UNDERSTANDING HEALING ENVIRONMENTS:

EFFECTS OF PHYSICAL ENVIRONMENTAL STIMULI ON PATIENTS' HEALTH AND WELL-BEING

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General Introduction

"The hospital has become so completely a product of the technologies of medicine and manufacture, so precisely adapted to the uses of science, as to become in effect a scientific instrument not essentially different from the X-ray machine or the operating table which it encloses".
Joseph Hudnet, 1947

Take a few seconds to imagine how you would feel if you were hospitalized. You experience a certain amount of physical discomfort, you feel vulnerable, you may be in pain, and you probably experience feelings of uncertainty. It is most likely that you experience a sense of depersonalization: you do not have control over you own body, you cannot control who enters your room, and you must fully rely on people you have never met, the healthcare professionals. Or imagine how you would feel if you were waiting for your annual appointment with the dentist? You might hear some distressing noises coming from the treatment area, and you still vividly remember how it felt the last time the dentist filled a cavity.

Encounters with healthcare situations are generally characterized by fear, anxiety, stress, and uncertainty (Mason, Sachar, Fishman, Hamburg & Handlon, 1965; Newman, 1984; Pride, 1968). When looking at most environments in which these encounters take place, one might rightfully ask how well these healthcare environments satisfy the psychological needs of patients. In 1947, Hudnet observed a lack of architectural values in healthcare facilities. Baron and Greene (1984, p. 1731) observed that "throughout the world new hospitals have been designed and built for high quality medical care. Few have been designed to be beautiful". Mahnke (1996, p. 147) stated that the medical qualities should not be presented through design, "otherwise the impression of a 'hospital factory' is quickly reflected". To date, the typical hospital room is still painted white, lacks decorations, and is minimally furnished. But how can healthcare facilities be designed that create spaces for the delivery of high quality medical care and are at the same time pleasant, in order to assist rather than hinder healing?

Well-designed facilities may increase positive emotions, which in turn could positively affect patients' health and well-being (Malkin, 2008). This presents an opportunity to comfort patients; physical surroundings can be designed in a way that is psychologically supportive (Ruga, 1989). The use of this knowledge on psychologically supportive healthcare environments is defined as evidence-based design (Hamilton, 2003). Evidence-based design, based on its medical equivalent, evidence-based medicine, refers to guiding design decisions by scientific evidence in order to promote health and well-being. Use of the evidence-based design of healthcare environments might impact health-related outcomes such as length of stay, pain, medication intake, stress, arousal, mood, or environmental appraisals. These variables are all considered to be relevant outcome measures in assessing the effects of the physical healthcare environment, but most research in this field focuses on stress (Ulrich, 1995). Stress can result in more pain and slower wound healing, but it also impacts the immune system (Rabin, 1999). These are convincing reasons to design healthcare environments that reduce stress and address patients' needs for relaxation and comfort (Malkin, 2008).

But which environmental characteristics of the healthcare environment may generate these benefits? And how do these effects come about? The present dissertation aims 1) to explore the effects of a variety of environmental stimuli on patients' health and well-being and 2) to develop a theoretical framework and provide empirical support for the underlying mechanisms explaining the effects of physical healthcare environments on the health and well-being of patients.

The remainder of this introductory chapter presents the context and scope of the studies in this dissertation. First, the potential impact of physical environments is discussed, followed by an introduction on healthcare environments. Next, a theoretical framework will be presented, followed by an overview of the content of the chapters.

Environmental influence

Research in the field of environmental psychology has demonstrated that environmental stimuli affect cognition (Babin, Hardesty & Suter, 2003), mood (Knez, 2001; Leather, Beale, Santos, Watts & Lee, 2003) and behavior (Gifford, 1988; Mattila & Wirtz, 2001). These studies show that the physical environment, in a variety of settings, appears to be an important determinant of how people think, feel, and act.

Utilizing the physical environment as a specific means to influence people originated in the domain of retailing. Kotler (1973) was the first to focus attention on the potential impact of the physical environment and used the term 'atmospherics', defined as "the effort to design buying environments to produce specific emotional effects in the buyer that enhance his purchase probability" (Kotler, 1973, p. 50). Based on this idea, a large number of studies have investigated the effects of the retail environment on, for example, mood, price perceptions, purchase intentions, and customer loyalty (for a review see Turley & Milliman, 2000). Research showed that using an ambient scent in a retail store resulted in more positive store evaluations, merchandise evaluations, and intentions to visit the store (Spangenberg, Crowley & Henderson, 1996). Studies on color demonstrated that warm colors induced approach behavior in customers (Bellizzi, Crowly & Hasty, 1983), and that wall colors affected customers' evaluations of the store (Babin, Hardesty & Suter, 2003). Another variable that has been widely studied in retail settings is music. Research demonstrated that playing French and German music in a wine store boosted the sales of the wine produced by that country (North, Hargreaves & McKendrick, 1999). These studies demonstrated the impact of the physical retail environment on psychological states, cognitions, and consumer behavior. However, the process by which atmospheric cues are channeled remains unclear (Chebat & Michon, 2003).

According to Bitner (1992), the ability of the physical environment to influence behaviors and to create an image is particularly relevant for services such as banks, travel agencies, and hospitals. These services have one thing in common: it is difficult to evaluate the outcome of service because of its intangible nature (Bebko,

2000; Zeithaml, 1988). More specifically, in the case of healthcare situations, it is difficult for patients to evaluate, for example, the clinical competence of their physician. Healthcare services are characterized by credence attributes, suggesting that it is difficult for consumers to evaluate the outcome of the service because they lack the required knowledge or skills (Darby & Karni, 1973). Generally, people tend to base their evaluations of a service on three types of clues (Berry, Wall & Carbone, 2006). They use functional clues that concern the technical quality of the service, humanic clues, which relate to the behavior and appearance of service providers, and mechanic clues, which refer to aspects of the physical environment. These clues create the service experience by influencing people's rational and emotional perceptions of service quality. The current research focuses on mechanical clues, the tangible elements of the service experience, which provide an interesting opportunity to affect people's thoughts, feelings, and behavior.

Berry et al. (2006) state that the more complex and personal a service is, the more customers act as detectives to unravel all of the available clues. Healthcare services are clearly one of the most personal, important, and complex services; therefore, patients will act in a detective-like manner because they are eager to obtain any evidence of the service provider's competence and caring. Patients will rely on all clues that are available to them to form an impression of this competence or lack thereof. Both interactions with the physician and other staff members as well as clues from the built environment will be assessed in such cases to assist this impression formation.

Overall, research in the field of services marketing demonstrates the importance of the physical environment for services that are characterized by credence attributes. Moreover, studies on the effects of the retail environment clearly demonstrated the potential impact that the physical environment has on cognitions, feelings, and behavior.

Healthcare environments

The environmental docility hypothesis suggests that the less competent the individual is, the greater the impact of environmental factors on that individual (Lawton & Simon, 1968). When ill, people tend to be uncertain, anxious, concerned, and in pain. This also implies that their adaptive resources are already drawn upon. Under such circumstances, people will be imbalanced more easily by distressing environmental stimuli. This suggests that they could also benefit more from calming, relaxing, and positive environments. Along the same line, the competence hypothesis suggests that as functional capacity diminishes, environmental effects will be more pronounced (Lawton & Nahemow, 1973). The impact of the physical environment could, thus, be of greater importance in healthcare settings than in other settings.

For a long time, the predominance of the medical model in diagnosis and treatment in hospitals deflected attention from the broader psychological impacts that healthcare settings have upon patients (Winkel & Holahan, 1985). In the last 20

years, however, many architects, physicians, and environmental psychologists have discussed the influence of the healthcare environment on the well-being and health of patients. Traditionally, healthcare facilities were built with an emphasis on the functional delivery of health care. Since research supports the idea that the built healthcare environment impacts health and well-being of patients, more attention is being paid to the psychological consequences of architectural choices. Several literature reviews on this topic are available, which will be described below.

Rubin, Owens, and Golden (1998) conducted the first literature review on whether the built environment affects patients' medical outcomes. They included all aspects of the physical healthcare environment that can affect patients. Most studies investigated a direct physiological impact of the physical environment on health outcomes. Their search yielded 84 studies, of which many were judged to have methodological flaws. Nevertheless, the findings of the majority of these studies suggest a positive correlation between environmental features and clinical outcomes. They described several studies that indicate that music therapy affects medical outcomes, and they also showed that environmental characteristics, such as light and noise, have an effect on the development of newborn infants.

Ulrich, Zimring, Quan, and Joseph (2004) performed a broad review focusing not only on the effects of the physical environment on patient outcomes, but also on staff outcomes and quality of care. They identified over 600 studies and categorized the findings into four areas: 1) staff stress and fatigue and effectiveness in delivering care, for example, ergonomic interventions or walking time of nurses; 2) patient safety, for example, risk of hospital-acquired infections by both airborne and contact transmission routes; 3) patient stress and outcomes, for example, noise or spatial disorientation, nature, and positive distraction or social support; 4) overall healthcare quality, for example, single-bed patient rooms and patient satisfaction with the quality of care. This review demonstrates that the impact of the architecture of healthcare facilities can be examined from a variety of perspectives. The research in this dissertation focuses on how the physical healthcare environment promotes patients' health and well-being.

In a recent review, Malenbaum, Keefe, Williams, Ulrich and Somers (2008) examined the effects of light, nature scenes and sounds, and virtual reality stimuli on pain. They concluded that environmental factors appear to increase pain control, and decrease pain perceptions, the use of analgesic medication, and medication costs. They even suggest that this can possibly eliminate some troublesome side effects from medications and improve outcomes.

These reviews demonstrate that much attention is being paid to the psychological consequences of architectural choices in order to support health and well-being. Such psychologically supportive environments are also referred to as *healing environments*. The concept of healing environments suggests 'that the physical healthcare environment can make a difference in how quickly the patient recovers from or adapts to specific acute and chronic conditions' (Stichler 2001, p.2). Although the literal meaning of healing environments suggests a restriction to healthcare situations in which healing is the aspired goal, the impact of the physical

environment is not limited to these situations. As Stichler (2001) clearly states in his definition, it is not only about healing and curing, the physical environment may also be helpful in care situations by helping people to adapt to chronic conditions. The importance of the physical environment is, thus, relevant for both cure and care situations. Furthermore, it is also of importance in outpatient settings where patients must cope with specific acute conditions.

Stress is an important factor in healthcare situations and stress reactions can be considered a clinical problem since they often result in negative or worsened medical outcomes (Malkin, 2008). Hospitalization is generally associated with feelings of fear, uncertainty, and anxiety (Mason et al., 1965; Pride, 1968). These feelings may affect the healing process. Volicer and Volicer (1978) found that hospital stress was positively correlated with changes in heart rate and blood pressure. Research also shows that psychological stress impairs wound healing in patients (Kiecolt-Glaser et al., 1995; Christian et al., 2006). Elbrecht et al. (2004) studied the effects of perceived stress and cortisol levels on wound healing and demonstrated a considerable effect of stress. Rabin (2004 in Malkin 2008; personal communication 2008) proposed that pleasant healthcare environments are those that are perceived by the brain as calming, meaning that the stress reactive areas of the brain decrease their activity with a resultant decrease in the concentration of cortisol and norepinephrine in the blood. This results in patients experiencing less pain, having more restful sleep, less anger, less muscle tension, and a lower risk of stroke. Furthermore, Kaplan and Kaplan (1989, p.189) states that "the nervous system seems to be structured in such a way that pleasure and pain tend to inhibit each other". A more pleasant healthcare environment could, therefore, result in less stress and anxiety in patients and this should lead to better health and increased feelings of well-being. Although these authors do not provide empirical evidence for these assumptions, they do provide a plausible explanation on why pleasant environments may reduce stress. When speaking about a more pleasant healthcare environment, a wide variety of environmental characteristics come to mind. Variables such as indoor plants, colors, and music could help create environments that generate positive feelings and, as a consequence, reduce negative outcomes.

Taken together, research in the domains of environmental psychology, architecture, and medicine shows that the physical healthcare environment plays an important role in the healthcare process. Understanding the effects of physical environmental stimuli in healthcare facilities will allow us to create environments that positively affect the health and well-being of patients. However, evidence on the effects of specific stimuli, for example, color, is lacking (see chapter 2 for an overview of the available evidence). Moreover, there is little available evidence that demonstrates how these effects of the physical healthcare environment come about. Understanding the underlying processes that cause these effects may help us to design healing environments more efficiently. In the next section, the theoretical framework that was developed to understand the effects of healing environments and that served as a guide for the empirical studies in this dissertation will be presented.

A theoretical framework

Several theoretical frameworks that explain the effects of the physical environment are available in the field of environmental psychology (Mehrabian & Russell, 1974; Ulrich, 1983), and, more specifically, in research on retail and service environments (Greenland & McGoldrick, 2005; Bitner, 1992). These models make stimulus-organism-response (S-O-R) predictions and emotional states are proposed to be mediators between environmental stimuli and human behavior. Mehrabian and Russell (1974) suggested that the influence of environmental stimuli was revealed in approach or avoidance behavior. They proposed that three emotional states, pleasure, arousal, and dominance, intervene in the relationship between the environment and behavior. Ulrich (1983) further specified this mediating process by suggesting that the environment leads to an initial affective reaction, which is followed by cognitive processing and, in turn, may result in a post-cognitive affective state. The initial affective reaction is believed to have major influences on attention, subsequent conscious processing, physiological responses, and behavior (Ulrich, 1991).

Several studies in the field of marketing demonstrated that the effects of the environment are mediated by cognitive and affective responses (see for example Babin, Hardesty & Suter, 2003). In her framework, Bitner (1992) proposes that the perceived servicescape does not directly cause people to behave in certain ways. These perceptions are believed to lead to certain cognitive, emotional, and physiological responses, which, in turn, influence behavior. Furthermore, the strength and relation between variables is hypothesized to be moderated by personal and situational factors (Bitner, 1992).

A framework for understanding healing environments was constructed (see figure 1.1) based on these previously developed models. The basis lies in the idea that the physical healthcare environment evokes internal responses (both cognitive and affective), which, in turn, affect the health and well-being of patients. These effects are expected to be moderated by individual differences such as personality traits (e.g., stimulus screening ability). Our framework differs from the previously developed frameworks on an important aspect. Where the other frameworks try to gain insight on the effects of the environment on behavior, the aim of the current framework is to explain which environmental variables have an impact on health and well-being. Next, the four elements in the framework will be introduced.

The environment

The physical healthcare environment is comprised of ambient, architectural, and interior design features (Harris et al., 2002). Ambient features include, for example, lighting, noise levels, odors, and temperature. The architectural features are the relatively permanent aspects of the physical healthcare environment, such as the spatial layout of the hospital, the size and shape of rooms, and the placement of windows. Interior design features can be defined as the less permanent aspects of the healthcare environment, such as furnishings, colors, interior plants, and artwork. Environmental stimuli can be classified as either purely stimulus objects or interactional objects (Rice et al., 1980). An environmental stimulus can be part of

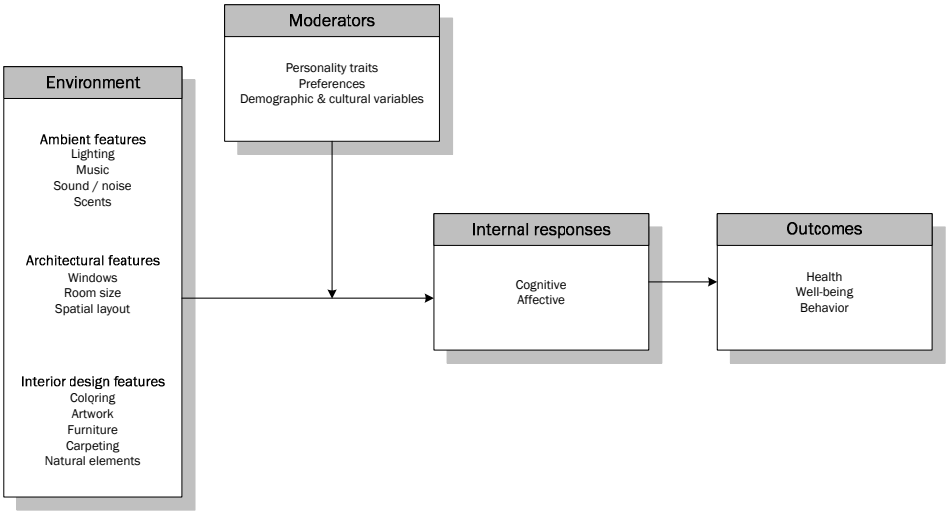

Figure 1.1 A framework for understanding healing environments

the environment to which one is passively exposed to, but it is also possible that one interacts with the stimulus. One can passively see interior plants that are in the room, but one can become actively involved when taking care of the plants. The research in this dissertation is restricted to purely stimulus objects. These stimulus objects can impact the health and well-being of patients in two ways. First, they can have a direct physiological influence, which means that the effects are unmediated or unmoderated by psychological processes (Taylor et al., 1997). A carpeted floor, for example, contains more microorganisms than a vinyl floor (Anderson et al., 1982) and may, thus, have a direct physiological effect on health by causing more infections. The environment may also impact health and well-being through psychologically mediated processes that can be of a cognitive or affective nature. The same carpeted floor may give patients a greater feeling of being at home, resulting in less anxiety, which, in turn, may promote recovery. These psychologically mediated processes are the processes of interest for the current research. Physical environmental stimuli are, thus, defined as:

Physical environmental stimuli are part of the (shared) healthcare environment and can be classified as ambient, architectural or interior design features that are purely stimulus objects (i.e. not interactional) and which influence patients through mediation by psychological processes.

Promoting health and well-being by using environmental stimuli can, thus, be accomplished in two ways: by reducing effects of negative stimuli or by adding positive stimuli to environments. Negative distracters are stressful because they are difficult to ignore (Ulrich, 1991). Research shows that hospitals are noisy places and that these noises create discomfort and stress (see Rashid & Zimring, 2008 for a review). These negative effects can be reduced by adding sound-absorbing tiles to

the ceiling (Hagerman et al., 2005). Environmental stimuli can also be added to the environment to influence the patient in a positive way. The environment may elicit positive feelings, hold attention and interest, and block or reduce negative thoughts, for example, by the presence of art or a view from a window (Ulrich, 1991). The purpose of the present studies is to improve health and well-being by either adding positive elements to existing healthcare environments, such as interior plants or music, or by making changes in existing environmental characteristics, for example, changing wall colors.

People respond to their surrounding environment in a holistic manner. Individuals perceive discrete stimuli, but it is the total composition of all stimuli that determines their responses to the environment (Bitner, 1992). This means that individual environmental stimuli can influence people, but they also affect the way other stimuli are being perceived, and, thus, both single and interactive factors create the effects of the holistically perceived servicescape. In the experimental studies described in the empirical chapters of this dissertation, effects of single environmental stimuli are studied in order to gain more insight into the effects of those particular stimuli and explain the way that they work. In order to be able to predict the ways in which environmental stimuli can reinforce or weaken one another, the knowledge of effects of single environmental stimuli is necessary. However, it is important to recognize the fact that the environment is perceived holistically, which is reflected in the framework by including all environmental characteristics, which altogether compose the physical healthcare environment.

Internal responses

Whereas the environment may potentially affect a wide variety of outcome measures, such as psychological outcomes, clinical outcomes, staff outcomes, or economic indicators, the outcomes studied in this dissertation are limited to those that are indicative for patients' health and well-being. Previous research demonstrated that environments are capable of affecting cognitive and affective responses. In line with the frameworks of Mehrabian and Russell (1974) and Bitner (1992), several psychological variables, both cognitive and affective, are proposed to be mediating variables.

As suggested by Ulrich (1983), people respond to environments with an initial affective reaction. Such immediate affective responses to environments may influence emotions and trigger physiological processes that can influence the immune system and, thus, health and well-being (Parsons, 1991). Perceptions of environments can even elicit automatic affective responses (Hietanen, Klemettilä, Kettunen & Korpela, 2007). Several experiments demonstrate that the initial affective responses occur extremely fast (Korpela, Klemettilä & Hietanen, 2002; Hietanen & Korpela, 2004). Korpela, Klemettilä, and Hietanen (2002) employed an affective priming paradigm to demonstrate the rapid affective evaluation of environmental scenes. Their results showed that environmental pictures automatically activated an associated affective evaluation. Parsons (1991) utilizes LeDoux's model of sensory emotional processes to argue that these fast responses are likely to be primarily affective because they are based on very little stimulus

information, and this process is completely subcortical and centered on the amygdala.

As can be seen in the framework in figure 1, this research does not attempt to explain the specific order in which these cognitive and affective responses occur. Discussing the primacy of affect or cognition (see Zajonc, 1984; Lazarus, 1984) is considered to be outside of the scope of the present research. Moreover, we attempt to establish the impact of the physical healthcare environment on health and well-being. The affective and cognitive responses can help explain how environmental effects come about, but ultimately the effects on health and well-being are of main interest.

The research described in this introductory chapter demonstrates that both cognitive and affective responses are triggered by the surrounding physical environment. There is also evidence available that suggests that these responses serve as mediating variables that (partially) explain the relationship between the physical environment and a variety of outcome measures (Bitner, 1992; Mehrabian & Russell, 1974).

Outcomes

Within the field of healing environments, stress appears to be the central point of attention. Ulrich (1995) indicated stress as a starting point for a theory of psychologically supportive design and healing environments are even called stress-reducing environments (Malkin, 2008). Stress can be defined as an imbalance between perceived demands and perceived coping resources (Lazarus, 1999). Furthermore, stress can help to explain the behavioral and health effects that occur when environmental stimulation exceeds an individual's adaptive resources (Gifford, 1997). According to Leather et al. (2003), stress offers a valuable heuristic to help explain how the physical features of an environment can influence human health and well-being.

