantage of qualitative studies in science is that they are currently still underappreciated and difficult to publish in international peer-reviewed scientific journals. Nevertheless, conducting qualitative studies is very important for gaining deeper and additional thorough understanding of the interactions between the hospital environment and patients' experiences and well-being.

To gain a greater understanding of the well-being of patients in hospitals, it is important to combine objective and subjective measurements. This combination not only requires close collaboration between researchers and health care professionals but also sincere curiosity and courage to explore the internal workings of a hospital building that is only limitedly understood.

8.4 General conclusions

In conclusion, this thesis emphasizes the relations between the hospital environment and the psychosocial and physical well-being of patients. It is of great importance to listen carefully to patients' experiences and needs when designing a hospital as many of our results showed individual differences with patients that emphasize that one size does not fit all. The well-being of patients in future hospitals can be improved by aligning the hospital environment with individual patient characteristics, needs, and preferences.

As such, the findings of this dissertation have important implications for the designers and policy makers of hospitals. It is necessary to better understand current interactions between hospital environments and the people that use it. A hospital environment does have a significant impact on patients' well-being. Therefore, it is important to evaluate practical design changes allowing decision makers to better understand its effectiveness and apply its latent positive impact on patients. In a wider context, better targeting building-related investments have great potential for saving money and receiving return via improved patients' well-being.

This current thesis has increased insights into the possibilities and pitfalls of design interventions and connected different but strongly related fields such as architecture, facility management, psychology, real estate, business, medicine, and nursing. This thesis calls on an urgency and willingness to collaborate, study, and improve future hospital buildings which subsequently enables us to improve experiences and well-being of patients in hospitals.

Appendix

Nederlandse samenvatting

Introductie *(hoofdstuk 1)*

Een ziekenhuisbezoek is vaak een angstige en onzekere gebeurtenis voor patiënten en hun familieleden. Patiënten zijn vaak bezorgd over de diagnose en/of de behandeling van hun ziekte in een ziekenhuis. De impact van de ziekenhuisomgeving op patiënten wordt nog steeds niet goed begrepen. Kennis over de invloed van deze omgeving op patiënten is essentieel om de kwaliteit van de gezondheidszorg te faciliteren. Inzicht in de ervaringen van patiënten stelt de ontwerpers en beleidsmakers in ziekenhuizen in staat om het welbevinden van patiënten positief te beïnvloeden. Het doel van dit proefschrift was om een beter inzicht te krijgen in een holistische beleving en het welbevinden van patiënten in ziekenhuizen. Het onderzoek is gericht op specifieke aspecten van het gehele traject dat een patiënt aflegt, vanaf de aankomst tot en met de diagnose en de behandeling in een ziekenhuis. Vanuit deze verschillende aspecten van een *patient journey* is de invloed van de ziekenhuisomgeving (gebouwcomplexiteit, natuur, geluidsomgeving en patiëntenkamer) op het welbevinden van patiënten onderzocht. In deze samenvatting zijn de belangrijkste bevindingen van de verschillende studies uit dit proefschrift weergegeven over deze specifieke aspecten van deze gehele *patient journey*. Ten eerste is het proces van aankomst van patiënten onderzocht; zo is de invloed van routecomplexiteit en gesimuleerde fysieke veroudering bij deelnemers op *wayfinding* onderzocht. Ten tweede is de invloed van natuurprojecties op het welbevinden van patiënten onderzocht tijdens een scan; de diagnose. In de vervolgstudies stond de behandeling van patiënten centraal. Zo is ten derde de invloed van het geluidsniveau op het welbevinden van patiënten in een poliklinisch infuuscentrum onderzocht. En ten vierde is een breder perspectief op de ervaringen van de patiënten met de fysieke, sociale en privacyaspecten bestudeerd in een poliklinisch infuuscentrum. Tot slot zijn de fysieke en psychosociale aspecten in verschillende meerpersoonskamers van een oncologie verpleegafdeling onderzocht.