In models on the stress process, a number of key factors are highlighted, namely coping processes, mood, and environmental appraisals (Cox, 1985; Lazarus, 1993; Ferguson, 1997). Lazarus (1993) argued that cognition is the mediator between the environment and stress. He states that environmental appraisals and coping processes shape the stress reaction and that these processes are influenced by variables in the environment and within the person. This suggests that stress can, in fact, be considered a post-cognitive state; more than a mere initial affective response. In the current research, stress is, thus, considered an outcome measure that is indicative of health and well-being.

Stress is an important predictor of actual health. Research showed, for example, that psychological stress impaired wound healing in patients (Kiecolt-Glaser, Marucha, Malarkey, Mercado & Glaser, 1995; Broadbent, Petrie, Alley & Booth, 2003). Ineffective stress recovery may undermine physical health through chronic arousal, immune suppression, and other aspects of allostatic load (Van den Berg et al., 2007). In most studies in this dissertation, stress is, therefore, considered to be the main outcome variable. However, stress is not equally relevant in every

healthcare situation. Patients awaiting a dental treatment experience feelings from mild to severe anxiety (Milgrom, Fiset, Melnick & Weinstein, 1988). In a counseling session with a psychologist, the amount of self-disclosure is an important outcome of interest since it is considered a vital component of counseling (Cohen & Schwartz, 1997).

Moderators

The effects of the physical healthcare environment are expected to be moderated by personal and situational factors. Responses to an environment depend, for example, on one's purpose or goal for being in that particular environment (Russell & Snodgrass, 1987). This situational dependence may vary quickly, even during the course of the day. A study by Ward, Snodgrass, Chew, and Russell (1988) demonstrated that the things an individual noticed, remembered, and felt were all influenced by the purpose for being in the context.

Individual differences in personality traits are more stable. Samuelson and Lindauer (1976) emphasized the importance of individual differences in the description and evaluation of environmental settings. Traits such as need for control, preference for consistency, and need for cognition can all be hypothesized to affect the relationship between the environment, internal responses, and health. For the purpose of this research, a personality trait that is very closely related to the way we perceive our surrounding environment was investigated. People differ in their sensitivity towards environmental stimuli. This is also referred to as the ability to screen out irrelevant stimuli within an environment (Mehrabian, 1977a). Some people have a natural tendency to reduce the complexity of an environment (high-screeners), whereas others are not capable of this information reduction (low-screeners). Mehrabian (1977b) developed a measure for this environmental sensitivity and named it stimulus screening ability. Low-screeners are inclined to be much more sensitive to and affected by the surrounding environment than high-screeners.

Given that hospitalization is generally associated with feelings of fear and anxiety (Newman, 1984) and that these feelings are closely related to individuals' stimulus screening ability, it could be the case that being ill results in people having a lesser ability to screen information. The construct of stimulus screening ability could be a construct that varies with people's wellness and might, thus, be of great importance in healthcare situations.

Furthermore, this specific trait is shown to be associated with a variety of health-related outcomes. Results demonstrated that low-screeners experienced more illnesses than high-screeners (Mehrabian & Ross, 1979). A review by Mehrabian (1995) reported that trait arousability (i.e., the converse of stimulus screening ability) is related to a variety of personality traits and behaviors. The ability to screen out irrelevant stimuli, thus, appears to be closely related to health-related outcomes (i.e., anxiety), but also to specific health conditions, such as diastolic pressure and the incidence of illnesses (Mehrabian, 1995).

Overview of the present dissertation

Understanding the effects of physical environmental stimuli in healthcare facilities will allow us to create environments that positively affect the health and well-being of patients. In addition, understanding the underlying processes that cause these effects may help in designing healing environments more efficiently.

This dissertation begins with a systematic literature review on the effects of the physical healthcare environment on health and well-being of patients in order to identify the gap in our knowledge on healing environments. Based on the insights from this systematic review, a series of empirical studies was conducted to add to the evidence-base by demonstrating that various aspects of the physical environment, in a variety of settings, are capable of affecting health and behavior. The effects of color, music, and interior plants were studied in the context of treatment areas, waiting rooms, and patient rooms. Moreover, the studies aim to reveal possible underlying mechanisms that cause these effects, and to gain insight in individual differences in reactions to the physical healthcare environment. See figure 1.2 for a graphic overview of the empirical chapters of this dissertation.

Chapter 2 provides a critical overview of methodologically rigorous studies on effects of the physical healthcare environment. This review shows that only 30 well-conducted clinical trials that studied effects of the physical healthcare environment on patients' health and well-being are available. The available studies support the general notion that the physical healthcare environment affects the well-being of patients. Predominantly positive effects were found for sunlight, windows, odor, and seating arrangements. Inconsistent effects were found for variables such as sound, nature, and spatial layout. This review concluded that although multi-stimuli interventions tend to be effective, singular effects of specific stimuli appear to be highly inconsistent. Additional knowledge of the contribution of specific environmental stimuli is, therefore, warranted. The following empirical chapters will address the effects of several environmental stimuli, namely color, music, and indoor plants.

In Chapter 3, two field studies that investigate the effects of music in a waiting room are reported. Most research in this field involved inpatients in acute and psychiatric settings. Waiting areas, however, may play an important role in reassuring or distressing ambulant patients. The first study demonstrates that playing classical music in a dentist's waiting room results in reduced feelings of stress and anxiety, as well as higher perceived attractiveness and professional quality of the waiting room. The second study replicates the beneficial effects of classical music in the waiting room of a general practitioner. Moreover, this study demonstrates that the calming effects of classical music are the result of patients being in a more positive emotional state after being exposed to classical music.

Chapter 4 deals with the question of whether the stress-reducing effects of environmental stimuli are also mediated by a cognitive response, namely perceived attractiveness. In order to investigate this cognitive mediator, the stress-reducing effects of indoor plants in a patient room were investigated. There is ample

evidence that demonstrated that nature possesses stress-reducing properties, but the hypothesized underlying process has not been tested. Results of this study show that the stress-reducing effects of indoor plants are mediated by perceived attractiveness of the patient room. This study, thus, confirms the stress-reducing properties of natural elements in the built environment. Moreover, it sheds light on the underlying mechanism that causes this stress-reduction. The mediating effect of a cognitive response was replicated in a second study. This second study shows that not only is stress reduced by indoor plants, but by a painting of nature as well. Apparently, both real plants and a painting of a tree activate the concept of nature, as was revealed by a word fragment completion task.

Chapter 5 focuses on the moderating effects of stimulus screening ability. In two laboratory studies, effects of wall color in a patient room were studied. Results demonstrate that the stress-reducing effects of green and arousal-inducing effects of orange were both more pronounced for people scoring low on stimulus screening ability than for those who are able to effectively screen out complexity in the environment. These studies demonstrate that environmental influences can be highly dependent on a personality trait, in this case, one's sensitivity to the surrounding environment.

Chapter 6 demonstrates that the physical healthcare environment not only affects well-being, but even affects actual health-related behavior. Results show that wall color in a counseling room affects participants' self-disclosure. Participants in a white room (as compared to a room with green walls) disclosed more information about themselves. Furthermore, they rated the room with white walls higher on professional quality and perceived the counselor in the white room as being more attractive, trustworthy, and competent.

This dissertation concludes with a general discussion in Chapter 7. A summary of the main findings will be presented, and theoretical and practical implications, limitations, and directions for future research will be discussed.

The chapters that follow are all based on articles that are currently published or submitted to scientific journals. To ensure that the chapters can be read independently from each other, the introductions to each chapter may show some overlap.

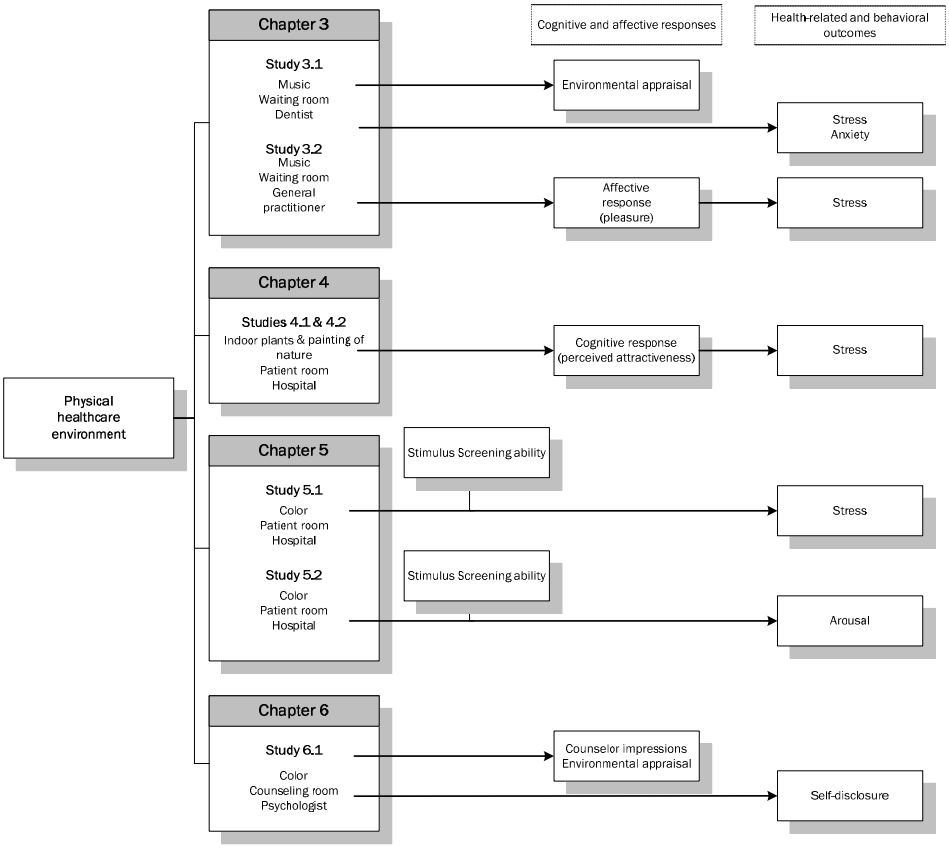

Figure 1.2 Overview of the empirical chapters of this dissertation

The following chapter reports a systematic review to determine the known effects of physical environmental stimuli in healthcare settings on the health and well-being of patients. Of the over 500 potentially relevant studies identified, only 30 met all criteria and were included in this review. Studies that manipulate several environmental stimuli simultaneously clearly support the general notion that the physical healthcare environment affects the health and well-being of patients. However, when scrutinizing the effects of specific environmental stimuli, conclusive evidence is still very limited and difficult to generalize. The field thus appears to be in urgent need of well-conducted, controlled clinical trials. At present, and on the basis of the available research, it would be premature to formulate evidence-based guidelines for designing healthcare environments.

2

Physical environmental stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: Systematic review[i]

[i] Dijkstra, K., Pieterse, M., & Pruyn, A. (2006). Physical environmental stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: Systematic review. *Journal of Advanced Nursing, 56*(2), 166-181.

Introduction

Traditionally, the emphasis on designing healthcare settings was on the functional delivery of healthcare (Ulrich 1995). Gradually, this emphasis shifted towards a perspective of designing healthcare environments that are 'psychologically supportive' (Ruga 1989), also referred to as healing environments (see Stichler 2001; Sloan Devlin & Arneill 2003; Schweitzer *et al.* 2004). The concept of healing environments suggests that the physical environment of healthcare settings "can make a difference in how quickly the patient recovers from or adapts to specific acute and chronic conditions" (Stichler 2001, p.2).

Understanding physical environmental stimuli in healthcare facilities will allow us to create environments that positively affect the healing process and well-being of patients. Healing environments are claimed to have beneficial effects on a variety of health indicators, such as anxiety, blood pressure, postoperative recovery, the use of analgesic medication, and the length of stay (Ulrich 1995). Moreover, if relatively inexpensive alterations such as introducing plants or colors can indeed shorten the length of stay, then these environmental changes may also prove to be highly cost-effective.

Previously conducted reviews on this topic (see Rubin *et al.* 1998; Ulrich *et al.* 2004; Van den Berg 2005) clearly state that environmental stimuli in the healthcare environment affect patient outcomes. These reviews each make their own contribution to the field, whether by including non-clinical evidence or by taking a broad scope involving both patients and staff and also including stimuli that provide a direct physiological hazard. However, a critical overview of methodologically rigorous studies is still lacking. It remains unclear for which environmental stimuli, and specific types of patients and in which specific healthcare settings, there is conclusive evidence that might enable us to formulate guidelines for the evidence-based design of healthcare facilities.

Physical environmental stimuli

Harris *et al.* (2002) distinguished three relevant dimensions of the physical environment: architectural features, interior design features and ambient features. Architectural features are relatively permanent characteristics, such as the spatial layout of a hospital, room size, and window placement. Interior design features are defined as less permanent elements, such as furnishings, colors and artwork. Ambient features comprise lighting, noise levels, odors and temperature.

Another classification, introduced by Rice *et al.* (1980), subdivides physical environmental features in either purely stimulus objects, or interactional objects. This is illustrated by the following example: plants – as an interior design feature - may serve as stimulus objects when patients are passively exposed to them (i.e. visually), whereas they become interactional objects as soon as patients are actively involved in taking care of them. This example also shows that some features can be classified in both categories, depending on how they are applied. This review is restricted to purely stimulus objects.

Psychologically-mediated effects

In general, there are two ways in which stimulus objects can impact the health or well-being of patients. First, they can have a *direct physiological influence*, meaning the effects are mainly unmediated or unmoderated by psychological processes (Taylor *et al.* 1997). For example, a carpeted floor contains more micro-organisms than a vinyl floor (Anderson *et al.* 1982) and may therefore have a direct physiological influence on patients' health by causing more infections. Second, environmental stimuli may act through *psychological processes* as a result of sensory perceptions. These processes can be of a cognitive or an emotional nature. For instance, the presence of plants in a hospital bedroom may give the patient a more homely feeling resulting in less anxiety, which in turn may promote recovery.

This review is restricted to this second category of processes. However, several stimuli influence health directly as well as through mediation by psychological processes. Carpeted floors, for instance, may not only have the aforementioned, direct physiological effect, but also an indirect effect by providing a more homely ambience or by improving acoustic conditions. In these ambivalent cases, studies were only included when the outcome measures were indicative of psychologically mediated effects. Taking the example of carpeted floors, we thus included studies with outcome measures such as arousal or calmness, but excluded studies measuring the number of respiratory infections.

Environmental stimuli can also be (part of) a specific medical treatment, as in light therapy for patients with seasonal depression (Golden *et al.* 2005). Studies in which environmental stimuli were applied as treatment were excluded from this review.

In summary, for the purpose of this review, physical environmental stimuli were defined as follows:

> *Physical environmental stimuli are part of the (shared) healthcare environment and can be classified as ambient, architectural or interior design features that are purely stimulus objects (i.e. not interactional) and which influence patients through mediation by psychological processes.*

Aim

The aim of this review was to achieve a rigorous evidence-base that could serve as a source for both the design of healthcare environments and for future research.

Search Methods

The review was conducted using the Cochrane Collaboration method (Alderson *et al.* 2003). Electronic searches were carried out using databases on medicine, psychology and architecture, namely MedLine, PsychInfo, Embase, CINAHL, Iconda, ScienceDirect, Compendex and the ISI Citation Indexes.

Some of the MeSH (medical subject headings) used in the searches were: interior design and furnishings, hospital design and construction, environment design and health facility planning. However, these were found inadequate to fully identify all relevant studies, nor were they suitable for all databases used. Therefore, an additional set of search terms was used for the type of healthcare setting (e.g. hospital, waiting room), environmental stimuli (e.g. furniture, color) and outcome measures (e.g. well-being, blood pressure), even though this meant over-selecting potentially relevant studies. The following 17 environmental stimuli were explicitly sought for: furniture, art, color, nature, plants, gardens, carpeting, room size, spatial layout, private rooms, noise, music, odor (i.e. a smell, pleasant or unpleasant), television/video, light, windows, and view from a window.

There were no limitations on the year in which the study was published. The only language restriction was an abstract provided in English, German, Spanish, French or Dutch. The reference lists of the previously published reviews were also sought (Rubin *et al.* 1998, Ulrich *et al.* 2004, Van den Berg 2005) and the final electronic search was performed in the summer of 2005.

Inclusion and exclusion criteria

Criteria for considering studies for this review were (i) interventions involving the health effects of environmental stimuli in healthcare settings compared to other environmental stimuli, or with no environmental stimuli at all; (ii) clinical trials with at least an adequate control group and published in peer-reviewed journals; (iii) patients staying in a healthcare setting for any length of time; and (iv) health-related outcome measures. Clinical outcomes such as length of stay, medication intake or pain were included as were psychological outcomes such as mood, stress or satisfaction with received care. Environmental stimuli were defined according to our definition stated in the introduction.

Studies that manipulate a single environmental stimulus - as well as those manipulating multiple stimuli simultaneously - were included. Studies were excluded if the environmental intervention(s) were confounded with non-environmental changes, such as changes in the nursing care policy.

Data extraction

For all the trials included, methodological quality was assessed. Information about study design, baseline measurements and data sources was extracted, as was information about the environmental stimuli, participants (age, gender, type of disease), healthcare setting (type and size) and measurement tools used.

Results

Search results

The search strategy revealed 4075 papers. After applying the inclusion criteria to titles and abstracts, 533 papers remained which were retrieved for a full-text screening. This screening led to the exclusion of 290 non-empirical papers. Another

83 studies were excluded because they adopted study designs other than controlled trials. Table 2.1 sets out other reasons for exclusion. Thirty studies were finally included in this review.

Table 2.1 Articles excluded from the review

Reason for exclusion	*n*
Non-empirical articles	290
Articles not studying effects of environmental stimuli	77
Articles not studying effects on patients	10
Articles not studying effects in a healthcare setting	7
Articles adopting study designs other than controlled trials	83
Articles lacking an adequate control condition	15
Articles confounding with non-environmental changes	10
Articles using the environmental stimulus as therapy	9
Articles studying the social environment	2
Total	**503**

Methodological characteristics of the studies

Only controlled clinical trials were included to ensure methodological quality. Of the 30 studies included, 18 could be described as controlled clinical trials and two as randomized controlled clinical trials. The other ten studies were categorized as natural experiments, of which seven were conducted retrospectively.

Most studies were not truly randomized, but groups were comparable at baseline. However, baseline differences were found for four studies but not adjusted in data analyses. Data retrieved from patient admission forms and automated systems were assumed to be reliable. The majority of the studies used self-reported measures as outcomes and these were also assumed to be reliable. Data collected in studies using observational measures were judged to be reliable when two or more raters scored at least 90% agreement or a kappa of 0.8. This was the case in two observational studies. Four studies did not present a kappa value.

Meta-analyses could not be executed due to the unique characteristics of the interventions (30 studies on 17 different environmental stimuli), healthcare settings, outcome measures, and patients, causing clinical heterogeneity.

Effects of physical environmental stimuli

No studies were retrieved that exclusively examined the manipulation of the following environmental stimuli: color, art, plants, gardens, carpeting and room size. Most of these stimuli, however, were manipulated simultaneously in combination with several others.

In this review, we sought studies manipulating a single environmental stimulus, as well as studies manipulating multiple stimuli at the same time. These multiple stimuli studies may support the general notion that the physical healthcare

environment is capable of affecting the health and well-being of patients. The results of the multiple stimuli studies will thus be presented first.

Multiple stimuli (see Table 2.2)

An entire renovation or redecoration project allowed for the examination of the simultaneous effects of multiple environmental stimuli. The 11 studies were subdivided into type of setting (entire wards, treatment areas, waiting rooms) and will be described below. If available, specifics on the environmental stimuli modified can be found in Table 2.2.

Entire wards

Outcome measures in the six trials that remodeled an entire ward can be roughly divided into two types, namely (1) health- and behavior-related measures, and (2) outcome measures regarding appraisal of the physical environment. Mainly positive effects were found on these environmental appraisals. For the health and behavior-related outcomes, primarily involving cognitively impaired or older patients, effects were highly inconsistent.

Holahan and Saegert (1973) found more socializing and less isolated passive behavior on a remodeled ward than on a control ward, but no differences for non-social active behavior. Christenfeld *et al.* (1989) also reported some positive effects. They found that patients' negative self-image showed greater improvement in the remodeled wards. No differences were found for depression, irritability and social isolation.

Tyerman and Spencer (1980), on comparing an institutional with a normalized ward, showed that the normalized environment improved measures of occupation and activity, but only slightly affected patterns of interaction and communication. Remarkably, the normalized ward was associated with poorer self-help skills than the institutional ward. Harwood and Ebrahim (1992) found even more negative effects when comparing a new and purpose-built ward with a refurbished one. The purpose-built ward showed no effects on disability scores and mortality, whereas Barthel scores (activities of daily living index) improved considerably for the refurbished ward.

Stahler *et al.* (1984) compared a redecorated dayroom with a control room. Although they found a positive result for pathological behavior, several negative effects were also observed in the redecorated room. Isolated passive behavior, hostility, and tension increased, whereas sociability and self-maintenance skills decreased.

Olsen (1984) compared a progressive-care unit (a less hospital-like environment) with a traditional unit and found more positive effects on medical-surgical patients. Patients in the progressive-care unit felt less confined and more positive, showed more social activity and mobility, and less passive behavior. There were no differences in perceived quality of nursing care, perceived boredom, and depression.

Three of these studies also measured subjective appraisals of the physical healthcare environment. Holahan and Saegert (1973) found more positive attitudes toward the physical environment on the remodeled ward. Olsen's (1984) progressive care unit was rated more pleasant and cheerful. The effects found by Christenfeld *et al.* (1989) were less consistent.

Treatment areas
Three trials focused on the effects of a total redecoration of treatment areas. Two types of outcome measures were studied, namely appraisal of the physical environment and patient's rating of their physician.

Janssen *et al.* (2000) compared the differences between single room maternity care (SRMC) and a traditional delivery care situation, using a satisfaction survey. The SRMC-group rated the physical layout higher with respect to spaciousness, availability of supplies, comfort of the support person, and lighting. Vielhauer Kasmar *et al.* (1968) found similar results on comparing two contrasting counseling rooms, labeled as either ugly or beautiful. The ugly room was rated less favorably on several aspects. Swan *et al.* (2003) found that patients even evaluated both food service and the whole hospital more positively when staying in the more appealing rooms. They also had stronger intentions to use the hospital again. It should be noted, however, that patients self-selected the appealing room by paying $40 per day extra and may therefore have been positively biased in their evaluations.

Patients in the study by Swan *et al.* (2003) also rated their attending physician more favorably and a similar but non-significant tendency was also found for nurses. Similar effects were found by Janssen *et al.* (2000). In their study, the SRMC-group was not only more satisfied with the information and support received, but also the nursing care was rated higher. The results of Vielhauer Kasmar *et al.* (1968) are less convincing with respect to these positive findings regarding patients' evaluation of the physicians and nurses. They showed no main effects on patients' rating of the physician.

Table 2.2 Study characteristics for studies investigating effects of multiple stimuli

Author/date	Method	Participants and setting	Interventions	Outcome measures
Holahan & Saegert (1973)	Randomized controlled trial Data retrieved by observations and self-reported measures	50 patients diagnosed as schizophrenic, other psychotic, non-psychotic or deferred Two admission wards large municipal hospital	Remodeled ward: wall painted bright off-white and blue, all doors painted in bright solid colors, attractive and comfortable modern furniture, brightly colored bedspreads, areas with range of social options Control ward: old, worn and rather uncomfortable furniture, walls in dull tan, brown, marble, dark brown doors	Social behavior Non-social active behavior Isolated passive behavior Attitude toward the physical environment Attitude toward the social atmosphere
Olsen (1984)	Controlled clinical trial Data retrieved by observations and self-reported measures	90 medical-surgical patients (mastectomies, hernias, rectal & misc. surgeries) Two units of a 1000-bed hospital	Progressive care unit (hospital beds/daybeds): a less hospital-like environment that contained daybeds, a dining room, patient pantry, and lounges. Traditional unit: precise attributes remain unclear	Quality of nursing care Confinement feelings Social activity Passive behavior Mobility Pleasantness ratings Associations with home

Tyerman et al. (1980)	Controlled clinical trial Data retrieved by observations	45 mentally handicapped patients Two wards of a subnormality hospital	New design Old institutional design (total redesign, remains unclear what precise attributes differed between the two settings)	Self-help (independent) Self-help (supervised) Self-help (aided) Occupation/activity (participatory/ non-participatory/ inactivity/ stereotypy) Interaction/communication (resident-resident/ staff-resident)
Christenfeld et al. (1989)	Natural experiment Data retrieved by observations	81 patients of which over 95% were diagnosed as psychotic and two thirds of them schizophrenic Six wards	<u>Remodeled ward:</u> (lowered ceilings, light-colored tiles on the floor, separate seating areas, regrouped furniture, relocation nursing station, recessed lighting, vinyl walls, full carpeting in bedrooms, wall hangings) <u>Control ward:</u> unclear	Satisfaction with rooms Depression Irritability Social isolation Negative self-image Episodes of patient violence
Harwood & Ebrahim (1992)	Natural experiment Data retrieved by observations and self-reported measures Baseline difference: higher dependency residents were	95 nursing home residents, the majority classified as CAPE dependency grades D and E Nursing home	<u>New and purpose-built ward</u>: on the ground floor, with single and twin bedrooms, and separate day and dining areas <u>Refurbished maternity ward:</u> four-bedded bays	Mortality Barthel (activities of daily living) Behavioral rating scale Cognitive assessment scale

	relocated in the new and purpose-built ward		and a separate day area	
Stahler et al. (1984)	Natural experiment Data retrieved by observations Baseline difference: only female patients in experimental ward and only male patients in control ward	69 female patients in a geriatric ward, 67 male patients in a comparison geriatric ward. Diagnoses for both wards were primarily chronic schizophrenic and organic brain syndrome. Geriatric wards	Remodeled ward: environmental enrichment and furniture rearrangement program: repainting, activity material, orientation signs Control ward	Pathological behavior Isolated passive behavior Isolated active behavior Patient-staff interaction Patient-patient interaction Patient-rater interaction Norristown behavior checklist (sociability, hostility, tension, self-maintenance skills, activity-participation, aggressiveness)
Janssen et al. (2000)	Controlled clinical trial Self-reported measures	205 women in Single Room Maternity Care, 104 women in traditional delivery care	Single Room Maternity Care: rooms with outside windows, maple furniture, bathrooms with bathtubs, sound-proof walls, family lounge Traditional delivery care: delivery rooms and postpartum rooms	Information and support Being with family and friends Privacy needs Physical environment Nursing care Teaching Feeding the baby Discharge planning
Vielhauer Kasmar et al. (1968)	Controlled clinical trial Self-reported measures	115 applicants for outpatient psychiatric treatment Outpatient psychiatric clinic at a	Beautiful room: carpeted in burnt-yellow carpeting and contained an abstract picture on one wall, a floor-sized artificial	Room ratings Rating of psychiatrist Mood

		Neuropsychiatric Institute	plant; a wooden wastebasket, and indirect lighting provided by a contemporary desk lamp, room was neat and well-kept Ugly room: carpetless, wit beige asphalt floor tiling, overhead fluorescent lighting, it was unkempt, with work papers strewn over the furniture and an overflowing grey metal wastebasket and ashtray	
Swan et al. (2003)	Controlled clinical trial Self-reported measures Baseline difference: Patients in the appealing rooms paid $40 per day extra; the nursing personnel was different in the two areas	177 patients for diverse medical service, e.g. gynaecological or orthopaedic Patient rooms at a major hospital	Appealing room: well-decorated, hotel-like, wood furniture, decorator art, carpeted floors, crown molding, ceramic tile baths Typical room: standard wardroom, typical metal hospital beds, inexpensive family sitting chairs, no artwork, slightly smaller rooms, higher noise	Evaluation of primary physician Evaluation of nurses Evaluation of food & food services Overall evaluation of hospital Intention to reuse Intention to recommend Length of stay

			levels	
Ingham & Spencer (1997)	Controlled clinical trial Self-reported measures	148 patients Dental practice	Baseline condition: nine plain black upright chairs, in plastic and wood, plus one small picture as decoration Increased décor condition: retaining the same chairs, decorated with four large landscape pictures, three potted plants and a vase of white carnations Added comfort condition: same decor as previous, seating consisted of comfortable lounge chairs, and a domestic-style standard lamp was added	Evaluation of waiting room: considerate / quality perception Mood: relaxation / security / comfort
Leather et al. (2003)	Controlled clinical trial Data retrieved by observations and self-reported measures	145 neurology (MS, Parkinson, epilepsy) outpatients Waiting rooms of neurology clinics of a large city hospital	Nouveau waiting room: L-shaped plan, color: grey/pink, lilac pile carpet, heavy curtains, fabric/wooden furniture, wall-mounted lights, nature pictures,	Self-reported stress Self-reported arousal Affective appraisal Pleasantness of the room Overall satisfaction Physiological arousal

		plants, glossy magazines Traditional waiting room: square plan, color: magnolia/dark brown, red flat carpet, flimsy curtains, plastic furniture, fluorescent strip lighting, easy reading materials

Waiting rooms
Two trials studied redecorated waiting rooms. Here, positive effects were also found for appraisals of the physical environment.

Ingham and Spencer (1997) created three waiting room layouts: a baseline condition, an increased décor condition, and an added comfort condition. They found that dental patients in the added comfort condition rated the practice as more considerate than patients in the increased decor condition, who rated the practice as more considerate than those in the baseline condition. The quality of the practice was rated lower by patients in the baseline condition than by those in the other conditions. Patients in the added comfort condition were more relaxed, secure and comfortable than those in the other two conditions.

Leather *et al.* (2003) compared a redecorated environment with a more traditional waiting area. They found that both affective appraisal and satisfaction were higher for the redecorated waiting area. No effects were found on self-reported arousal.

The results of these multiple stimuli studies may support the general notion that the physical healthcare environment affects the behavior and well-being of patients, but to what specific environmental stimuli can these effects be attributed? What clinical research is there that presents conclusive evidence of the effects of specific environmental stimuli?

Ambient features (see Table 2.3)
The physical (healthcare) environment was distinguished into three dimensions: ambient, architectural, and interior design features. With the first dimension, the so-called ambiance of the healthcare environment, included studies focused on sunlight, sound and odor.

Sunlight
Findings from the four studies investigating the effect of sunlight showed mainly positive effects on the length of stay, mortality rate, perceived stress and pain. However, it should be noted that detrimental effects were found for patients with a specific type of depression, indicating that sunlight is not necessarily beneficial to all patients.

Beauchemin and Hays (1996) found that depressed patients had a shorter length of stay (16.9 days) in sunny rooms than those in dull rooms (19.5 days). Benedetti *et al.* (2001) showed that patients with a bipolar depression had a shorter length of stay (19.8 days) in rooms with morning sunlight (with higher amounts of lux) than in rooms with evening sunlight (23.5 days). Remarkably, for patients with unipolar depression the difference was marginally significant, favoring evening sunlight rooms (20.9 days) to rooms with morning sunlight (23.1 days).

Beauchemin and Hays (1998) found that patients with a first myocardial infarction had a shorter length of stay in sunny rooms than in dull rooms, but the statistically significant difference was confined to women (2.3 days versus 3.3 days). They also

found that mortality was higher in dull rooms (11,6%) than in sunny rooms (7,2%). In a prospective study of the effects of sunlight, Walch *et al.* (2005) showed that patients who had undergone spinal surgery and were exposed to higher-intensity sunlight experienced less perceived stress, marginally less pain, took 22% less analgesic medication, and thus accounted for pain medication costs which were 21% lower.

For the studies by Benedetti *et al.* (2001) and Beauchemin and Hays (1998), clinical heterogeneity was found, data from Beauchemin and Hays (1996) were missing and could not be retrieved, so meta-analysis was not possible.

Sound

Four trials studied the effects of different aspects of sound on patient health and well-being. Mainly positive effects were found if the intervention aimed to prevent negative effects of noise. Adding sound to the environment as a positive distractor showed highly ambiguous results.

Hagerman *et al.* (2005) focused on preventing negative effects of sounds. They studied the effect of noise-absorbing ceiling tiles on patients admitted to an intensive coronary care unit. The rehospitalization rate was statistically significantly higher in the bad acoustics group, as was the need for extra intravenous beta-blockers. Subgroup analyses showed statistically significant effects favoring the noise-absorbing condition for pulse amplitude in patients with acute myocardial infarction and unstable angina pectoris. In addition to these clinical outcomes, good acoustics positively affected perceived quality of care.

Sound may also be included in the environment as a positive distractor. Williamson (1992) studied the effects of ocean sounds during the night on postoperative coronary artery bypass graft patients after transfer from an ICU. Patients hearing ocean sounds scored statistically significantly higher on a scale measuring self-reported sleep, indicating better sleep.

Two trials were included that studied the effects of a specific type of sound, namely music, as part of the ambient environment. Ferguson *et al.* (1997) studied the effects of music during blood donation and showed that playing music had either detrimental or beneficial effects on environmental appraisals, depending on patient characteristics. Effects of music on mood were negligible. Thorgaard *et al.* (2004) studied the effects of music on the perceived pleasantness of the sound in a cardiac laboratory. In the music group, 91% of patients undergoing coronary procedures described the sound environment as pleasant/very pleasant, compared to 56% in the non-music group.

Table 2.3 Study characteristics for studies investigating effects of ambient features

Author/date	Method	Participants and setting	Interventions	Outcome measures
Beauchemin & Hays (1996)	Natural experiment, retrospective Data retrieved from admission forms	174 patients with major depressive disorders, single or recurrent Patient rooms in psychiatric wards	Sunny room (max. 5000 lux) Dull room (max. 300 lux)	Length of stay
Beauchemin & Hays (1998)	Natural experiment, retrospective Data retrieved from admission forms	628 patients with a first attack of myocardial infarction Cardiac intensive care unit	Sunny room (max. 2500 lux) Dull room (max. 400 lux)	Length of stay Fatal outcomes
Benedetti et al. (2001)	Natural experiment, retrospective Data retrieved from admission forms	415 unipolar depressed and 187 bipolar depressed inpatients Patient rooms	Morning sunlight (max. 15500 lux) Evening sunlight (max. 3000 lux)	Length of stay
Walch et al. (2005)	Controlled clinical trial Data retrieved from medical records and self-reported measures	89 postoperative patients who had undergone spinal surgery Patient rooms	Bright side (73.537 lux) Dim side (50.410 lux)	Analgesic medication use Pain medication cost Severity of pain Stress Anxiety Depression

Ferguson et al. (1997)	Controlled clinical trial Self-reported measures	152 volunteer blood donors University mobile collection service	Music No music	Mood Environmental appraisals
Thorgaard et al. (2004)	Controlled clinical trial Self-reported measures	193 patients undergoing coronary procedures cardiac laboratory	Music No music	Perceived pleasantness environment
Williamson (1992)	Controlled clinical trial Self-reported measures	60 postoperative coronary artery bypass graft patients ICU in a large public hospital	Ocean sounds No ocean sounds	Sleep depth Falling asleep Awakening Return to sleep Quality of sleep Total sleep score
Hagerman et al. (2005)	Controlled clinical trial Data retrieved from automated systems and self-reported measures	94 patients diagnosed with stable angina pectoris, unstable angina pectoris, acute myocardial infarction Intensive coronary heart unit of a University hospital	Good acoustics Bad acoustics	Heart rate Heart rate variability Systolic blood pressure Diastolic blood pressure Pulse amplitude Healthcare in general Staff attitude quality Waking due to sounds Can hear what staff say Sounds from corridor Disturbed by sounds
Lehrner et al. (2000)	Controlled clinical trial Self-reported measures	72 patients waiting for dental treatment	Ambient odor of orange No odor	Pain Trait anxiety State anxiety

	Waiting room of a dental clinic	Mood Alertness Calmness

Odor
Only one study was included that studied the effects of ambient odor. Lehrner *et al.* (2000) diffused an ambient odor of orange essential oil in the waiting room of a dental practice, and found statistically significant results for women only. Women in the odor group reported less pre-treatment state anxiety, improved mood and increased calmness.

Architectural features (see Table 2.4)
The second dimension of the physical healthcare environment is the architectural features, i.e. the relatively permanent aspects of the healthcare environment. Studies focused on effects of windows and spatial layout.

Windows
Three studies investigated the effects of windows on the health and well-being of patients. Research focused on the presence or absence of windows, but also on the content of the view afforded from them. Both the presence of windows and a natural view have positive effects on clinical outcomes, such as delirium, sleep and the length of stay.

Two studies investigated the effects of windows in intensive care units versus a situation without windows. Keep *et al.* (1980) sent questionnaires to patients with varying diagnoses after discharge. They found that those treated in the ICU with windows remembered their admission and discharge more accurately and had better orientation for day of the week and time of day. They also experienced less sleep disturbance and visual disturbance and suffered less from hallucinations and delusions. Wilson (1972) studied the effects of windows on surgical patients retrospectively. Data were extracted from admission charts and demonstrated that patients in the windowless unit had statistically significantly less delirium reactions following surgery.

One study focused on the content of the view from a window. Ulrich (1984) retrospectively studied the effects of a view of nature versus a view of a brick wall. Patients with a natural view had shorter postoperative hospital stays, had fewer negative evaluative comments from nurses, took fewer moderate and strong analgesics doses, and had slightly lower scores for minor post surgical complications.

Table 2.4 Study characteristics for studies investigating effects of architectural features

Author/date	Method	Participants and setting	Interventions	Outcome measures
Keep et al. (1980)	Natural experiment Retrospective Self-reported measures	150 patients; postoperative, head injury, other trauma, cardio respiratory, neuromuscular or obstetric Intensive Therapy Unit	Windows No windows	Remember admission Remember discharge Oriented as to day of the week Oriented as to time of the day Sleep disturbance Visual disturbance Hallucinations and delusions
Wilson (1972)	Controlled clinical trial Data retrieved from clinical charts	100 patients undergone cholecystectomy, hysterectomy or abdominal surgeries Two Intensive Care Units	Windows No windows	Delirium Depressive reaction
Ulrich (1984)	Natural experiment Retrospective Data retrieved from admission forms	46 patients who had undergone cholecystectomy (gall bladder surgery) Patient rooms of a wing of a suburban hospital	View of trees View of brick wall	Length of stay Number and strength of analgesics each day Number and strength of doses for anxiety Minor complications Nurses' notes
Dolce et al. (1995)	Natural experiment Retrospective	80 orthopaedic inpatients with pain-	Private rooms Semi-private rooms	Type and amount of narcotic analgesics:

	Data retrieved from admission forms	related back disorders		1) oral time-contingent 2) intramuscular time-contingent 3) oral request-contingent 4) intramuscular request-contingent
Barlas et al. (2001)	Controlled clinical trial Self-reported measures	108 patients who received care Emergency Department of a University Hospital	Curtained area Curtained area close to the nursing station Room with solid walls	Auditory privacy Visual privacy Overall privacy
Pattison & Robertson (1996)	Controlled clinical trial Self-reported measures Baseline difference: numbers of hours worked by permanent nursing staff being 688 on the bay ward and 532 on the Nightingale ward	64 female patients undergoing surgical procedures involved a similar degree of post-operative discomfort Two gynaecological wards	Bay ward: bays of four or more beds parallel with the corridor and the external wall Nightingale ward: long single open plan room	Disturbance due to noise Anxiety Depression Patient visibility and nursing attention Patients' privacy Relationships with others Changes in sleep Patient preferences in ward design

Spatial layout
Three studies investigated the effects of changes in spatial layout on patient health and well-being. Most effects of spatial layout appear to be inconsistent, but some positive effects were found concerning perceptions of privacy.

First, Pattison and Robertson (1996) compared a bay ward (bays of four or more beds parallel with the corridor and the external wall) with a Nightingale ward (long, single, open-plan room) where female patients were nursed after surgical procedures involving similar degrees of post-operative discomfort. Patients scored higher on disturbance due to noise on the Nightingale ward than on the bay ward, but no differences were found in sleep scores. Marginally statistically significant differences for level of anxiety were found, with higher levels of anxiety on the Nightingale than the bay ward. The mean levels of depression were higher on the Nightingale ward, but this effect was not statistically significant.

Second, as a consequence of a different spatial layout, the level of privacy may be affected. Barlas *et al.* (2001) compared the effects on privacy of curtained areas in an emergency department with rooms with solid walls. They found that patients in the curtained areas believed more often that they could overhear others and that others could hear them, view them, hear personal information, and view personal parts of their bodies. In short, they perceived a lower sense of privacy.

Dolce *et al.* (1995) assessed the use of narcotic analgesics in orthopaedic inpatients with pain-related back disorders, comparing private with semi-private rooms. They found no differences in observed narcotic use between room types for oral time-contingent, intramuscular time-contingent, or oral request-contingent medications. Intramuscular request-contingent medication use was higher in private rooms than in semi-private rooms. However, after controlling for other variables in a multiple regression analysis, this effect of room type appeared non-significant.

Interior design features (see Table 2.5)
The third dimension of the physical healthcare environment comprises the interior design features, i.e. the less permanent aspects of the healthcare environment. Here, research focused on the effects of natural elements through images or video, on the presence or absence of a television, and on seating arrangements.

Nature
Two trials involved the introduction of natural elements either through images or video. Some positive effects were found on both pain control and pulse rate. However, most effects resulting from these manipulations were either non-significant or only small.

Diette *et al.* (2003) compared the effects of natural murals and nature sounds on patients undergoing flexible bronchoscopy with a control group without either. Pain control during the procedure was better in the intervention group. No differences in patient-reported anxiety were found. Ulrich *et al.* (2003) studied the effects on blood donors by comparing a videotape of a nature setting, a tape of an urban environment, daytime television and a no television condition. Pulse rate was lower

during Nature than Urban, No television compared to Television, and Low stimulation (no television and nature) compared to High stimulation (television and urban). No statistically significant results were found for blood pressure, although there were non-significant tendencies in the predicted direction. There were no main effects found on variables such as fear, arousal, anger/aggression, sadness, positive affects, and attentiveness/concentration as a function of environmental interventions.

Television

Ulrich *et al.* (2003) used television to introduce natural elements in a healthcare setting. Pruyn and Smidts (1998), on the other hand, studied whether the presence of a television in the waiting room had any effect on the waiting experience of patients. Watching intensity appeared highly dependent on the length of the wait. They found that the presence of a TV does not serve as a distractor in a waiting room in terms of changes in the waiting experience when compared to a waiting room without a TV.

Seating arrangements

Holahan (1972) studied the effect of different seating arrangements on hospitalized male psychiatric patients. He observed that in sociopetal (i.e. encouragement of interactions) and mixed arrangements statistically significantly more social and personal interactions occurred than in sociofugal (i.e. discouragement of interactions) and unstructured arrangements.