Aankomst *(hoofdstuk 2)*

De *patient journey* begint bij de aankomst in het ziekenhuis, waarna de patiënt een route loopt naar de bestemming van de afspraak. De complexiteit van de gebouwde omgeving is een toenemend probleem in ziekenhuizen, omdat ziekenhuizen in omvang toenemen door de toenemende zorgvraag, meer diagnostische technieken en meer gespecialiseerde zorg. Voor patiënten kan het een moeilijke en stressvolle taak zijn om de weg te vinden in complexe gebouwde omgevingen en dit kan voornamelijk voor oudere mensen moeilijk en uitdagend zijn. Het doel van de studie in Hoofdstuk 2 was om de invloed van routecomplexiteit en fysieke veroudering op *wayfinding* (efficiëntie looproute en loopsnelheid) te onderzoeken in een ziekenhuisomgeving. Het was niet bekend of het effect van routecomplexiteit (het aantal veranderingen in gebouw en verdieping) op *wayfinding* verschilt voor oudere personen met een lichamelijke beperking als gevolg van veroudering, dit betreft zowel de zintuiglijke als de motorische veroudering.

De deelnemers liepen verschillende routes in een leeftijdssimulatie-experiment (d.w.z. zij werden willekeurig aan één of twee routes toegewezen). Om uitsluitend de lichamelijke veroudering te onderzoeken, werd een deel van de jonge deelnemers aan dit onderzoek ingedeeld in een groep die gerontologische pakken droeg. Deze pakken simuleerden de typische lichamelijke beperkingen van ouderen, zoals veranderingen in spierkracht, gezichtsvermogen en gehoor. Deelnemers liepen dus een of twee routes, met of zonder gerontologisch pak.

De resultaten toonden aan dat de routecomplexiteit (meer veranderingen: van het ene naar het andere gebouw of naar een andere verdieping) van invloed was op *wayfinding* (efficiëntie looproute) bij beide "leeftijdsgroepen". Dit kan worden verklaard doordat de deelnemers de centrale wayfinding-strategie toepasten, wat betekent dat zij eerst naar een centraal punt liepen zoals de hoofdingang of de centrale hal (Hölscher, Büchner, Meilinger, & Strube, 2009). Hierdoor liepen de deelnemers tijdens complexe routes minder efficiënt. Deze resultaten zijn deels in overeenstemming met het conceptuele kader voor evidence-based design (Ulrich et al., 2010) waarin wordt gesteld dat de contextuele variabelen van het gebouw, inclusief de entree, bewegwijzering en plattegrond, van invloed zijn op patiëntuitkomsten. De resultaten toonden ook aan dat de gesimuleerde oudere deelnemers minder goed presteerden tijdens een looproute dan jonge deelnemers in termen van snelheid. Volgens Davis (2012) worden oudere personen langzamer in lichaam en geest, en de resultaten van deze studie bevestigen dat gesimuleerde oudere deelnemers langzamer lopen en dus meer tijd nodig hebben om de route af te leggen. Bovendien toonden de resultaten aan dat zij een hogere hartslag en ademhalingssnelheid hadden tijdens een route in vergelijking met jongeren, en daarom meer energie verbruikten in vergelijking met deelnemers die geen pak droegen tijdens een route.

Concluderend kan worden gezegd dat de routecomplexiteit en de fysieke veroudering van invloed zijn op *wayfinding*. Inzicht in de invloed van routecomplexiteit op *wayfinding* kan de ontwikkeling van effectieve interventies in complexe gebouwomgevingen vergemakkelijken. Ziekenhuizen dienen zich bewust te zijn van de voordelen voor patiënten van een eenvoudig gebouwde omgeving tijdens de route en de voordelen voor ouderen van bestemmingen die beter bereikbaar zijn te voet.