Table 2.5 Study characteristics for studies investigating effects of interior design features

Author/date	Method	Participants and setting	Interventions	Outcome measures
Holahan (1972)	Controlled clinical trial Data retrieved by observations and self-reported measures	120 hospitalized male psychiatric patients Dayroom	<u>Seating patterns</u>: 1) Sociofugal (chairs arranged shoulder to shoulder along the walls of the room) 2) Sociopetal (chairs arranged around two small tables in the middle of the room) 3) Mixed (chairs arranged both along the walls and around a small table in the middle of the room) 4) Free (patients were told to arrange the chairs themselves in any manner they wished)	Conversation Verbal games Other verbal Total verbal Nonverbal games Other nonverbal Total nonverbal Total social Non-social active Non-social passive
Diette et al. (2003)	Randomized controlled trial Self-reported measures	80 patients undergoing Flexible Bronchoscopy with conscious sedation Endoscopy Suite at a Teaching Hospital	Natural mural scene and tape of nature sounds No mural, no sounds	Anxiety Pain Ability to breathe Willingness to return for another FB Rating of bronchoscopy area

		Teaching Hospital		
Ulrich et al. (2003)	Controlled clinical trial Data retrieved from automated systems and self-reported measures	872 blood donors Blood bank	Videotape of nature setting Videotape of urban environment Daytime television No television	ZIPERS-score (fear arousal, anger/aggression, sadness, positive affects, attentiveness/concentration) Pulse rate Systolic blood pressure Diastolic blood pressure
Pruyn & Smidts (1998)	Controlled clinical trial Self-reported measures	337 patients with appointment at polyclinics of gynaecology, dermatology, ophthalmology, laryngology, internal medicine Nine waiting rooms of three hospitals	TV no TV	Perceived time spent Perceived waiting time Overall satisfaction with service Cognitive appraisal of the wait Affective appraisal of the wait

Discussion

Limitations

The purpose of this review was to achieve a rigorous evidence-base of the effects of physical environmental stimuli on the health and well-being of patients. The systematic search and selection process revealed only 30 studies in which these effects were rigorously investigated.

This number of included studies is surprisingly low when compared to the number of studies retrieved in previously conducted reviews on this subject (Rubin *et al.* 1998, Ulrich *et al.* 2004, Van den Berg 2005). This difference is mainly caused by the fact that we only included controlled clinical trials, whereas the previous reviews included almost all types of study designs.

It could be argued that this limitation regarding study design was too stringent. Clearly, by excluding all other study designs in this review, a large body of potentially supportive evidence is discarded. However, this supportive body of evidence had already been incorporated in the earlier reviews. Moreover, the explicit purpose of this review was to collect the available conclusive evidence, allowing the formulation of practice guidelines for evidence-based design. This necessarily implies a critical selection on the basis of methodological rigor. Since randomized and controlled clinical trials are generally accepted as the most reliable methodology for assessing effects of healthcare interventions (Schulz *et al.* 1995), the inclusion criteria used in this review seem justified. By using the Cochrane review methodology, the research in the field of healing environments was subjected to the same rigor as is generally accepted in clinical research and practice.

Results of the review

Three relevant dimensions of environmental stimuli were distinguished, namely ambient, architectural, and interior design features. Of the 30 included trials, 11 appeared to study a simultaneous manipulation of multiple environmental stimuli. Stimuli such as color, art, plants, gardens, carpeting, and room size were not studied in isolation from other environmental stimuli, but most of these stimuli were manipulated simultaneously in combination with several others.

The multiple stimuli studies concerned redesigning waiting rooms, treatment areas and entire wards. For several of these studies, positive effects were found for patients' environmental appraisal, but with regard to patients' evaluations of physicians and nurses, the results were less convincing. Conflicting results were also demonstrated for social behavior and no effects were found on clinical outcomes. It could be concluded that renovating or redesigning healthcare environments in general is appreciated by patients, but evidence of clinical effects is still lacking. Moreover, the conflicting results for social behavior also show that renovation may have negative consequences for specific types of patients and should therefore be planned carefully.

Nine included trials studied ambient features. Positive effects were found for several ambient features, with the most convincing results for exposure to sunlight. However, specific effects appeared to be highly dependent on the characteristics of the patient population. Designers should thus be prudent when using these findings to design healthcare environments.

The six trials that studied architectural features showed inconsistent effects: positive effects on both clinical and psychological outcomes and statistically non-significant outcomes on several measures. Methodological flaws in most of these trials, moreover, impede drawing causal inferences. For example, the reported effects of windows may have been confounded by varying amounts of daylight or by the content of the view, which were not considered.

Isolated interior design features were researched in only four trials. Adding natural elements only caused slightly positive effects. Seating arrangements have effects on social interactions, but a television set does not improve the waiting experience. In general, for interior design features the available evidence is very limited. Although interior design features were involved in several of the multiple stimuli trials, it is difficult to attribute positive effects from these trials to specific features.

Remarkably, the previously conducted reviews that included all types of evidence tended to draw considerably more favorable conclusions with respect to the power of healing environments than this review. This suggests that studies with less rigorous methodology tend to show more positive results than more rigorously controlled trials - an inference also drawn by Rubin *et al.* (1998).

Conclusion

The field appears to be in urgent need of well-conducted, controlled clinical trials. We sought 17 different environmental stimuli as possible interventions to affect the health and well-being of patients. We found only 30 trials that met the criteria for both relevance and methodology.

Studies manipulating several environmental stimuli simultaneously support the general notion that the physical healthcare environment affects patient well-being. However, when looking at the effects of specific environmental stimuli, conclusive evidence is still very limited and difficult to generalize.

Single environmental stimuli thus need to be explored further. Several environmental stimuli, such as color, have still not been studied rigorously, whereas the evidence for other environmental stimuli is still inconclusive. Effects of many stimuli appeared to be highly dependent on the characteristics of the patient population. Most stimuli have thus far been studied in only one or two trials, leaving no scope for analyzing the effects for different patient populations or pool results in meta-analyses.

Also, possible interactions between different environmental stimuli need further exploration. It is likely that the effects of different environmental stimuli will reinforce or weaken one another. In none of the 11 multiple stimuli trials were such interactions studied.

Furthermore, a clear understanding of the cognitive and emotional processes through which the effects can be mediated or moderated, is imperative. Insight into these processes may provide us with the necessary information to develop truly evidence-based healthcare environments.

At present, and on the basis of the available research, the formulation of evidence-based guidelines for designing healthcare environments would be premature. Nevertheless, the available evidence indicates that the concept of healing environments remains a promising field for future clinical research.

Based on the insights from the systematic review in the previous chapter, a series of empirical studies was conducted to add to the evidence-base on healing environments. The following chapter demonstrates the stress-reducing effects of classical music in waiting rooms and sheds light on the underlying mechanism. Exposure to music has been associated with more positive moods and reduced feelings of anxiety. The studies in the following chapter investigate whether playing music in waiting rooms of a dental practice (study 3.1) and a general practitioner's office (study 3.2) has beneficial effects on anxiety and stress in patients. Findings show that, when compared to no music or popular music, classical music can be effectively used in waiting rooms to reduce feelings of anxiety and stress prior to treatment. Furthermore, the second study demonstrates that the calming effects of classical music are the result of patients being in a more positive emotional state after being exposed to classical music.

3

Stress-reducing effects of classical music in waiting areas

Introduction

Healthcare areas have traditionally been built with emphasis on the functional delivery of health care (Gesler, Bell, Curtis, Hubbard & Francis, 2004; Ulrich 1995). Since research, however, supports the notion that the healthcare environment impacts the health and well-being of patients (for reviews see Ulrich, Zimring, Quan, Joseph & Choudhary, 2004; Dijkstra, Pieterse & Pruyn, 2006), more attention is now directed towards the psychological consequences of architectural choices. These reviews have shown that environmental stimuli, such as sunlight and scents, appeared to have beneficial effects on perceived stress (Walch, Rabin, Day, Williams, Choi & Kang, 2005) and feelings of anxiety (Lehrner, Eckersberger, Walla, Pötsch & Deecke, 2000). This field of research is characterized by the concept of *healing environments*, which implies that the physical environment of healthcare settings 'can make a difference in how quickly the patient recovers from or adapts to specific acute and chronic conditions' (Stichler 2001, p. 2). Most studies in this field involve inpatients in acute care and psychiatric settings. Waiting areas, however, may also play an important role in reassuring or distressing ambulant patients (Leather, Beale, Santos, Watts & Lee, 2003).

Three dimensions of the physical healthcare environment that can have effects on health and well-being have been distinguished (Harris, McBride, Ross & Curtis, 2002): architectural features (e.g. spatial layout, room size), interior design features (e.g. color, artwork, interior plants), and ambient features (e.g. lighting, odors, music). Both interior design and ambient features provide relatively easy and inexpensive ways to alter the atmosphere of healthcare spaces. Here we investigate the effects of ambient background music in patient waiting spaces.

The review by Dijkstra et al. (2006) concluded that, although multi-stimuli interventions (i.e. renovations) tend to be effective, singular effects of specific environmental features appear to be highly inconsistent. Additional knowledge of the contribution of specific environmental stimuli is therefore warranted. Furthermore, elucidating the underlying processes causing these effects may help to clarify the inconsistent findings in earlier studies and eventually help us to design healing spaces more efficiently. A clearer understanding of the precise mechanisms involved is necessary before it is possible to implement such designs on a larger scale.

In the next section, the literature investigating effects of music will be reviewed and the importance of waiting areas in healthcare settings will be outlined. Next, two field experiments will be reported that test the effects of music in waiting rooms of a dentist (study 3.1) and a general practitioner (study 3.2).

Music

Exposure to music has been associated with positive changes in emotional states (for reviews, see Evans, 2002; Garlin & Owen, 2006) and cognitive processing (Sweeney & Wyber, 2002). Although music is an environmental stimulus that can easily be applied to change the atmosphere of an environment, it has been shown that the empirical evidence regarding the effects of music as being part of the

shared healthcare environment is still limited (Dijkstra et al. 2006; Ulrich et al. 2004).

When looking at music as being part of the shared physical healthcare environment, the review by Dijkstra et al (2006) only found two eligible trials that studied the effects of background music. One study investigated the effects of music on the perceived pleasantness of the sound in a cardiac laboratory (Thorgaard, Henriksen, Pedersbaek & Thomsen, 2004). Patients exposed to music while undergoing coronary procedures described the sound environment as being more pleasant. Of those patients, 68% reported that music was of major importance to their feelings of well-being. Another study showed that playing music in a blood donor setting is not necessarily beneficial (Ferguson, Singh & Cunningham-Snell, 1997). They found that playing music had beneficial effects on people who were regular donors, but observed adverse effects on first and second time donors. In sum, although some beneficial effects of music have been reported, conclusive evidence regarding the effects of background music on patients is still lacking.

A specific use of music in healthcare settings is music as a therapeutic instrument. In this case, patients are individually exposed to music through headphones shortly before or during treatment. Although this clearly differs from the use of background music as a part of a shared physical environment, findings may be indicative of the healing potential of music on patients in healthcare environments. A review on the therapeutic application of music concluded that music can reduce anxiety during normal care delivery (Evans, 2002). Such music interventions effectively calmed patients before going into surgery (Cooke, Chaboyer, Schluter & Hiratos, 2005; Lee, Henderson, Shum, 2004), decrease postoperative pain (Good, Anderson, Ahn, Cong & Stanton-Hicks, 2005) and decrease pain during surgical procedures (Dubois, Bartter & Pratter, 1995).

Most studies investigating music as a therapeutic intervention used either self-selected music, which could be any genre the patient prefers, or some type of calming music (e.g. classical or instrumental). A comparison of the effectiveness of specific types of music based on these studies is not possible, however, because of differences in study populations and outcome measures (Evans, 2002). There is some evidence available from research in different settings that indicate what might be expected from different musical genres. A laboratory experiment on the effects of different types of music on coping with stress showed that after exposure to a stressor, classical music significantly reduced negative emotional states and physiological arousal compared to listening to heavy metal music or sitting in silence (Labbé, Schmidt, Babin & Pharr, 2007). A study that investigated the effects of objective characteristics of music demonstrated that classical music was perceived as more pleasant than popular music (Kellaris & Kent, 1993).

Waiting rooms

Waiting places may play an important role in reassuring or distressing patients. The first impression of the practice is given by the waiting room. It is the place where anxiety and worry about the consultation and possible treatment are likely to be built (Leather et al., 2003; Ingham & Spencer, 1997).

Oosterink, Jongh and Aartman (2008) investigated the anxiety-provoking capacity of various aspects of dental visits. They showed that invasive stimuli, such as having dental surgery or receiving an injection, were the most anxiety-provoking. They also found non-invasive stimuli to have anxiety-provoking capacities, including the waiting room. A study on patient anxiety in the dentist's office concluded 'that the most appropriate time to apply anxiety-reducing techniques with patients is during the waiting room period of a dental visit' (Lamb & Plant, 1972, p. 2).

Several studies underline the importance of the architectural qualities of waiting room environments. Ingham and Spencer (1997) showed that both decorations and more comfortable furniture in the waiting room of a dental practice led to patients feeling more comfortable, secure, and relaxed. Leather et al. (2003) studied the effects of a renovated waiting area. Changes in lighting, furnishings and color schemes (among other changes) resulted in more positive environmental appraisals, improved mood and greater satisfaction. Research has also demonstrated the beneficial effects of scents on anxiety and mood in dental patients (Lehrner et al. 2000; Lehrner, Marwinski, Lehr, Johren, & Deecke, 2005). Lehrner et al. (2005) also included a control condition consisting of uplifting and cheerful music, but no differences were found.

Tansik and Routhieaux (1997) investigated the effects of relaxing music in a hospital waiting room on visitors waiting for patients undergoing surgery. The results of that study showed that classical music decreased stress and increased relaxation in people waiting for surgery patients, which supports the idea that music is capable of affecting people in the waiting room. The specific effects on patients waiting for a consult or treatment are, however, unknown.

Moreover, the underlying mechanisms of these potentially positive effects of music are unclear. Several theoretical frameworks are available that explain effects of the physical environment (Mehrabian & Russell, 1974; Ulrich, 1983). These models make stimulus-organism-response predictions. Emotional states are proposed to be mediators between environmental stimuli and human behavior. Considering this, it might be hypothesized that the physical healthcare environment evokes internal emotional responses which, in turn, affect the health and well-being of patients. Furthermore, research suggests that music facilitates feelings of relaxation by refocusing attention onto pleasurable emotional states (for a review, see Cooke et al., 2005). To our knowledge, however, the idea of the calming effects of music being mediated by emotional states has never been empirically tested.

Overview of the studies

The purpose of the present field experiments is to investigate whether playing music in waiting spaces results in less dental anxiety (study 3.1), less stress (studies 3.1 and 3.2), and higher environmental appraisals (attractiveness and professional quality; study 3.1) of the waiting room. In the second study, we investigated whether the stress-reducing effects of music are due to patients experiencing a more positive emotional state.

Study 3.1

Fear of dental visits has been shown to be the primary reason to avoid necessary dental care, which in turn reduces oral health status and the quality of life (Berggren, 1993). Other research has shown that highly anxious patients appear to be more sensitive to pain (Asmundson & Taylor, 1996; Klages, Kianifard, Ulusoy & Wehrbein, 2006). In fact, visiting the dentist has been widely associated with feelings of stress and anxiety (for example, see Milgrom, Fiset, Melnick & Weinstein,1988). Therefore, the reduction of such negative feelings before undergoing treatment might be useful. Creating a less fearful experience may lead to beneficial effects such as less dental fear and subsequently to less avoidance behavior.

The purpose of this study was to investigate whether music in a dentist waiting room would decrease feelings of anxiety and stress and improve cognitive appraisals of the waiting environment. Because no conclusive evidence regarding differential effects of musical genres is known in healthcare settings (Evans, 2002), this study included both classical music and popular music. Several positive effects of classical music have been reported (Labbé et al., 2007; Kellaris & Kent, 1993). These findings suggest that classical music may be more beneficial than popular music. Furthermore, the use of music in the waiting room is not limited to emotional and health-related responses and it has been suggested that research should therefore simultaneously consider emotional and cognitive responses (Sweeney & Wyber, 2002). Thus, the following hypotheses will be tested:

H1a: The presence of music in the waiting room leads to reduced feelings of anxiety and stress in patients.
H1b: The reduction of anxiety and stress will be strongest when classical music is being played.
H2a: The presence of music in the waiting room leads to higher cognitive environmental appraisals (attractiveness and professional quality) of the waiting room.
H2b: The environmental appraisals will be the highest when classical music is being played.

Method

Participants

A total of 72 patients (30 male / 41 female; 1 missing value) were included in this study. Their mean age was 38.8 years (*SD* = 14.4). One third of the patients visited the dentist for their annual check-up, 29% of the patients for filling a cavity, another 15% for the removal of calculus and the other 23% for other treatments (e.g. tooth extraction). All patients were considered eligible. Two participants were excluded from all analyses because they listened to their individual music player.

Procedure

The music intervention was implemented in the waiting room of a dentist. On a daily basis, a situation where no music was played was alternated with popular music and classical music. Data were collected during six weekdays. Both music styles

were matched with respect to volume and tempo (classical music mean was 98.8 BPM (*SD* = 8.3); popular music mean was 104.8 BPM (*SD* = 6.6)). The classical music compilation consisted of pieces from well-known primarily orchestral compositions of Mozart, Beethoven, and Bach. The popular music consisted of popular hit parade songs both recent and from the last decades. See appendix 1 for both playlists.

All patients were approached after spending 5-10 minutes in the waiting room. They were escorted to the treatment room where they filled out the questionnaire after which the dentist entered and started treatment. In the questionnaire they were asked to complete measures assessing dental anxiety, stress, and environmental appraisals. Patients were also asked about their demographic variables, the type of treatment, their number of visits to the practice in the last 12 months, and their musical preference.

Measures

Dental anxiety To measure anxiety of dental treatment, patients completed the six-item AZI-state questionnaire using a four-point scale (Lehnartz, 2003). A sample item is "I'm wondering whether the treatment will be painful". The average score on this scale was used as a measure of anxiety (α = .77).

Stress To measure feelings of stress, patients responded to the six-item subscale for tension from the Profile of Mood States (McNair, Lorr & Droppleman, 1971; Wald & Mellenbergh, 1990) using a five-point scale. The average score on this scale was used as a measure of stress (α = .80).

Environmental appraisal To measure the environmental appraisal of the waiting room, patients completed an environmental rating scale (Lohr & Pearson-Mims, 2005; Russell, Ward & Pratt,1981) consisting of two dimensions: attractiveness and professional quality. The average score on the bipolar adjective scale (five points) served as a measure of attractiveness (four items, α = .92). Sample items include "pleasant-unpleasant" and "beautiful-ugly". The average score on four items measured professional quality (α = .82). Sample items include "efficient-inefficient" and "professional-unprofessional".

Statistical analysis

Baseline characteristics of patients were compared for the three study groups and tested by calculating the Chi-square (for categorical variables) or the Kruskall-Wallis test (for continuous variables).

To determine if playing music in the waiting room resulted in less anxiety and stress and more positive environmental appraisals (attractiveness and professional quality), ANOVA's were conducted on all four dependent variables. The Bonferroni post-hoc test was used to test which of the music conditions differed. A probability of .05 was the criterion used for statistical significance.

Results

Patient characteristics

There were no differences between the groups regarding age, gender, the number of visits to the practice in the last 12 months, the type of treatment or their musical preference (p > .05 for all comparisons). Controlling for these potentially confounding variables using an analysis of covariance resulted in no difference for the pattern of results and are therefore not reported here.

Dental anxiety

A significant effect of exposure to music on feelings of anxiety was observed (ANOVA, $F(2,69) = 3.85$, $p = .026$, partial $\eta^2 = .10$)[2].The Bonferroni post-hoc test revealed that patients who were exposed to classical music experienced less anxiety ($M = 1.32$, $SD = .33$) than those in the no-music condition ($M = 1.65$, $SD = .42$; $p = .02$). No differences were found between the no-music and the popular music condition ($M = 1.48$, $SD = .49$) or between the classical and popular conditions.

Stress

Playing music appeared to have a significant effect on feelings of stress (ANOVA, $F(2,68) = 4.0$, $p = .023$, partial $\eta^2 = .11$). The Bonferroni post-hoc test showed a significant difference with patients in the classical music condition experiencing less stress ($M = 1.27$, $SD = .27$) than those in the no-music condition ($M = 1.60$, $SD = .49$; $p = .02$). Again, no differences were found between the no-music and the popular music condition ($M = 1.48$, $SD = .43$) or between the classical and popular conditions.

Environmental appraisals

Attractiveness We found that the attractiveness of the waiting room was significantly influenced by the music (ANOVA, $F(2,66) = 4.35$, $p = .02$, partial $\eta^2 = .12$). A Bonferroni post-hoc test showed a significant difference with the waiting room rated as more attractive when classical music was played ($M = 4.36$, $SD = .73$) compared to the no-music condition ($M = 3.66$, $SD = .77$; $p = .01$). No differences were found between the no-music and the popular music condition ($M = 3.89$, $SD = .96$) or between the classical and popular conditions.

Professional Quality Music was found to significantly influence the perception of professional quality (ANOVA, $F(2,64) = 4.77$, $p = .012$, partial $\eta^2 = .13$). The Bonferroni post-hoc test showed that patients rated the waiting room as more professional when classical music was played ($M = 3.99$, $SD = .88$) compared to the no-music condition ($M = 3.39$, $SD = .68$; $p = .03$). The post-hoc test also revealed a similar difference between the popular music condition ($M = 3.96$, $SD = .70$; $p = .04$) and the control condition. No difference was found between the popular and classical conditions.