Diagnostiek *(Hoofdstuk 3)*

Diagnostische scans spelen een cruciale rol in de diagnose en behandeling van ziekten. Om deze reden moeten patiënten, na aankomst in een ziekenhuis, vaak een diagnostische scan ondergaan. Dit zorgt vaak voor spanning bij patiënten, omdat zij meestal bezorgd en bang zijn dat ze een ernstige ziekte hebben (Munn & Jordan, 2011). De invloed van de natuurlijke omgeving krijgt steeds meer aandacht en lijkt potentieel de spanning te kunnen verminderen. Inzicht in de invloed van de natuur tijdens een diagnostische scan stelt ziekenhuizen in staat om scanruimtes te creëren die het welbevinden van patiënten positief beïnvloeden.

In hoofdstuk 3 is onderzocht of het gebruik van bewegende natuurprojectie in computertomografie (CT)-ruimtes effectief is in het verminderen van psychofysiologische spanning. Deelnemers ondergingen een CT-scan voor het hart. In een quasi-willekeurig experiment met een tussen-proefpersonen opzet werden de deelnemers toegewezen aan één van de twee condities. In de experimentele conditie werd een bewegend natuurbeeld geprojecteerd op het apparaat en de wand in de CT-ruimte. De projectie op beide objecten weerspiegelde een tijdsverloop van een heuvellandschap, dat werd gedomineerd door een heuvel met gras, bomen en langzaam bewegende wolken met de bijbehorende schaduwen. In de controle conditie werden geen beelden getoond.

De resultaten toonden aan dat, tijdens de diagnostiek, de natuurlijke omgeving (de projectie van de bewegende natuur) een positieve invloed had op de patiëntuitkomsten door de beoordeling van de aangenaamheid van de scanruimte. Patiënten ervaarden de scan-ruimte als aangenaam wanneer er bewegende natuurbeelden werden geprojecteerd, waardoor de psychologische en fysiologische spanning werd verminderd (d.w.z. een lagere hartslag en bloeddruk). Dit bevestigt het baanbrekende onderzoek van Ulrich (1984), dat uitzicht op de natuur de patiëntuitkomsten positief kan beïnvloeden; in dit geval zelfs met een digitale weergave van de natuur. Deze huidige resultaten zijn ook belangrijk omdat, volgens de protocollen voor coronaire beeldvorming, patiënten met een hartfrequentie van minder dan 70 hartslagen per minuut onmiddellijk kunnen worden gescand zonder toediening van bètablokkers. Deze resultaten suggereren dat de projectie van bewegende natuurbeelden mogelijk kunnen leiden tot een verminderde behoefte aan toediening van bètablokkers, wat een positieve invloed kan hebben op de werkefficiëntie van radiologen. Bovendien maakt een lagere hartslag tijdens de hartscans een vermindering van de stralingsblootstelling mogelijk, wat de gezondheidsrisico's kan verminderen.

De resultaten van deze studie zijn ook in overeenstemming met het kader van Bitner (1992) en tonen aan dat de beleving van de ruimte (ervaren aangenaamheid) een essentiële mediator is in het verbeteren van het welbevinden van patiënten. De resultaten toonden aan dat de natuurprojectie de spanning niet direct verminderde, maar resultaten toonden een indirect effect van natuurprojectie op spanning door de aangenaamheid van de ruimte. Toen de natuur werd geprojecteerd, ervaarden de patiënten de kamer als aangenamer en daardoor zelf minder spanning. Deze rol van gepercipieerde aangenaamheid heeft ook een sterke affiniteit met de emotionele respons plezier, volgens het model van Mehrabian & Russell (1974). Zij onderscheiden drie emotionele reacties om de perceptie van de fysieke omgeving te beschrijven, namelijk plezier, opwinding en dominantie. Zij beschrijven plezier als een positieve affectieve staat (bijvoorbeeld gelukkig, blij, tevreden). Volgens de psycho-evolutionaire theorie van Ulrich (1983) is de invloed van de natuurlijke omgeving ook een psychologisch proces als gevolg van visuele waarneming. Hij stelt dat de visuele perceptie van de natuurlijke omgeving psychologische stress kan verminderen door de initiële affectieve reactie (gevoelens) of door cognitie (gedachten). Dit betekent dat aangenaamheid, als gevolg van visuele waarneming, één van de mediatoren is in het effect tussen de ziekenhuisomgeving en de patiëntuitkomsten. Het is zeer waarschijnlijk dat een groter aantal affectieve of cognitieve mediatoren een cruciale rol spelen in de manier waarop patiënten de ziekenhuisomgeving ervaren die leidt tot welbevinden.

Concluderend kan worden gesteld dat de natuur van invloed is op de uitkomsten voor de patiënt. Door het creëren van een aangenamere scan-ruimte, door middel van bewegende natuurprojectie, kunnen ziekenhuizen de psychofysiologische spanning van de patiënt tijdens een diagnostische scan beïnvloeden. Door het creëren van een prettige scanruimte kan het welbevinden van patiënten aanzienlijk worden verbeterd.

Behandeling op het dagcentrum *(Hoofdstuk 4 en 5)*

Na de diagnose krijgt een toenemend aantal uiteenlopende patiënten behandelingen op het dagcentrum, voor bijvoorbeeld kanker of chronische ziekten, zoals spier- of vaatziekten. Patiënten kunnen verschillend omgaan met deze latent stressvolle situatie. Lawaai is een veel voorkomend probleem in ziekenhuizen en het is bekend dat sociaal gedrag het geluidsniveau kan beïnvloeden. Tijdens de dagbehandelingen kunnen sommige patiënten de voorkeur hebben voor een behandelingsruimte die hen in staat stelt om na te denken en te rusten (minimaal lawaai), terwijl anderen voorkeur hebben voor behandelingsruimte die hen afleidt en hen de mogelijkheid biedt om met medepatiënten en bezoekers te praten (Browall, Koinberg, Falk, & Wijk, 2013). Aandacht voor de individuele voorkeur en ervaring van patiënten met betrekking tot sociaal contact is van groot belang, omdat ziekenhuizen tegenwoordig worden ingericht met steeds meer éénpersoonskamers.

In hoofdstuk 4 is de invloed van het geluid van praten op het werkelijke en gepercipieerde geluidsniveau onderzocht in het dagcentrum. In een quasi-willekeurig onderzoek werden de deelnemers toegewezen aan één van de twee condities, namelijk geen gedragsregel (praatconditie) versus een gedragsregel (niet-praatconditie). Beide condities zijn uitgevoerd in dezelfde behandelingsruimte. In deze studie werd het volgende gemeten: de werkelijke geluidsniveaus in dB(A), de voorkeuren van de patiënten met betrekking tot het geluid en de percepties van patiënten van de fysieke omgeving.

De bevindingen toonden aan dat de geluidsomgeving slechts in geringe mate werd beïnvloed door de niet-praten gedragsregel, en er werd geen effect van de geluidsomgeving op de resultaten van de patiënt vastgesteld. De resultaten suggereren echter dat de voorkeur van de patiënten wel degelijk invloed had op de gepercipieerde mate van spanning. De helft van de patiënten gaf de voorkeur aan een praatconditie, ongeveer één-derde van de patiënten had geen voorkeur en de resterende groep van patiënten gaf de voorkeur aan een niet-praatconditie. De resultaten suggereren dat patiënten die de voorkeur gaven aan niet-praten, de omgeving negatiever ervaarden dan de meerderheid van de patiënten en hogere niveaus van gepercipieerde spanning rapporteerden in beide condities.

Tot slot geven de resultaten aan dat een niet-praten regel niet voldoende is voor het verminderen van het geluidsniveau en het verbeteren van het welbevinden van de patiënt. Patiënten hebben mogelijk meer baat bij een patiëntgericht ontwerp waarbij ze de mogelijkheid krijgen om te kiezen tussen een mix van behandelingsplaatsen.