[2] Degrees of freedom vary across analyses due to missing values.

Discussion of study 3.1

The aim of this study was to test the hypotheses that playing music in the waiting room of a dentist has beneficial effects on anxiety and stress in patients as well as on the environmental appraisals of the waiting room.

This study demonstrated that playing classical music in a waiting room (compared to the same waiting room in which no music was played) results in less anxiety and stress in patients as well as in more positive cognitive evaluations of the waiting room. The beneficial effects were only found for the classical music condition. This result suggests that classical music has calming properties, whereas the effects of popular music were generally too weak. Furthermore, it is of interest to note that these differences occur regardless of musical preference. Classical music was also found to be calming for people who prefer popular music.

Study 3.2

The second field study aimed to extend the results of the first study by changing the setting from the waiting room of a dental practice to the waiting room of a general practitioners office. This second study was designed to shed more light on the mechanism underlying the stress-reduction of classical music. Specifically, the potential mediating effect of an emotional state was investigated (Mehrabian & Russell, 1974).

The purpose of the second field experiment was to investigate whether the stress-reducing effects of music occur because a waiting room with music results in a more positive emotional state. The following hypotheses will be tested:

H1: The presence of classical music in the waiting room leads to reduced feelings of stress in patients.
H2: Feelings of pleasure mediate this relation between music and stress.

Method

Participants

A total of 35 (18 male, 16 female; 1 missing value) patients were included in this study. Their mean age was 22.3 years (*SD* = 6.1). For privacy reasons, we did not ask them for the reason of their visit. All patients were considered eligible, but patients listening to their own musical player were not approached to participate in this study.

Procedure

This study was implemented in the waiting room of a practice of general practitioners on the university campus. Days on which classical music (see study 1 and appendix 1 for more details) was played were alternated with days on which no music was played in the waiting room (the control condition). Data were collected during four weekdays.

To avoid selection bias, every patient that visited the practice was approached after spending approximately five minutes in the waiting room. They were then asked to complete the questionnaire, which assessed their levels of stress and pleasure. They were also asked about their demographic variables, the number of visits to the practice in the last 12 months and their musical preference.

Measures
Pleasure To measure feelings of pleasure, patients completed five items of the Pleasure-Arousal-Dominance Model (Mehrabian & Russell, 1974) using a nine-point scale. The average score on this scale was used as a measure of pleasure (α = .73).

Stress To measure feelings of stress, patients responded to the six-item subscale for tension from the Profile of Mood States (McNair et al., 1971; Wald & Mellenbergh, 1990) using a five-point scale. The average score on this scale was used as a measure of stress (α = .82).

Statistical analysis
Baseline characteristics of patients were compared using the Student's t test. An ANOVA was conducted to determine if playing classical music in a waiting room resulted in less stress (H1). A probability of .05 was the criterion used for statistical significance.

To test the second hypothesis, that feelings of pleasure mediates the relation between music and stress, a mediation analysis using multiple regressions was performed (Baron & Kenny, 1986). With a first regression analysis, the relationship between music and stress was tested. A second regression analysis was performed with the mediator (pleasure) as the dependent variable and music as the predictor. Subsequently, in line with the procedure outlined by Baron and Kenny (1986), the relationship between music and stress was examined as to whether this relationship was mediated by pleasure. Another regression analysis was performed with both music and pleasure as the predictors and stress as the criterion. In the case of mediation, the previously described relationship between music and stress should become insignificant, whereas the mediator should retain its significance.

Results

Patient characteristics
There were no differences between the groups regarding age, gender, the number of visits to the practice in the last 12 months, the type of treatment or their musical preference (p > .05 for each comparison). Controlling for these potentially confounding variables using an analysis of covariance made no difference for the pattern of results reported here.

Stress
Patients in the waiting room with classical music were found to experience less stress (M = .69, SD = .51) than patients in the waiting room without music (M = 1.20, SD = .74; ANOVA, $F(1,33)=5.69$, p = .02, partial η^2 = .15).

Mediation analysis

The first regression analysis, with stress as the dependent variable and the presence of music as the predictor, yielded a significant relationship (β = -.26, p = .02) with participants perceiving less stress when exposed to classical music. A second regression analysis, with the mediator (pleasure) as the dependent variable and music as the predictor, showed that the presence of music significantly increased feelings of pleasure (β = .34, p = .03). It was then tested whether the relation between music and stress was mediated by feelings of pleasure.

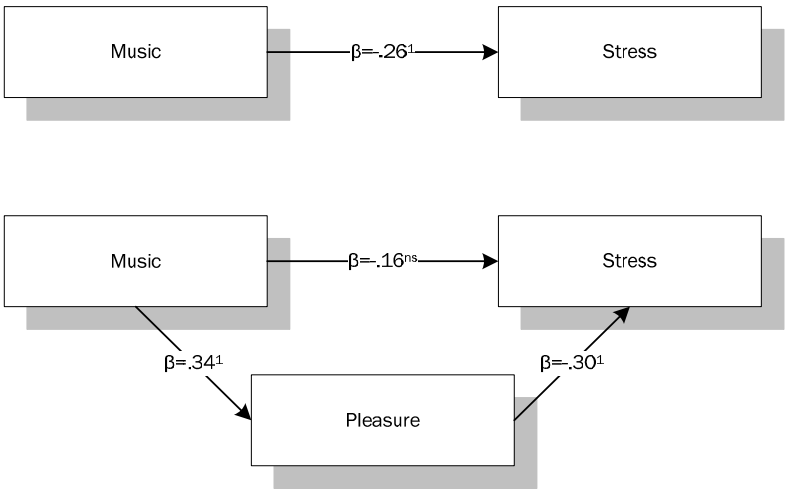

Figure 3.1 Mediation model with pleasure as mediator
[1] significant at .05 level
[ns] non-significant

Another regression analysis was performed with both music and pleasure as predictors and stress as the criterion. This analysis revealed that the previously described relationship between music and stress became insignificant (β = -.16, p = .15), whereas the mediator retained its significance (β = -.30, p = .013), indicating partial mediation (Figure 3.1).

Discussion of study 3.2

The second study aimed to elucidate the underlying mechanism of the stress-reducing effects of classical music. The results confirm that classical music reduces stress in a waiting room. Most importantly, the present results also demonstrate that these stress-reducing effects are mediated by feelings of pleasure; playing classical music in a waiting room leads to a more positive emotional state. This in turn leads to reduced feelings of stress in patients.

General discussion

The aim of these two field experiments was to test the hypothesis that playing music in the waiting room has beneficial effects on anxiety and stress in patients as well as on their cognitive appraisals of the waiting room environment. The hypothesized mediating effect of pleasure on stress was also tested.

Studies on the effectiveness of music as a therapeutic intervention have already underlined the potential influence of music on patients (Evans, 2002). Empirical evidence of the effects of background music (i.e. music as being part of the shared healthcare environment), however, appears to be limited. Research in the field of healing environments has clearly demonstrated an impact of the environment on the health and well-being of patients (Dijkstra et al. 2006; Ulrich et al. 2004). Our study supports this theory that a relatively easy and inexpensive intervention can alter the atmosphere of the healthcare environment and lead to beneficial effects for patients.

The first study demonstrated that playing music in a waiting room results in less dental anxiety and stress in patients as well as in higher ratings of the attractiveness and professional quality of the waiting room. These beneficial effects were only found for the classical music condition. These findings show that classical music has calming properties, whereas popular music does not appear to possess these properties.

These findings automatically raise the question why classical music turns out to be more effective in reducing stress than popular music (as compared to a no-music condition). Previous research has demonstrated several positive effects of classical music (Labbé et al., 2007; Kellaris & Kent, 1993). Lehrner et al. (2005) included a music condition in their study on the effectiveness of scents in a dental waiting room. The music was described as being cheerful and uplifting, and resembles the characteristics of our popular music. They also failed to find an effect when comparing the music condition to the control group, which suggests that popular music may not be effective in reducing anxiety. Investigating the musical genres in more detail (with respect to, for example, the use of vocals or complexity), however, is necessary to provide more details on the possible explanations. Conversely, it seems logical to think that the person responsible for the music in waiting rooms is prone to think in genres instead of more detailed characteristics of music. Nonetheless, the lack of effects for playing popular music is of interest and should be investigated in greater detail in future research.

In the second study, more insight was gained on the processes that cause the stress-reduction by classical music. The results of the first study were also extended to a different setting. Music appears not only to be efficient in a dental setting, but the stress-reducing effects of classical music were replicated in a waiting room of a general practitioner. The findings of the second study indicate that the stress-reducing effects of classical music are the result of patients being in a more positive emotional state after being exposed to classical music. These findings are in line with the predictions made by models originating from environmental psychology

(Mehrabian & Russell, 1974; Ulrich, 1983). To our knowledge, however, the mediating effects of an emotional state had never been empirically studied in the healthcare context.

The waiting room may be the most appropriate place to apply anxiety-reducing techniques (Lamb & Plant, 1972). It could be expected that relaxed patients are more easily treatable for medical practitioners. A music intervention may thus be beneficial for both patients and physicians; however, this hypothesis should be further tested in future research. It may also be of interest to know whether the reduction in stress and anxiety will last while undergoing the actual consult or treatment. In our first study, we measured stress and anxiety just before the dentist entered the treatment room, so we cannot be sure that the effects were still present during the actual treatment. The effects, however, were measured after the actual exposure to music and when patients were already in the treatment room, which makes it more likely that effects persist during treatment. It should thus be tested whether the effects are strong enough to last all the way through treatment. Nevertheless, music has been shown to be effective during treatments, and may even reduce the need for sedation or analgesia during procedures (Evans, 2002). If the reduction of stress and anxiety does not last long enough, however, one might also consider using classical music during both the waiting and the treatment periods.

Several studies have demonstrated that the design of waiting spaces may affect satisfaction and perceived quality of care (Arneill & Devlin, 2002; Leather et al., 2003). Arneill & Devlin (2002, p.355) provided an explanation by stating that 'when patients perceive that a physician (or someone connected to him or her) has put time, thought, and care into the environment of the waiting room, it suggests that the physician must put the same quality into the care that is given to patients'. Furthermore, the environment represents the first impression of a healthcare facility. Well-designed waiting spaces may result in patients entering the system with a positive image of the healthcare process. This may affect their perceptions of the quality of care, satisfaction with care and even health outcomes (Arneill & Devlin, 2003). Although we did not measure perceived quality of care or satisfaction with care, music did affect the perceived professional quality of the waiting room, indicating that music may also affect the perceived quality and satisfaction with care.

Both clinical (e.g. treatment) and non-clinical (e.g. staff attitudes) factors will indisputably play an important part in determining the overall impact of healthcare settings on the patient, but the role of the physical environment should not be undervalued. The music intervention implemented here are not proposed to be a solution for serious health-related problems (e.g. dental fear), but they can be considered as an effective and relatively inexpensive tool to create better healthcare experiences.

Although this study took place in waiting areas, stress is an emotion that is present in almost all healthcare settings. Our studies have clearly demonstrated the stress and anxiety reducing effects of exposure to classical music in the waiting rooms of a

dentist and a general practitioner. Given that highly anxious patients appear to be more sensitive to pain and that, in most healthcare situations, patients spend time in a waiting room, these results may also be very useful in other healthcare settings.

Appendix

Playlist classical music

Georg Friedrich Händel:
Concerto Grosso in A minor, Op. 6, no. 4 - larghetto affettuoso
Salomon - Sinfonia, Act 3
Water Music - Allegro (Suite No. 1)
Water Music - Andante Allegro da capo

Johann Sebastian Bach:
Brandenburg Concerto No. 3 in G first movement
Violin Concerto in E first movement
Brandenburg Concerto No. 4 in G third movement
Easter Oratorio - Overture
Kommst du nun, Jesu, vom Himmel herunter
Art of the Fugue - Contrapunctus 9

Joseph Haydn:
Concerto for Violin No. 2 in D - third movement
Flute Trio No. 31 in G - second movement
Concerto for 2 Horns & Orchestra in E-flat - second movement
Notturno No. 1 in C - second movement
Symphony No. 98 in B - Londoner No. 4 - fourth movement
Concerto for Trumpet & Orchestra in E-flat - first movement

Vivaldi:
Concerto No. 1 in E (Spring)
Concerto Grosso in A-minor, Op. 3, no. 8 Allegro

Franz Schubert:
German Dance No. 2 in G

Ludwig van Beethoven:
First Movement from Symphony No. 5 in C Minor
Symphony No. 6 in F Beethoven

Wolfgang Amadeus Mozart:
Violin Concerto - first movement
Symphony No. 40 in G minor - first movement
Divertimento - Minuet

Pyotr Il'yich Tchaikovsky:
String Serenade - Waltz
The Sleeping Beauty - Waltz
Swan Lake - Waltz
The Nutcracker - Waltz of the Flowers
Swan Lake - Dance of the Swans

Antonin Dvorák:
Slavic Dance No. 8 in G-minor, Op. 46, no. 8
Symphony No. 7 in D-minor third movement

Johann Strauss II:
Die Fledermaus, overture to the operetta
Wiener Blut, waltz for orchestra, Op. 354
Wein, Weib und Gesang, waltz for orchestra, Op. 333
An der schönen, blauen Donau, waltz for orchestra, Op. 314

Johannes Brahms:
Hungarian Dance No. 5
Concerto for Violin and Orchestra in D, Op. 77 - third movement
Hungarian Dance No. 1 in G minor

Richard Wagner:
Die Meistersinger Von Nurnberg – Overture

Playlist popular music

Fuer Dich	Yvonne Catterfeld
Aicha	Outlandish
Anyone of Us (Stupid Mistake)	Gareth Gates
La Isla Bonita	Madonna
Lovelight	Robbie Williams
Feel	Robbie Williams
The Look	Roxette
We Don't Need another Hero	Tina Turner
Can't Hold Us down	Christina Aguilera
In The Air Tonight	Phil Collins
Everyday Girl	Preluders
Family Portrait	Pink
Like A Prayer	Madonna
Dancing Queen	Abba
I Am I Said	Neil Diamond
The Best	Tina Turner
Life Is For Living	Barclay James Harvest
Upside down	Diana Ross
Nur geträumt	Nena
Cambodia	Kim Wilde
Big in Japan	Alphaville
I just called to say i love you	Stevie Wonder
I want to break free	Queen
West end girls	Pet Shop Boys
Take my breath away	Berlin

Girl you know it's true	Milli Vanilli
Love changes everything	Climie Fisher
Verdammt, ich lieb' Dich	Matthias Reim
Tom's Diner	DNA feat Suzanne Vega
Se Bastasse Una Canzone	Eros Ramazzotti
Joyride	Roxette
All that she wants	Ace of Base
Two princes	Spin Doctors
My Heart Will Go On	Celine Dion
Frozen	Madonna
Torn	Natalie Imbruglia
Truly Madly Deeply	Savage Garden
If you believe	Sasha
Tabula Rasa	Freundeskreis & Mellowbag
Breathe	Midge Ure
Johnny B	Down Low
All I have to give	Backstreet Boys
The Power of Goodbye	Madonna
My Love Is Your Love	Whitney Houston
Big Big World	Emilia
I Wish	Oli.P
If You Had My Love	Jennifer Lopez
Sometimes	Britney Spears
Flugzeuge Im Bauch	Oli.P
Larger Than Life	Backstreet Boys
Mein Stern	Ayman
Lucky	Britney Spears
Shape of My Heart	Backstreet Boys
Whole Again	Atomic Kitten
Follow Me	Unkle Kracker
Another Day in Paradise	Brandy Feat. Ray J
Eternity	Robbie Williams
Can't Fight the Moonlight	LeAnn Rimes
Wenn Das Liebe Ist	Glashaus
Funny	Jennifer Lopes
Free	Lighthouse Family
You Rock My World	Michael Jackson
Mensch	Herbert Grönemeyer
How You Remind Me	Nickelback
Somethin' Stupid	R. Williams & N. Kidman
Just Like a Pill	Pink
A Thousand Miles	Vanessa Carlton
When You Look At Me	Christina Milian
Don't Let Me Get Me	Pink
Here I Am	Bryan Adams
Moi Lolita	Alizée
I Love Rock'n'Roll	Britney Spears
Genie in a Bottle	Christina Aguilera

Quit Playing Games	Backstreet Boys
Where is the Love?	Black Eyed Peas
She 4s So	Tobias Regner
Stars Are Blind	Paris Hilton
99 Luftballons	Nena
Paid My Dues	Anastacia
Perfekte Welle	Juli
Save Me	Clout
Lady In Black	Uriah Heep
One Way Wind [Deutsch]	Cats
Song Sung Blue	Neil Diamond
Another One Bites The Dust	Queen
Wo Bist Du	Peter Maffay
Listen To Your Heart	Roxette
The Tide Is High	Blondie
Yesterme Yesteryou Yesterday	Stevie Wonder

The previous chapter demonstrated that classical music in waiting rooms can reduce stress in patients and that this stress-reducing effect of classical music is mediated by an affective response; patients' positive emotional state. The following chapter investigates if stress-reduction can also be mediated by a cognitive response, in these studies the perceived attractiveness of the hospital room. Natural elements in the built healthcare environment have shown to hold potential stress-reducing properties. In order to shed light on the underlying mechanism of stress-reducing effects of nature, this chapter presents two studies that investigated the mediating effect of perceived attractiveness on stress. The stress-reducing properties of natural elements in the built healthcare environment were confirmed. Additionally, the second study demonstrated that a figurative painting of a tree leads to similar stress-reducing effects, probably through evoking nature associations. Furthermore, these studies indicate that the stress-reducing effects of nature interventions are the results of a higher level of perceived attractiveness of such environments.

4

Stress-reducing effects of indoor plants in the built healthcare environment: The mediating role of perceived attractiveness[i]

[i] Based on: Dijkstra, K., Pieterse, M.E. & Pruyn, A. (2008). Stress-reducing effects of indoor plants in the built healthcare environment: The mediating role of perceived attractiveness. *Preventive medicine, 47*, 279-283.

Introduction

Traditionally, healthcare facilities were built with the emphasis on the functional delivery of health care (Ulrich, 1995). However, since research supports the idea of the built healthcare environment having an impact the health and well-being of patients, more attention is being paid to the psychological consequences of architectural choices (Dijkstra, Pieterse & Pruyn, 2006; Ulrich, Zimring, Quan, Joseph & Choudhary, 2004). Such 'psychologically supportive' healthcare environments are also referred to as *healing environments*. This concept suggests that the physical environment of healthcare settings 'can make a difference in how quickly the patient recovers or adapts to specific acute and chronic conditions' (Stichler 2001, p2).

Three dimensions of the physical healthcare environment that can have effects on health and well-being have been distinguished (Harris, McBride, Ross & Curtis, 2002): architectural features (e.g., spatial layout, room size), ambient features (e.g., lighting, odors), and interior design features (e.g., color, artwork, indoor plants). Interior design variables provide relatively easy and inexpensive opportunities to alter the atmosphere of healthcare environments. This applies especially to facilities that have already been built, but may also be scheduled for renovation. The review from Dijkstra et al (2006) concluded that effects of interior design variables appear to be highly inconsistent. The knowledge of specific environmental stimuli and their effects on health and well-being may facilitate atmospheric changes in an environment. In addition, understanding the underlying processes causing these effects may help us to design healing environments more efficiently. A clearer understanding of the exact mechanisms involved is necessary before we can implement such designs on a larger scale.

Being hospitalized is generally associated with feelings of fear, uncertainty, and anxiety (Mason, Sachar, Fishman & Hamburg, 1965; Pride, 1968). These feelings of stress and anxiety may affect the healing process. Research shows for example, that such psychological stress impairs wound healing in patients (Kiecolt-Glaser, Marucha, Malarkey, Mercado & Glaser, 1995; Broadbent, Petrie, Alley & Booth, 2003). With regard to the idea of healing environments, aspects of the built healthcare environment that can reduce this stress may therefore have beneficial effects on health-related outcomes.

Natural elements

Research on restorative environments suggests that certain environments are capable of promoting recovery from stress, and shows that especially natural settings have these restorative effects (Hartig, Böök, Garvill, Olsson & Gärling, 1996). Considering the potential healing properties of nature (Ulrich, 1984; Lohr & Pearson-Mims, 2000), exposing patients to natural elements may be an effective way of reducing stress associated with hospitalization. However, most healthcare facilities have been built in urban environments and thus lack natural resources that patients can be exposed to. Bringing nature into the hospital might be a good alternative to reduce stress in patients and in turn aid their recovery.

Ulrich, Simons, Losito, Fiorito, Miles & Zelson (1991) studied the effects of exposure to nature on stress recovery. Participants watched a videotape that induced feelings of stress, and were afterwards exposed to a tape with either a natural or an urban environment. Results demonstrated that individuals recover sooner from stress when exposed to the former (natural) than the latter (urban). A trial by Diette, Lechtzin, Haponik, Devrotes & Rubin (2003) studied the effects of natural murals and sounds on patients undergoing flexible bronchoscopy. It was found that pain control was better for patients exposed to nature. Lohr and Pearson-Mims (2000) studied whether the presence of indoor plants would increase pain tolerance. Participants were either placed in a room with plants, a room with non-plant objects (as visually distractive as the plants), or a control room (no objects). Results showed that a significantly larger proportion of respondents in the room with plants were able to keep their hand in the ice water for 5 minutes as compared to the other conditions, suggesting increased pain tolerance by exposure to indoor plants. They also showed that the room with plants was rated more positively (e.g., cheerful, calming, pleasant) than either of the control rooms. The results of these studies support the idea that indoor plants may have beneficial effects on the health and well-being of people.

Natural elements in the built environment have clearly shown stress-reducing properties, but it is still unclear which underlying mechanism causes this stress-reduction. A potential explanation lies in the theories by Kaplan (1987) and Ulrich (1983), which state that people have a tendency to prefer natural settings to built environments. Although these two theories have some important differences (see Hartig et al. (1996) for a discussion), both are based on the same evolutionary assumptions. The preferences for natural settings are assumed to have an evolutionary base; people are to some extent biologically adapted to natural as opposed to built environments. Secondly, it might be argued that nature may be processed more easily and efficiently because the brain and sensory systems evolved in natural environments (Wohlwill, 1983). As a result, humans have an innate tendency to pay attention and respond positively to natural elements (Ulrich et al., 1991). This predisposition to prefer natural elements to man-made objects may be the explanation of the stress-reducing effects of nature. It might thus be hypothesized that natural elements affect feelings of stress through the perceived attractiveness of an environment.

Study 4.1

The purpose of this experiment was to investigate whether the stress-reducing effects of indoor plants occur because an environment with indoor plants is perceived as being more attractive. The following hypotheses will be tested:

H1: The presence of indoor plants in a hospital room leads to reduced feelings of stress in patients.
H2: The perceived attractiveness of the hospital room mediates this relation between plants and stress.

Methods

Design and procedure

The experiment employed a single-factor between-subjects design (indoor plants vs. no plants) with participants being exposed to a scenario and a photo of a hospital room. This procedure has been shown to accurately simulate real environments (Stamps, 1990; Bateson & Hui, 1992). The meta-analysis by Stamps (1990) showed a 0.86 correlation between environmental preferences obtained by photographs and preferences obtained by exposure to real environments.

The scenario described that participants had been hospitalized with symptoms of a legionella infection. They were asked to imagine having a headache, muscle pains and a fever several days after having gone swimming with some friends. Their primary care doctor referred them to the hospital for thorough testing and treatment.

In both conditions, participants were exposed to a photo of the hospital room into which they were admitted. In the experimental condition indoor plants were placed in the room, whereas in the control condition there were no plants but there was a painting on the wall depicting an urban setting to generate a similar level of distraction (see figure 4.1).

Figure 4.1. The photos of the hospital room (plants vs. no plants) used in study 4.1.

Participants
A total of 77 students (35 male and 42 female) with a mean age of 21 years (*SD* = 2.2) were randomly assigned to either the experimental or the control condition. Participation was voluntary and a lottery with several cash prizes was used to attract volunteers.

Measures
Attractiveness To measure the perceived attractiveness of the hospital room, participants completed a 10-item bipolar adjective scale (c.f. Lohr & Pearson-Mims, 2000; Russell, Ward & Pratt, 1981). Sample items include "pleasant-unpleasant", "beautiful-ugly" and "friendly-unfriendly". The average score on this 5-point scale was used as a measure of attractiveness (α = .92).

Stress To measure perceived stress, participants responded to the 18-item stress dimension of the Stress Arousal Checklist (MacKay, Cox, Burrows & Lazzerini, 1978) on a 4-point scale (ranging from this word definitely describes my feelings [++] to this word doesn't describe my feelings [-]). Sample items include "tense", "up-tight", and "worried". The average score on this scale was used as a measure of stress (α = .94).

Statistical procedures
To test the first hypothesis that indoor plants in a hospital room effect to less stress, an independent samples *t* test was conducted. To test the second hypothesis that the perceived attractiveness of the room mediates this relation between plants and stress, a mediation analysis using multiple regressions was performed (Baron & Kenny, 1986). With a first regression analysis, the relation between plants and stress was tested. A second regression analysis was performed with the mediator

(attractiveness) as the dependent variable and plants as the predictor. Subsequently, in line with the procedure outlined by Baron and Kenny (1986), it was tested whether the relationship between plants and stress was mediated by perceived attractiveness. Therefore, yet another regression analysis was performed with both plants and attractiveness as the predictors and stress as the criterion. In the case of mediation, the previously found relation between plants and stress should become insignificant, whereas the mediator should retain its significance. Further support was given by means of a Sobel test (Baron & Kenny, 1986; Preacher & Hays, 2004). A probability of .05 was the criterion used for statistical significance.

Results

Stress

An independent samples *t* test confirmed that participants in the hospital room with indoor plants perceived less stress (M = 1.92, SD = .69) than participants in the hospital room with the painting (M = 2.30, SD = .75; $t(75)$ = 2.34, P = .022).

Mediation analysis

The first regression analysis, with perceived stress as the dependent variable and the presence of indoor plants as the predictor, yielded a significant relation (β = -.39, P = .022) with participants perceiving less stress in the room with the indoor plants. A second regression analysis, with the mediator (attractiveness) as the dependent variable and the presence of plants as the predictor, showed that the presence of plants increased the perceived attractiveness significantly (β = .41, P = .017). Subsequently, it was tested whether the relation between the presence of plants and perceived stress was mediated by the perceived attractiveness of the room. Another regression analysis was performed with both the presence of plants and the perceived attractiveness of the room as predictors and perceived stress as the criterion. This analysis revealed that the previously found relation between the presence of plants and perceived stress became insignificant (β = -.23, P = .152), whereas the mediator retained its significance (β = -.38, P = .001), which indicates partial mediation (see figure 4.2). Further support for this mediating effect of attractiveness was found by means of a Sobel test, which confirmed that attractiveness mediates the relation between the presence of indoor plants and perceived stress (Z = -2.02, P = .042).

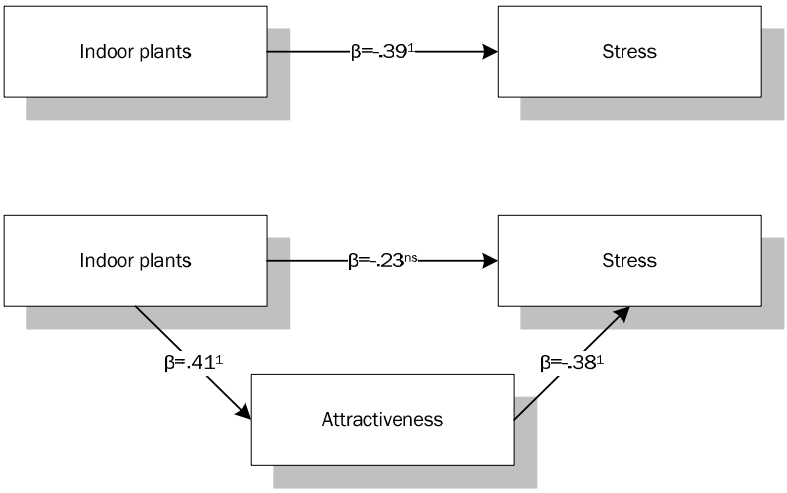

Figure 4.2. Mediation model with attractiveness as mediator.
[1] significant at .05 level
[ns] non-significant

Discussion of study 4.1

The results of this first experiment demonstrated the stress-reducing properties of indoor plants in a hospital room. Moreover, this effect was mediated by the perceived attractiveness of the hospital room. The presence of indoor plants in a hospital resulted to participants perceiving the room as more attractive, which in turn resulted in less perceived stress.

Until now, most research on indoor plants in healthcare facilities has focused on health risks rather than on health benefits (LaCharity & McClure, 2003). Indoor plants are a potential source of bacteria through their soil and water and may cause hospital-acquired infections, although this has not been confirmed by research (Bartzokas, Holley & Sharp, 1975; Siegman-Igra, Shalem, Berger, Livio & Michaeli, 1986). Clearly, the introduction of indoor plants in hospitals needs to be closely monitored with respect to infection risks, and other side-effects such as, for example, limited working space for medical personnel. Nevertheless, the healing potential of indoor plants should not be overlooked.

Study 4.2

Study 4.2 was designed to replicate the mediating effect of perceived attractiveness on stress. Moreover, since indoor plants are widely associated with infection risks, this second experiment included a condition with a figurative painting of a tree. This experiment aimed to demonstrate that artificial nature could lead to similar beneficial effects as real nature interventions. Furthermore, it aimed to explain why

artificial nature generates similar beneficial effects as real nature. The following hypotheses will be tested:

H1: The presence of both indoor plants and a painting of a tree in a hospital room lead to reduced feelings of stress in patients.
H2: The perceived attractiveness of the hospital room mediates this relation between plants and stress.
H3: Both indoor plants and the painting of a figurative tree activate the construct of nature.

Method

Design and procedure

This second experiment also employed a single-factor between-subjects design (indoor plants vs. painting of nature vs. no plants) with participants being exposed to a scenario and a photo of a hospital room. Participants were asked to imagine being hospitalized with appendicitis. The scenario described that they had undergone successful surgery but that they had to stay in the hospital for three more days. Next, participants were randomly assigned to a photo of the hospital room into which they were admitted. In the first experimental condition indoor plants were placed in the room and in the second experimental condition there was a painting of a figurative tree on the wall. In the control condition there were no natural stimuli in the hospital room (see figure 4.3).

Figure 4.3. The photos of the hospital room (plants vs. painting vs. control condition) used in study 4.2.

Participants
A total of 85 students (23 males and 62 females) with a mean age of 20.5 (SD = 2.9) years participated in this study. They received course credits or €3,- for their cooperation.

Measures
Attractiveness Similar to experiment 1, participants completed a 10-item scale (α = .96) to measure their perceived attractiveness of the hospital room.
Stress Participants in this second experiment also completed the 18-item stress dimension of the Stress Arousal Checklist (α = .91).

Word fragment completion task To measure the accessibility of the concept of nature, participants responded to a word fragment completion task in which the completed a set of 10 incomplete words by filling in one or more syllables. Eight of these words could be completed as either neutral or nature-related and the other two words served as filler items. Examples include "Flo…", which participants could complete as either "Flower" or "Floor", and "..ant", which could be completed as "Plant" or "Giant". The summed total of nature-related words that participants completed served as an index for the activation of the concept nature. (M = 1.95, SD = .99, range = 0-4).

Results

Stress

A significant effect of exposure to nature on feelings of stress was observed (ANOVA, $F(2,82 = 5.05$, $p = .009$). The Bonferroni post-hoc test revealed that participants exposed to the room with indoor plants experienced less stress (M = 1.97, SD = .51) than those in the control condition (M = 2.34, SD = .62; p = .038). Participants exposed to the room with the painting of a tree also experienced less stress (M = 1.90, SD = .57; p = .014) than those in the control condition.

Mediation analysis

The first regression analysis, with perceived stress as the dependent variable and the presence of indoor plants as the predictor, demonstrated a significant relation (β = -.14, P = .006) with participants perceiving less stress in the room with the indoor plants. A second regression analysis, with attractiveness as the dependent variable and the presence of plants as the predictor, showed that the presence of plants increased the perceived attractiveness significantly (β = .52, P < .000). Next, it was tested whether the relation between the presence of plants and perceived stress was mediated by the perceived attractiveness of the room. A third regression analysis was executed with both the presence of plants and the perceived attractiveness of the room as predictors and perceived stress as the criterion. This analysis revealed that the previously found relation between the presence of plants and perceived stress became insignificant (β = -.02, P = .659), whereas the mediator retained its significance (β = -.22, P < .000), which indicates partial mediation (see figure 4.4). Further support for this mediating effect of attractiveness was found by means of a Sobel test, which confirmed that attractiveness mediates the relation between the presence of indoor plants and perceived stress (Z = -3.48, P < .000).

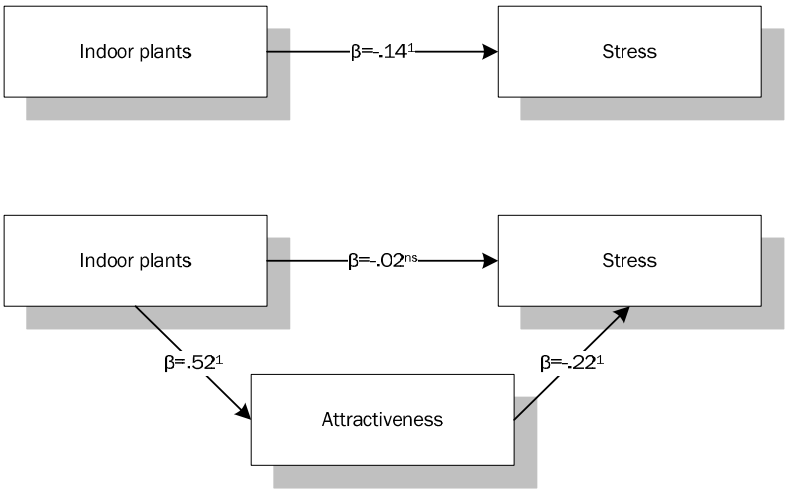

Fig.4.4. Mediation model with attractiveness as mediator.
[1] significant at .05 level
[ns] non-significant

Word fragment completion task
Exposure to natural elements appeared to have a significant effect on feelings of stress (ANOVA, $F(2,82 = 3.89$, $p = .024$). The Bonferroni post-hoc test showed a significant difference with participants in the indoor plants condition completing more nature-related words ($M = 2.17$, $SD = 1.03$) than participants in the control condition ($M = 1.55$, $SD = .95$; $p = .046$). The difference between participants exposed to the painting ($M = 2.15$, $SD = .86$) and the control condition was marginally significant ($p = .066$).

Discussion of study 4.2

This second experiment re-confirmed the stress-reducing properties of nature, and replicated the mediating effect of perceived attractiveness on stress. Furthermore, stress is not only reduced by indoor plants, but by a painting of nature as well. A word fragment completion task revealed that, next to indoor plants, a painting of a tree also activated the concept of nature. This suggests that a mere association with nature could potentially lead to beneficial effects. Future research should further explore these associations, what types of artificial nature can generate such beneficial effects, and the specific requirements for these artificial interventions (see for example De Kort, Meijnders, Sponselee & IJsselsteijn, 2006; Joye, 2007).

General discussion

The present experiments aimed to gain an understanding of the underlying mechanism of stress-reducing effects of natural elements in the built healthcare

environment. Our results suggest that the presence of indoor plants in a hospital room leads to a reduction of perceived stress in patients. This finding supports the general notion that nature has stress-reducing properties (Ulrich, 1983; Ulrich et al., 1991). Most importantly, the present results also demonstrate that these stress-reducing effects are mediated by the perceived attractiveness of the hospital room. The presence of indoor plants in a hospital room leads to a higher perceived attractiveness of the room and this, in turn, leads to reduced feelings of stress in patients. Furthermore, the presence of nature in a more artificial form, i.e. a figurative painting of a tree, reduced stress just as well as real indoor plants.

The positive effects of indoor plants on the perceived attractiveness of an environment (Lohr & Pearson-Mims, 2000; Larsen, Adams, Deal, Kweon & Tyler, 1998) as well as on the feelings of stress have been established in previous research (Ulrich, 1984; Diette et al., 2003). The explanations of these effects of nature were mainly sought in evolutionary theory (Ulrich et al., 1991), which states that humans have a natural tendency to prefer natural elements to man-made objects (Kaplan, 1987). However, to our knowledge the mechanism by which exposure to nature may reduce feelings of stress had never been empirically studied. This experiment showed that the stress-reducing effects of nature are caused by the perceived attractiveness of the hospital room. This result would mean that, by basically making the environment more attractive, healing environments can contribute to the health and well-being of patients. Of course, there are numerous ways to improve the attractiveness of a hospital room, for example by changing the wall color. However, people vary in their preference of color (Grossman & Wisenblitz, 1999), and it is therefore difficult to design a color scheme that is universally attractive. Since people generally prefer natural elements, the use of indoor plants and an artificial representation of nature in healthcare interiors thus seems a straightforward and effective way to promote the patients' recovery.

One might argue that the findings of a simulation experiment cannot be translated into actual healthcare settings. There is evidence available, though, that photographs can accurately simulate real environments and such studies show results similar to field experiments (Stamps, 1990; Bateson & Hui, 1992). Moreover, if exposure to an imaginary hospitalization and a photo of a hospital room with plants is already capable of generating such a clear effect, this may be very promising for actual exposure of hospitalized patients to indoor plants. Furthermore, even if these effects only appeared in moderation in real healthcare settings, such a simple and low-cost intervention may well be highly cost-effective.
The current studies employed a simple design by essentially testing the hypothesis that natural elements make a hospital room more attractive and that it is the attractiveness that reduces stress. In future research the evolutionary explanation given for the effects should be tested by including information processing or attention measures. It will also be interesting to know which other environmental stimuli are capable of affecting the perceived attractiveness of an environment. These hypotheses obviously demand replication in field experiments in healthcare settings with real patients.

Conclusions

All in all, these studies confirm the stress-reducing properties of natural elements in the built healthcare environment. Moreover, they shed light on the underlying mechanism causing this stress-reduction. These experiments indicate that the stress-reducing effects of nature interventions in the built healthcare environment are the result of a higher level of perceived attractiveness of such environments. Additionally, the second experiment demonstrated that a painting of a tree leads to similar stress-reducing effects.

The previous chapters demonstrated beneficial effects of music in waiting rooms and natural elements in patient rooms. Moreover, they shed light on the psychological mechanisms underlying the stress-reducing effects of environmental stimuli. It could be expected that the environment affects people rather differently depending on personal characteristics. The following chapter provides insight in individual differences in reactions to the physical healthcare environment. The notion that the physical healthcare environment can affect our mood and behavior is well established. Despite this, individual differences in sensitivity to environmental stimuli have not received much attention. The research in this chapter shows the importance of individual differences in sensitivity towards color, and these may explain the contradictory effects found in earlier color research. Two experiments focus on differences in environmental sensitivity, measured with stimulus screening ability. In both experiments, participants were presented with a scenario describing hospitalization with appendicitis and were exposed to a photo of a hospital room. The experiments test the effects of environmental coloring of the hospital room (green and orange, both contrasted with white as a control condition), and the moderating role of stimulus screening ability (high-screeners vs. low-screeners) on stress (study 5.1) and arousal (study 5.2), and cognitive appraisals of the room (study 5.2). Stress-reducing effects of green and arousal-inducing effects of orange are both more pronounced for people scoring low on stimulus screening ability than for those who are able to effectively screen out complexity in the environment (high-screeners).

5

Individual differences in reactions towards color in simulated healthcare environments: The role of stimulus screening ability[i]

[i] Dijkstra, K., Pieterse, M.E. & Pruyn, A.Th.H (2008). Individual differences in reactions towards color in healthcare environments: The role of stimulus screening ability. *Journal of Environmental Psychology, 28*, 268-277.

Introduction

Research in environmental psychology has demonstrated that different environmental stimuli can affect both mood (Knez, 2001; Leather, Beale, Santos, Watts & Lee, 2003) and behavior (Gifford, 1988; Mattila & Wirtz, 2001). According to this research, in a variety of settings, the physical environment appears to be an important determinant in how people feel and act.

The effects of the physical environment may be of particular importance in healthcare settings, where people experience a relatively high degree of uncertainty, fear and stress. Possible effects of the physical healthcare environment on the healing process of patients have received some attention (Devlin & Arneill, 2003; Schweitzer, Gilpin, & Frampton, 2004; Ulrich, 1995). Environments showing such effects are also referred to as 'healing environments'. This idea suggests that the physical healthcare environment 'can make a difference in how quickly the patient recovers from or adapts to specific acute and chronic conditions' (Stichler, 2001, p.2). Research supports this idea of healing environments, where the physical healthcare environment affects the health and well-being of patients (see for reviews Dijkstra, Pieterse & Pruyn, 2006, Ulrich, Zimring, Quan, Joseph & Choudhary, 2004). These reviews showed that environmental stimuli such as sunlight and scents appeared to have beneficial effects on, for example, perceived stress (Walch, Rabin, Day, Williams, Choi & Kang, 2005) and feelings of anxiety (Lehrner, Eckersberger, Walla, Pötsch & Deeke, 2000). Although wall color is an environmental stimulus that can easily be changed and might fairly easily alter the atmosphere of an environment, the reviews also showed that the empirical evidence regarding the effects of environmental coloring (i.e., the use of color in an environment) in healthcare settings is still weak.

In the current studies, the effects of environmental coloring in a healthcare setting will therefore be studied. Although much fundamental research has been conducted on the effects of color on emotions, applied research on color as an environmental factor is limited, especially in healthcare settings. Previous research suggests a link between colors and emotions, with warm colors associated with aroused feelings and cool colors with calming ones (Kaya & Epps, 2004, Valdez & Mehrabian, 1994; Wexner, 1954). However, these results are not always consistent and sometimes they are even contradictory. A review report on color in healthcare settings concluded that the evidence regarding color effects is 'conflicting, anecdotal, and loosely tested' (Tofle, Schwartz, Yoon & Max-Royale, 2004, p.4). Tofle et al. (2004) also concluded that 'emotional responses to colors are caused by culturally learned associations and by the physiological and psychological makeup of people' (p. 5). An explanation for these conflicting effects could be that individuals differ in how they deal with the environment, how they perceive different aspects of it, and in what ways they process this kind of information. Thus we argue that the inconsistencies in color research may partially be explained by individual differences, something that has been largely neglected in color research.

Samuelson and Lindauer (1976) already emphasized the importance of individual differences in the description and evaluation of environmental settings, when

studying the effects of individual differences in sensation seeking on performance and perceptions of neat and messy rooms. Individual differences may explain why some studies do find effects of environmental coloring (Kwallek & Lewis, 1990), where other studies do not (Ainsworth, Simpson & Cassell, 1993). One key variable that might explain why the environment has different effects on individuals is the way they process or perceive their surrounding environment. This could be referred to as the ability to screen out irrelevant stimuli within the environment (Mehrabian, 1977a). Some people have a natural tendency to effectively reduce the complexity of an environment (high-screeners), where others are not capable of this information reduction (low-screeners). Therefore, we expected that effects of environmental coloring would be moderated by people's stimulus screening ability.