Een diepgaand vervolgonderzoek (hoofdstuk 5) is uitgevoerd om de ervaring van patiënten beter te begrijpen en om te bepalen hoe een dagcentrum beter kan worden ontworpen waarbij rekening gehouden wordt met de individuele voorkeuren. In deze kwalitatieve studie is onderzocht hoe patiënten de fysieke aspecten, sociale aspecten en privacyaspecten in de behandelingsruimte van een dagcentrum ervaren. Aan de hand van een interviewleidraad op basis van vijf percepties (aangenaamheid van de ruimte, geluid, nabijheid, drukte, privacy) van een omgeving, werden de deelnemers thuis geïnterviewd.

De resultaten van dit onderzoek toonden aan dat patiënten niet klaagden over het geluid van praten, maar dat ze niet alle gesprekken van anderen wilden horen. Vooral gezondheidsgerelateerde gesprekken bleken storend te zijn. Patiënten ervaarden een gebrek aan akoestische privacy en probeerden zich daarom emotioneel te isoleren of hielden informatie achter voor het personeel. Volgens het raamwerk van Donabedian (1988) kan hieruit worden afgeleid dat het zorgproces wordt beïnvloed door de niet-praten gedragsregel (structuur) wat gevolgen kan hebben voor de kwaliteit van de zorg. Deze bevinding komt ook overeen met Bitner's servicescape model waarin zij stelt dat de omgevingsdimensies van invloed zijn op de sociale interacties tussen klanten en personeel. In deze zorgcontext beïnvloedt de omgeving de medische interacties tussen patiënten en zorgpersoneel. Zo trokken patiënten, die de akoestische blootstelling tijdens de behandeling in een open gedeelde behandelruimte niet prettig vonden, zich emotioneel terug en hielden zij zelfs medisch relevante informatie achter voor het personeel. Hoewel de meeste patiënten niet klaagden over het geluid van praten of het geluidsniveau, uitten veel patiënten ontevredenheid over het geluid van de infuuspompen. De resultaten van het onderzoek toonden aan dat verschillende patiënten verschillende ruimtelijke behoeften hadden. Patiënten die de voorkeur gaven aan niet-praten hebben behoefte aan afgesloten privékamers en ervaarden negatieve afleiding als gevolg van ruimtelijke drukte. Daarentegen hadden patiënten zonder voorkeur of met een voorkeur voor praten behoefte aan gedeelde kamers en zij ervaarden positieve afleiding van de ruimtelijke drukte. Deze individuele verschillen in voorkeuren kunnen mogelijk verklaard worden door verschillen in persoonlijkheidskenmerken (Mehrabian & Russell, 1974) of kunnen afhangen van de ernst van de aandoening van de patiënten en de mogelijkheid om te communiceren (Rowlands & Noble, 2008).

Concluderend kan worden gesteld dat de resultaten een relatie aantonen tussen de fysieke omgeving en de sociale omgeving. Patiënten met verschillende voorkeuren hadden behoefte aan verschillende fysieke aspecten in de ziekenhuisomgeving. Daarom is het belangrijk dat het zorgpersoneel de voorkeuren van patiënten vaststelt en dat er verschillende soorten behandelplaatsen worden geïntegreerd in nieuwe ontwerpen.

Behandeling op de verpleegafdeling *(Hoofdstuk 6)*

Under submission

Conclusie *(hoofdstuk 7 en 8)*

Dit proefschrift laat zien dat de ziekenhuisomgeving een grote impact heeft op het fysieke en psychosociale welbevinden van patiënten. De bevindingen laten zien dat bij het ontwerpen van een ziekenhuis het van groot belang is om te luisteren naar de ervaringen en behoeften van patiënten, omdat veel van de resultaten individuele verschillen aantonen die benadrukken dat *one size does not fit all*. Door de ziekenhuisomgeving af te stemmen op de individuele kenmerken, behoeften en voorkeuren van de patiënt kan het welbevinden van patiënten in toekomstige ziekenhuizen worden verbeterd. Hoofdstuk 7 geeft een overzicht van de bevindingen en hoofdstuk 8 licht de implicaties van deze bevindingen toe.

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