In the next section, the literature investigating the relationship between colors and emotions will be reviewed and the importance of stimulus screening ability outlined. Next, two experiments will be reported that test the moderating role of stimulus screening ability on effects of environmental coloring.

Color

Color is an important variable in interior design as it is a relatively easy way to alter the atmosphere of an environment. First, a more pleasant atmosphere may have a beneficial effect on patients (i.e., a healing environment). Second, changing the wall colors in existing environments is fairly easy and inexpensive, making it an interesting variable for healthcare organizations to generate such a favorable effect. Previous research has claimed that certain colors are capable of arousing people whereas others might give people a feeling of calmness (Stone & English, 1998). More specifically, warm colors (red and yellow hues) are believed to have more arousing properties on physiological and psychological outcomes than cool ones (blue and green hues), as opposites in the color spectrum (Jacob & Suess, 1975; Wilson, 1966).

Color and emotions

Testing the effects of color on anxiety state, Jacob and Suess (1975) exposed their subjects during fifteen minutes to color slides and measured their anxiety state every five minutes. They found higher anxiety scores in the red and yellow groups than in the blue and green ones. These results may suggest more aroused feelings when people are exposed to warm as opposed to cool colors. Kaya and Epps (2004) asked participants to indicate their emotional responses to different colors and confirmed positive effects for the color green. Their results showed that green evoked mainly positive emotions such as relaxation and comfort. This effect was explained by the associations of the color green with nature and trees, creating a feeling of comfort and being emotionally soothing. Wexner (1954) also studied the associations between colors and certain moods by showing colored cards and asking participants to associate these with different moods. Participants were asked to match the colors with the mood they felt the color represented. The results showed that the color green is associated with moods such as comfortable, tender, calm and serene. Wexner also studied associations with among others the color orange. This color is associated with moods such as excitement, distress and upset. These results also suggest more relaxed feelings for a cool color and more aroused

feelings for a warm color. Although this research was conducted by exposing participants to colored cards or to projections of colored slides, the effects on and associations with different moods are indicative of possible effects of such colors as an environmental stimulus in an applied setting.

Color and cognitive appraisals
Color may also affect the way in which people perceive and evaluate an environment. A study by Babin, Hardesty and Suter (2003) showed that wall colors in a retail setting affect customers' evaluations of the store. Cooper, Mohide and Gilbert (1989) studied the effects of environmental coloring in a long-term care setting. Their results showed that by changing the color scheme of the ward both staff and families perceived the new environment as less institutional and more cheerful. These studies suggest that wall color may change the way people perceive and evaluate an environment.

Effects of the'color' white
Most color research compares the effects of different 'real' (i.e., non-white) colors, but Kwallek, Woodson, Lewis and Sales (1997) contrasted a red office with a blue/green office and a white office and used the stimulus screening ability as a covariate in their analyses. They found a main effect of red versus blue on mood, with workers in the red office experiencing more feelings of dysphoria. Their results showed that low-screeners in the white office (vs. red) reported more dysphoria with respect to anger and depression than high-screeners. This finding was explained by 'the possible starkness of the white office regarding lack of contrast and pigment, which could be more disturbing for people scoring low on stimulus screening ability' (Kwallek et al., 1997, p. 131).

Since white is the most commonly used color in hospitals and highly associated with hospital buildings (Kaya & Crosby, 2006), we will use white in our studies as a control condition and this will be compared with green and orange respectively. The effects of white are less clear, but as shown above, the color green is associated with nature and might therefore have some stress-reducing properties, whereas the warm color orange is hypothesized to have arousal-inducing properties.

Stimulus Screening Ability
People differ in their sensitivity towards environmental stimuli. Mehrabian (1977a) developed a measure for this environmental sensitivity, and named it stimulus screening ability. The concept of stimulus screening ability is based on individual differences in arousability as a result of the ability 'to automatically screen less important components of stimulation in various sensory channels' (Mehrabian, 1977a, p.239). People's trait arousability is partly defined by the strength of arousal responses to increases in complexity, variation, or novelty of stimuli. Individuals with a high stimulus screening ability, referred to as high-screeners, are able to effectively reduce the complexity of an environment. As a consequence, they show less aroused responses to an environment. Individuals with a low stimulus screening ability typically screen fewer of the less relevant components of an environment and are referred to as low-screeners. They demonstrate a greater arousal response to the same environment than do screeners (Mehrabian, 1977a).

These individual differences in automatic screening of irrelevant stimuli and rapid habituation to distracting, irrelevant stimuli are explained by the information rate-arousal hypothesis (Mehrabian & Russell, 1974). This hypothesis implies that by effectively screening an environment, the information rate of an environment is reduced, which leads to less arousable responses for high-screeners than for low-screeners to the same environment. This suggests that arousability is inversely related to individual differences in stimulus screening; high-screeners are less arousable persons, and low-screeners are more arousable persons (Mehrabian, 1977b).

Stimulus screening ability and color
Stimulus screening ability has shown to be of importance in color effects in office environments. Kwallek et al. (1997) studied the effects of interior office color and stimulus screening ability on worker performance. They showed that workers with low scores on stimulus screening ability performed more poorly in a red office (versus blue/green) than workers who scored high on stimulus screening ability. Stimulus screening thus appears to be a moderator in effects of environmental coloring in office environments on productivity.

Mehrabian and Ross (1979) studied the effects of physical and psychological problems as a consequence of life changes and found that non-screeners experienced more illnesses. A review by Mehrabian (1995) reports relations of trait arousability with a variety of personality traits (e.g., empathy and neuroticism) and behaviors (e.g., eating disorders and suicidal tendencies), but no associations with more cognitive measures (the way people perceive and evaluate an environment) were reported. The ability to screen out irrelevant stimuli appears to be closely related to health-related outcomes, such as anxiety, as well as to specific health conditions, such as diastolic pressure, heart disease and the incidence of illnesses (Mehrabian, 1995).

Overview of the studies
The purpose of the present experiments is to investigate whether a personality trait, namely stimulus screening ability can explain the contradictory effects of coloring on emotional states found in the literature. We propose that stimulus screening ability moderates the effects of the wall color green on stress (study 5.1) and the wall color orange on arousal (study 5.2) in a hospital room. We also propose that environmental coloring affects cognitive appraisals of the hospital room (study 5.2). In both of the following experiments, the wall color of a hospital room was manipulated and the personality trait 'stimulus screening ability' was measured.

The aim of this first experiment is to test whether people experience fewer feelings of stress in a room with the wall color green (versus white). The proposed relation between wall color and stress is expected to be stronger for people who score low on stimulus screening ability as they are more likely to be affected by environmental influences. In other words, it is expected that individuals' stimulus screening ability moderates the relation between wall color and stress such that the effect of wall color will be more pronounced for low- as opposed to high-screeners.

Study 5.1

Method

Design and participants

The experiment employed a design with 'wall color' (white vs. green) as a dichotomous between-subject variable, and participants' 'stimulus screening ability' as a continuous independent variable. A total of 89 students (38 males and 51 females) participated in this study and received course credits or € 3,- for their cooperation. Their mean age was 20.4 years (*SD* = 2.13).

Environmental manipulation

Participants were randomly assigned to the experimental or the control condition. In the experimental condition, participants were exposed to a photo of a hospital room with green walls (Hue 125°, Saturation 64%, Brightness 54%), whereas participants in the control condition were exposed to a photo of a hospital room with white walls (Hue 0°, Saturation 0%, Brightness 98%). People's aesthetic responses and evaluations of photographic simulations of real environments have been established to be adequately similar to people's responses to the actual environment (Stamps III, 1990). Both photos were identical, except with respect to wall color, which was manipulated using Adobe Photoshop[i]. Figures 5.1 and 5.2 show the photos used in experiment 5.1.

Procedure

Upon arrival at the laboratory, each participant was placed in a separate room with a computer (distance to the screen varied between 60 and 70 centimeters) which provided all the instructions. Participants were asked to imagine being hospitalized with appendicitis. The scenario described that they had undergone successful surgery but that they had to stay in the hospital for three more days. Next, participants were randomly assigned to either a photo of a hospital room with green walls (the experimental condition) or to a hospital room with white walls (the control condition) which was displayed full-screen (screen size: 17 inch).

Participants were instructed to take the time they needed to imagine being hospitalized in the room on the photo, but had to look at the photo for at least 15 seconds. After exposure to the photo, participants were requested to complete a measure assessing stress. After completing the experiment, participants were paid and thanked for their help. One week later, participants were contacted and asked to complete the stimulus screening questionnaire using an online questionnaire.

[i] The reported hue, saturation and brightness represent the pure colors. In order to make these (wall) colors realistic, the opacity of the layer with the color was adjusted to 20 - 40%, resulting in a less saturated and less bright color.

Figure 5.1. The hospital room with white walls

Figure 5.2. The hospital room with green walls

Measures

Stimulus Screening Ability To assess whether participants were sensitive to their environment, they completed the 34-item Stimulus Screening Ability questionnaire (Mehrabian, 1994). Sample items include "I am not affected much by sudden or intense events" and "Drastic changes in weather affect my mood" (Mehrabian, 1995, p. 9). Participants responded to the items on 9-point scales (ranging from very strong agreement [+4] to very strong disagreement [-4]) so that the possible range of scores was 136 (high screening ability) to –136 (low screening ability). Scores were computed by summing up the responses to the 17 positively worded items (α = .87) and by subtracting the sum of the negatively worded items (α = .90).

Stress To measure feelings of stress, participants responded to the 18-item stress dimension of the Stress Arousal Checklist (MacKay, Cox, Burrows & Lazzerini, 1978) on a 4-point scale (ranging from this word definitely describes my feelings [++] to this word doesn't describe my feelings [-]). Sample items include "tense", "uptight", and "worried". The average score on this scale was used as a measure of stress (α = .85).

Statistical procedure
To test our hypothesis whether wall color affects stress and whether this effect is moderated by stimulus screening ability, a regression analysis was performed. To interpret the interaction effect, simple slopes were derived for high and low levels of the moderator (stimulus screening ability) and tested for their significance. The assumptions for regression analysis of normality, equality of variance and absence of outliers were met.

In this case, there are two methodological reasons to prefer regression analysis to analysis of (co)variance. First, stimulus screening ability is a continuous variable. By using a covariance analysis, statistical information would be lost due to dichotomizing the covariate. Second, the purpose of an analysis of covariance lies in the elimination of systematic bias due to a covariate and the reduction of within-group error variance (Stevens, 2002). Since we are explicitly interested in the moderating role of stimulus screening ablity, treating it as a covariate does not do justice to the moderating role we propose for this variable.

Results

To test our hypothesis, a regression analysis was performed with 'wall color' (dummy coded), 'stimulus screening ability' (centered, see Aiken & West, 1991), and the interaction between 'wall color' and 'stimulus screening ability' as predictors, and stress as the dependent variable. Wall color appeared not to have an effect on stress (β = -.10, *n*s). However, the interaction between 'wall color' and 'stimulus screening ability' approached significance (β = .28, p = .063). Subsequently, simple slopes analysis revealed that wall color only had an effect on the low-screeners (b = -.25, t = -1.99, p < .05), and not on screeners (b = .08, t = .65, p = .52), as can be seen in Figure 5.3.

Inspection of the means showed that for the high-screeners no differences were found between the green (M = 1.65, SD = .50) and white room (M = 1.61, SD = .40). Low-screening participants experienced more stress in the white (M = 1.86, SD = .46) than in the green room (M = 1.59, SD = .22).

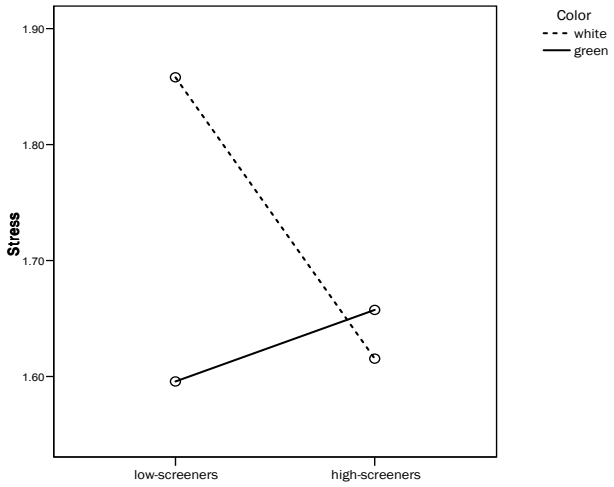

Figure 5.3. Stress as a function of 'color' and 'stimulus screening ability'
Note The variable 'Stimulus Screening Ability' is dichotomized for descriptive purposes only. Regression analysis with the continuous variable is used throughout.

Discussion

The results of this first experiment suggest the importance of individual differences in effects of wall color in a hospital room on stress and give us three important insights. First, no effect of wall color on stress was found, indicating that the color green appeared not to be strong enough to generate a direct impact on feelings of stress. Second, the results on the hypothesis that the effect of wall color will be more pronounced for low-screeners as opposed to high-screeners, approached significance. When the personality trait 'stimulus screening ability' is taken into account, a green wall color does have an effect on stress, but only for low-screening participants. These participants experience more feelings of stress in a white room than in a green one. Third, this interaction effect appears to be mainly caused by the increase of stress experienced by participants in the white room, as opposed to the hypothesized stress-reducing properties of green.

Study 5.2

Study 5.2 was designed to extend the results of study 5.1 by using a different color and by adding two extra dependent variables that measure cognitive appraisal of the hospital room. In this experiment a color on the warm side of the color spectrum was chosen. As explained in the introduction, warm colors are believed to be more arousing. Therefore, it was hypothesized that the wall color orange increases feelings of arousal. We predicted that stimulus screening ability moderates the

relation between wall color and arousal, such that the effect of wall color will be more pronounced for low-screeners as opposed to high-screeners.

A second hypothesis concerns the cognitive appraisals of the room. White is the most commonly used color for hospital rooms, and is highly associated with healthcare facilities (Kaya & Crosby, 2006). This association of white with the medical profession leads to the hypothesis that the white room will receive higher ratings on professional quality than the orange room.

Effects of the color orange can be hypothesized by the prototypicality paradigm (Ward, Bitner & Barnes, 1992), which can be defined as the degree to which a service facility matches previous customer perceptions of how a setting is supposed to feel and look. This prototypicality paradigm can be considered a special case of the disconfirmation of expectations (Swan, Richardson & Hutton, 2003). Swan et al. (2003) state that the physical facilities of a service can be more attractive than the typical facility, which may result in a facility that exceeds expectations and which in turn should result in positive responses. We thus expected that the orange room would be rated as more attractive. Main effects were expected of wall color on cognitive appraisal. No effects of stimulus screening ability were expected, given that participants were asked to rate the hospital room, which can be considered a task that explicitly demands participants to pay attention to the environment (including wall color) and thus overrule possible screening tendencies.

Method

Design and participants

In this experiment, 'wall color' (white versus orange) served as a dichotomous between-subject variable, and participants' 'stimulus screening ability' served as a continuous independent variable. A total of 44 undergraduate students (16 males and 28 females) with a mean age of 20.7 years (SD = 2.25) participated in this study and received course credits or € 3,- for their cooperation.

Environmental manipulation

As in study 1, participants in the experimental condition were exposed to a photo of a hospital room with orange walls (Hue 30°, Saturation 82%, Brightness 94%), whereas participants in the control condition were shown a photo of a hospital room with white walls (Hue 0°, Saturation 0%, Brightness 98%). Figures 5.4 and 5.5 show the photos used in experiment 5.2.

Figure 5.4. The hospital room with white walls

Figure 5.5. The hospital room with orange walls

Procedure

Participants were placed in a separate room with a computer which provided all the instructions. They were told that they would participate in a series of unrelated studies. First, participants were asked for their demographic variables, and their stimulus screening ability was measured. Next, they were then assigned to either the experimental condition (orange wall color) or the control condition (white wall color). As in study 1, participants were asked to imagine being hospitalized with appendicitis.

Measures

Stimulus Screening Ability Similar to study 1, participants completed the 34-item Stimulus Screening Ability questionnaire. Reliability of both positively worded items (α = .84) and negatively worded items (α = .84) was good.
Arousal To measure feelings of arousal, participants responded to the 12-item arousal dimension of the Stress Arousal Checklist (MacKay et al., 1978) on a 4-point scale *(*ranging from *this word definitely describes my feelings* [++] to *this word doesn't describe my feelings* [-]*).* Sample items include "active", "stimulated", and "alert". The average score on this scale was used as a measure of arousal (α = .88).
Attractiveness and professional quality To measure cognitive appraisal of the hospital room, participants rated the room on attractiveness and professional quality, on a bipolar adjective scale (7 points) Items were based on scales developed and used by Russell, Ward and Pratt (1981) and Lohr and Pearson-Mims (2000). The average scores on 10 items served as a measure of attractiveness (α = .96). Sample items include "pleasant – unpleasant" and "friendly – unfriendly". The average score on 3 items measured professional quality (α = .84), a sample item is "efficient – inefficient".

Statistical procedure
As in the first experiment, regression analyses were performed to test the hypothesis whether wall color affects arousal, attractiveness and professional quality and whether this effect is moderated by stimulus screening ability. To interpret the significant interaction effect, simple slopes were derived for high and low levels of the moderator (stimulus screening ability) and tested for their significance. For all analyses, the assumptions of normality, equality of variance and absence of outliers were met.

Results
Arousal To examine the effects of our independent variables on arousal, a regression analysis was performed with 'wall color' (dummy coded), 'stimulus screening ability' (centered, see Aiken & West, 1991), and the interaction between 'wall color' and 'stimulus screening ability' as predictors. The analysis showed that the relation between 'wall color' and arousal approached significance (β = .27, p = .07), with orange being more arousing (M = 2.84, SD = .59) than white (M = 2.51, SD = .66). In line with our predictions, the interaction between 'wall color' and 'stimulus screening ability' on arousal was significant (β = -1.11, p < .05). Simple slopes analysis showed that the effect of wall color on arousal is more pronounced for non-screeners (b = .81, t = 3.10, p < .05) than for screeners (b = -.12, t = -.44, p = .67), shown in Figure 5.6.

Inspection of the means showed that for the high-screeners no differences were found between the orange (M = 2.93, SD = .56) and white room (M = 2.80, SD = .59). Low-screening participants experienced more arousal in the orange (M = 2.74, SD = .64) than in the white room (M = 2.14, SD = .58).

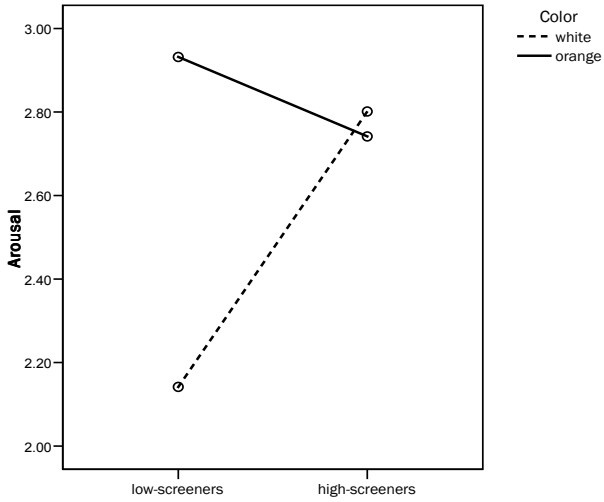

Figure 5.6. Arousal as a function of 'color' and 'stimulus screening ability'
Note The variable 'Stimulus Screening Ability' is dichotomized for descriptive purposes only. Regression analysis with the continuous variable is used throughout.

Attractiveness To test whether wall color affects the rating of attractiveness of the room, a regression analysis was conducted. This analysis showed a relation between wall color and attractiveness of the room (β = .58, p < .01), with the orange walls being rated more positively (M = 5.18, SD = .88) than the room with white walls (M = 3.66, SD = 1.26). To explore whether the stimulus screening ability had any effect on ratings of attractiveness, a regression analysis was conducted with 'wall color', 'stimulus screening ability', and the interaction between 'wall color' and 'stimulus screening ability' as predictors. As expected, this analysis showed that the ratings of attractiveness were not affected by stimulus screening ability (β = .02, p = .93) and the interaction was also non-significant (β = -.26, p = .14)
Professional Quality A regression analysis was conducted to test whether wall color affects the rating of professional quality of the room. The analysis showed a relation between wall color and the professional quality of the room (β = -.35, p < .05), with white walls receiving a higher rating (M = 5.33, SD = .27) on professional quality than the orange room (M = 4.38, SD = .28). A regression analysis with 'wall color', stimulus screening ability' and the interaction between those two factors as predictors, showed that ratings of professional quality were not affected by stimulus screening ability (β = .22, p = .29) and the interaction was also non-significant (β = -.18, p = .38).

Discussion

Results of the second experiment again demonstrated the role of stimulus screening ability in effects of environmental coloring. The color orange resulted in a marginally significant effect on arousal, compared to white. This suggests a link between the color orange and feelings of arousal. Most importantly, however, the

interaction between color and stimulus screening ability was significant. This supports our hypothesis that the wall color orange does have an effect on feelings of arousal but that this effect is more pronounced for low-screeners. A closer look at the means revealed that this interaction is mainly caused by the drop in arousal for low-screeners in the white room. This surprising effect underscores our lack of knowledge about effects of the color white. According to our second hypothesis, stimulus screening ability showed no effect on cognitive appraisals of an environment. Color revealed main effects, with the orange room being rated as more attractive, but at the same time lower on professional quality.

General discussion

In two experiments we tested the effects of environmental coloring in a healthcare setting. Besides the manipulation of wall color, stimulus screening ability was measured in both experiments to determine the importance of individual differences in effects of the physical healthcare environment on health-related effects and cognitive appraisals of the environment.

Results suggest that (compared to white) the color orange has a greater impact on feelings of arousal than the color green has on reducing feelings of stress, since orange yielded a marginally significant effect whereas the color green did not. Most significantly, however, the importance of individual differences has been demonstrated in effects of environmental coloring. Stress-reducing effects of green and arousal-inducing effects of orange were both more pronounced for people scoring low on stimulus screening ability than for those who are able to effectively reduce the complexity of an environment (high-screeners). These results may partially explain why research on environmental coloring is still inconclusive and sometimes even contradictory. Wall color only appeared to have a small effect on health-related outcomes, but when stimulus screening ability is taken into account, these effects are fairly straightforward.

Studies on effects of environmental coloring in office settings (Kwallek et al., 1997; Kwallek et al., 2007) already underlined the importance of environmental sensitivity. In healthcare settings, this personality trait may be relevant as well. Being hospitalized is generally associated with feelings of fear, uncertainty and anxiety. These feelings are closely related to the ability to screen out irrelevant stimuli (Mehrabian, 1995) and it could be that being ill results in people having less ability to screen information. Stimulus screening ability may be a construct that varies with people's wellness and might thus be of even greater importance in healthcare settings than in others.

It could be argued that the findings of simulation experiments cannot be translated to actual healthcare settings. Indeed, participants in our studies were not actual hospital patients, norwere they experiencing a real stay in a hospital room. These methodological limitations obviously demand replication in field experiments in healthcare settings with real patients. However, there is evidence available that photographs can accurately simulate real environments and such studies show

results similar to field experiments (Stamps, 1990; Bateson & Hui, 1992). Furthermore, even if the effects appear to be very subtle in real healthcare settings, such simple and low-cost interventions may well be highly cost-effective. As environments appear to be perceived holistically (Lin, 2004), applying a different wall color to a room might have consequences on how people perceive the entire environment. For example, a different color could result in more or less distinct contrasts with other objects in a room. Nonetheless, such possible bias seems unavoidable in studying effects of color in real environments. This suggests that there may not be an adequate control condition in color research. However, white is the most used wall color in many environments, such as offices, homes and hospitals, which is why we chose this color as our control condition.

Special attention should thus be paid to the effects of the color white, which is neglected in most color research. Our results indicate that white in fact might not be neutral but may have distinct effects on people, under the condition that people are sensitive to their environment. Kwallek et al. (1997) already reported that a white office (vs. red) might result in more dysphoria for low-screeners. These results show a great resemblance to an effect we found for the white hospital room, where white (vs. green) increased feelings of stress for low-screeners. At the same time, for low-screeners, white (vs. orange) also has the potential to reduce arousal. This effect is difficult to interpret as being either positive or negative. A room resulting in too much arousal for people is not desirable, but a certain amount of arousal might be advantageous to people who are listless. Nevertheless, we feel that researchers and designers should be aware of the possible desired or undesired effects a seemingly neutral environment might also have on people.

Taken together, the current experiments studied the moderating effect of stimulus screening on environmental coloring. The nature of the stimulus screening ability scale, measuring how sensitive people are to the surrounding environment, suggests that this ability also changes the effects of other environmental stimuli. Therefore it is advisable for future studies on effects of environmental stimuli to include a measure for stimulus screening ability in order to at least control for an individual difference very closely related to environmental effects. As stated above, stimulus screening ability is a characteristic that is closely related to the way people perceive their surrounding environment, but other personality traits may be of importance as well. Samuelson and Lindauer (1976) demonstrated for example that differences in sensation seeking affect performance and perceptions of neat and messy rooms. Our research, as well as a study by Kwallek et al. (1997), also indicate that white, a color which was assumed to be neutral, might even in some cases also have a detrimental effect.

Our results suggest that creating a healing environment by using wall colors may thus be quite complex, and be associated with modest rather than profound effects. The same interior design appears to affect people rather differently depending on an individual characteristic. However, in healthcare environments where people's ability to screen out information may be reduced due to their current medical conditions, the influence of color could be of greater importance.

The previous chapter studied effects of environmental coloring, since color appeared to be a powerful, but largely neglected variable in research on healing environments. The following chapter presents a study which investigates whether environmental color can affect health-related behavior. Clients' communication in a counseling setting can be affected by the physical environment in which it occurs, but there is little evidence available on specific environmental effects of the counseling room on clients' self-disclosure. Previous research suggested that counseling rooms should be pleasant and intimate, and cool colors have been suggested to be beneficial in healthcare settings. However, research also demonstrated that creating such environments may be seen as a cosmetic act without professional substance. This chapter shows that participants exposed to the counseling room with white walls, as compared to green walls, disclosed more personal information. The perceived trustworthiness of the counselor was higher in the white room and the counseling room itself was perceived as more professional with white walls. This suggests that creating pleasant and intimate rooms may not necessarily be effective and that white walls can also generate beneficial effects, these effects are in line with the idea of professionalism.

6

Color in the counseling room: Effects on self-disclosure and impressions of professionalism

"All social interaction is affected by the physical container in which it occurs". Bennet & Bennet, 1970

Introduction

Early research on communication and self-disclosure primarily concentrated on personality factors (Cozby, 1973), while little attention has been paid to the proximate physical environment in which the interaction occurs (Gifford, 1988). Bennett and Bennett (1970) suggest that the physical environment can affect the nature of a social interaction in terms of the duration of the interaction and the actual progression of events. In the counseling context, the counseling room can be considered the physical container in which the counseling process occurs. While clinical (e.g., treatment) factors will indisputably play an important role in determining the overall impact of the counseling process, the role of the physical environment should not be undervalued given its potential healing effects (Dijkstra, Pieterse & Pruyn, 2006; Gross, Sasson, Zarhy & Zohar, 1998). Consequently, one might question whether the environment can facilitate counseling-relevant processes, such as self-disclosure (Pressly & Heesacker, 2001).

Possible healing effects of the physical healthcare environment on patients have received some attention (Devlin & Arneill, 2003; Schweitzer, Gilpin & Frampton, 2004; Ulrich, 1995). This field of research is characterized by the concept of healing environments, which implies that the physical environment of healthcare settings "can make a difference in how quickly the patient recovers or adapts to specific acute and chronic conditions" (Stichler, 2001, p. 2). Most of the studies that investigated the effects of the physical healthcare environment involved inpatients in acute care and psychiatric settings. However, Pressly and Heesacker (2001) concluded in their literature review that most of the research that studied the effects of the environment in psychiatric settings focused on public areas, such as common rooms in psychiatric facilities, rather than on private counseling rooms.

There is little research available that investigates the effects of the physical environment in which the counseling process occurs. Color is a fundamental element of environmental design (Tofle, Schwarz, Yoon & Max-Royale, 2004), yet it appears to be rarely studied in healthcare settings (Dijkstra et al., 2006). The present study, therefore, investigates the effects of color in the counseling room environment.

Counseling environment and color

Mental health professionals have long speculated about, and now pay increasing attention to, the physical environment in which treatment occurs and its impact on both the treatment process and its outcome (Gross et al., 1998). Renovation projects of psychiatric wards demonstrated that, for example, changing furniture, carpeting, and colors affects patient well-being. Holahan and Saegert (1973) studied the effects of a remodeled admission ward and found that patients were involved in more socializing and less isolated passive behaviors than in the control

ward. Furthermore, Christenfeld, Wagner, Pastva, and Acrish (1989) found that patients' negative self-image showed greater improvements in remodeled wards.
A limited number of studies investigated the effects of environmental characteristics in counseling rooms. Vielhauer Kasmar, Griffin, and Mauritzen (1968) studied the influence of a beautiful and an ugly room on mood and perception of the psychiatrist. Apart from several higher order interactions, no clear pattern was found for the effects of the physical environment on these outcomes. Chaikin, Derlega, and Miller (1976) hypothesized that most counseling rooms are characterized by 'hard' architecture and that counseling would have more favorable outcomes in a warm and intimate room. They found that the intimacy of self-disclosure was higher in the 'architecturally soft' room (pictures on the wall, soft cushioned furniture, rug, soft lighting) than in the 'architecturally hard' room (bare cement, block walls, overhead fluorescent lighting). In an investigation of seating arrangements and lighting conditions, Lecomte, Bernstein, and Dumont (1981) found that counselor-client interactions were enhanced by a moderate interpersonal distance, as opposed to an extremely close or distant proximity. Differences in light intensity did not affect clients' self-disclosure. However, Miwa and Hanyu (2006) found that dim lighting yielded more pleasant and relaxed feelings and led to more self-disclosure. They also investigated the effects of home-like decorations, but no effects of decorations were found.

These studies demonstrate that several variables of the physical environment can affect clients. Seating arrangement, lighting, and redecoration and renovation projects all appear to have an effect on counseling-relevant measures. However, to our knowledge, no studies have tested the effects of color in the counseling setting. Color appears to be one of the most powerful elements in our environment, and it is typically one of the first features that individuals notice when entering a room (Venolia, 1988).

In their review on the physical environment of the counseling setting, Pressly and Heesacker (2001) showed that there are no studies available that tested the effect of color in a counseling setting. They based their preliminary clinical implications on general color theory, which suggests that cool colors (e.g., blue and green) may be desirable because they may decrease blood pressure and pulse rate.

Color is not only an important variable in interior design, but it is also a relatively easy way of altering the atmosphere of an environment (Pressly & Heesacker, 2001). Jacob and Suess (1975) tested the effects of color on people's anxiety states and found that exposure to red and yellow colored slides led to higher anxiety scores than exposure to blue and green slides. In healthcare settings, research demonstrated that wall color affects stress and arousal (Dijkstra, Pieterse & Pruyn, 2008). Color also appears to affect cognitive appraisals of environments (Babin, Hardesty & Suter, 2003; Cooper, Mohide, & Gilbert, 1989), suggesting that wall colors may influence the way in which people perceive and evaluate an environment.

Most color research compares the effects of different "real" (i.e., non-white) colors. Furthermore, a current trend in healthcare design is the use of colors to generate

positive effects (Malkin, 2008). This suggests that, in general, researchers and interior designers expect colors to generate more favorable effects than white. However, this may not necessarily be the case in every healthcare situation. Dijkstra et al. (2008) studied a different healthcare setting, but they demonstrated that a patient room with white walls was rated higher on professional quality than a room with orange walls. It might, therefore, be expected that a counseling room with white walls will be rated higher on professional quality than a counseling room with colored walls.

The current study aimed to test the effect of white walls on a variety of measures related to perceived professional quality, which may result in desired health behavior. White remains the most commonly used color in healthcare settings and is strongly associated with healthcare facilities (Kaya & Crosby, 2006). This association of white with the medical profession suggests that a counseling room with white walls might be rated higher on professional quality. Cool colors have been suggested to lead to favorable outcomes in the counseling setting (Pressly & Heesacker, 2001). Moreover, green walls in a patient room were shown to reduce stress (Dijkstra et al., 2008), which allows green to be an adequate and interesting control condition. Green walls appear to have some calming properties when applied in patient rooms, but one might question whether this color is also effective in a healthcare setting where stress-reduction is not the main outcome of interest.

The aforementioned research suggests that the counseling environment influences clients. If clients are affected positively, the counselor's task is made easier because client growth is more likely. If clients are affected in a negative manner by the counseling environment, the already difficult task of the counselor is made more difficult (Miller, 1981).

Self-disclosure and impressions of the counselor

Self-disclosure can be defined as information about oneself that is communicated to another person (Cozby, 1973). Clients' self-disclosure is considered a vital component of counseling in essentially all theoretical frameworks and intervention strategies (Cohen & Schwartz, 1997). Self-disclosure has been strongly associated with treatment outcomes, and it is often the primary variable upon which counselors assess client progress (Anchor & Sandler, 1973). Furthermore, it is considered as an effective behavioral measure of estrangement from the counselor (Chaikin et al., 1976). Research demonstrates that self-disclosure is related to both physical and mental health and is a predictor of therapeutic outcomes (Cozby, 1973; Truax & Carkhuff, 1965). Low levels of self-disclosure have, for example, been associated with suicidality (Horesh & Apter, 2006), whereas distress disclosure tendencies predict improvement in counseling (Kahn, Achter & Shambaugh, 2001). Moreover, in an overview of factors that contribute to verbal self-disclosure, Ignatius and Kokkonen (2007) concluded that, along with individual characteristics and cultural factors, the physical environment or context affects self-disclosure.

It could be argued that the amount of self-disclosure depends on the client's impression of the counselor. Wilson and Mackenzie (2000) demonstrated that people may form an impression of the social and personal aspects of others based

on the design of the room in which they supposedly reside. In a classic study on the effects of aesthetic conditions on ratings of human faces, Maslow and Mintz (1956) demonstrated that these aesthetic conditions influenced the perceptions of human faces. Participants in a beautiful room rated the room as more pleasant than those in ugly rooms, but, most importantly, they rated photos of human faces as having higher energy and well-being. In a more recent investigation, Miwa and Hanyu (2006) demonstrated that dim lighting resulted in more favorable impressions of the interviewer.

Current study

Considering the significance of self-disclosure in the counseling process, it is important to assess which environmental variables boost clients' self-disclosure (Cohen & Schwartz, 1997; Pressly & Heesacker, 2001). The aim of the current study was, therefore, to investigate whether the environmental stimuli of wall color affect participants' self-disclosure and impressions of the counselor and the counseling environment. In this simulation study, a counseling room with white walls was compared to a counseling room with green walls. The color green has been, as mentioned above, shown to have stress and anxiety reducing properties, and the use of cool colors in healthcare settings has been recommended (Pressly & Heesacker, 2001). However, it remains questionable whether such a color is effective in a variety of healthcare situations. For instance, calming distressed patients is not the outcome of interest in all cases. Furthermore, colors can affect individuals' judgment of the professionalism of the healthcare environment (Dijkstra et al., 2008). Mahnke (1996, p. 147) states that "a too-casual look might stimulate skepticism as to the level of the professional services offered." He explains that excessive colorfulness can be quickly unmasked as being cosmetic and without professional substance. Moreover, white remains the most commonly used color in healthcare facilities, and it is highly associated with these facilities (Kaya & Crosby, 2006).

This study will test the hypothesis that participants in the white counseling room will disclose more information about themselves than those in the green room. Moreover, it is expected that the white counseling room will be rated as more professional, and that the counselor in the white room will receive more favorable ratings on trustworthiness, expertness, and attractiveness.

Method

Design and participants

The experiment employed a single factor between-subjects design (white walls vs. green walls). Sixty-nine participants (21 males and 48 females) with a mean age of 20.9 years (SD = 1.9) participated in the experiment. Participants received course credits or €2 for their participation.

Procedure

In the first condition, participants were exposed to a photo of a counseling room with green walls (hue 125°, saturation 64%, brightness 54%), whereas participants

in the other condition were exposed to a photo of a counseling room with white walls (hue 0°, saturation 0%, brightness 98%). Both photos were identical, except for wall color, which was manipulated using Adobe Photoshop[i] (see figure 6.1). Research has demonstrated that people's aesthetic responses to and evaluations of photographic simulations of real environments are adequately similar to their responses to the actual environment (Stamps, 1990).

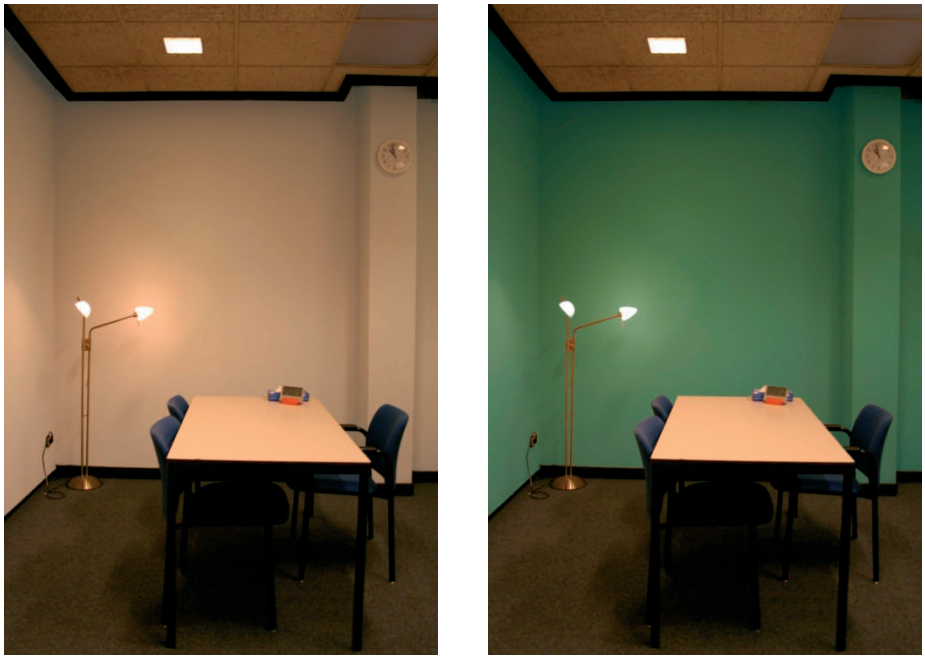

Figure 6.1 The photos of the counseling room used in this study

Upon arrival at the laboratory, each participant was placed in a cubicle with a computer, which provided all of the instructions. Participants were asked to participate in a simulated counseling session with a counselor from the university counseling service. They were told that the purpose of the study was to examine the processes that occur in a counseling interview. They were randomly assigned to the room with white walls or the room with green walls and then examined the photo of the counseling room in which the consult would occur. Subsequently, the first video clip began, in which the counselor introduced herself and informed the participants of the purpose of the consult. During the video clips of the counselor, the photo of the counseling room was depicted on the left side of the screen. In order to provide participants with the opportunity to get acquainted with the video clips and the text boxes in which they responded to the counselor, the consult began with three

[i] The reported hue, saturation, and brightness represent the pure colors. In order to make these colors realistic, the opacity of the layer with the color was adjusted to 20-40%, resulting in a less saturated and less bright color.

general questions. They were asked to inform the counselor about how they were doing in their studies, about their hobbies and activities, and the activities to which they devote most of their time. Next, the counselor introduced the incomplete sentences blank test (see measures for more details) and asked them to complete the test, after which she thanked the participants for the consult. After completing the simulated consult, the participants were asked to complete measures on their impressions of the counselor and of the counseling room.

Measures

Self-disclosure To measure the self-disclosure of participants, they completed eight sentences of the Rotter Incomplete Sentences Blank test (Rotter & Rafferty, 1950). Sentences could be completed in a positive or more conflictual manner, which are both considered as a form of self-disclosure. Responses in a neutral manner are generally on a simple descriptive level and evade the purpose of the test and are, therefore, scored as not self-disclosing. The total score on the eight sentences was used as the measure of self-disclosure. Sample items include "I like…", "Most girls…", and "The future….". Furthermore, they also completed 15 items of the Twenty-five Item Self-disclosure Questionnaire (Jourard, 1971) to assess their general tendency to self-disclose. On a three point scale, they indicated the degree to which another person knows the information given in a statement about them. People can be expected to differ in how much information they generally disclose about themselves. This tendency can affect how much people disclosed in this particular experimental setting. This measure was, therefore, used as a covariate in the analysis of self-disclosure.

Impressions of the counselor To measure the participants' impressions of the counselor, they completed the short version of the Counselor Rating Form (Corrigan & Smith, 1983). This scale includes three constructs, which are all measured with four items on a 5-point Likert scale. The average scores on the four items were used as measures of trustworthiness (α = .81), expertness (α = .68), and attractiveness (α = .80).

Impression of the counseling room To measure the appraisal of the counseling room, participants rated the room on professional quality, using a 7-point bipolar adjective scale. This self-constructed measure consisted of two items (α = .71), "efficient" and "practical".

Results

Analysis of baseline characteristics indicated that there were no gender differences in the dependent measures. Consequently, data from male and female participants was combined in the analyses.

Self-disclosure

Wall color appeared to have an effect on self-disclosure (ANCOVA, $F(2,66) = 4.82$, $p = .032$). Participants exposed to the counseling room with white walls disclosed more personal information ($M = 6.8$, $SD = .9$) than those in the room with green

walls (*M* = 6.21, *SD* = 1.3). In this analysis, we included participants' general tendency of self-disclosure as a covariate (F(2,66) <1).

Impressions of the counselor

Trustworthiness Wall color was found to significantly influence the perceived trustworthiness of the counselor (ANOVA, F(1,67) = 8.60, *p* = .005). Participants exposed to the room with white walls rated the counselor higher on trustworthiness (*M* = 3.9, *SD* = .70) than participants in the room with green walls (*M* = 3.4, *SD* = .72).

Expertness The effect of wall color on the perceived expertness of the counselor was marginally significant (ANOVA, F(1,67) = 3.37, *p* = .071). The counselor was rated higher on expertness by participants who were exposed to the counseling room with white walls (*M* = 3.58, *SD* = .64) than those exposed to the room with green walls (*M* = 3.28, *SD* = .68).

Attractiveness The effect of wall color on attractiveness of the counselor was marginally significant (ANOVA, F(1,67) = 3.52, *p* = .065). Participants in the counseling room with white walls rated the counselor as being more attractive (*M* = 4.1, *SD* = .64) than participants in the room with green walls (*M* = 3.8, *SD* = .58).

Impression of the counseling room

Wall color was found to have an effect on the impression of the professional quality of the counseling room (ANOVA, F(1,67) = 5.85, *p* = .018). Participants in the room with white walls rated the room as more professional (*M* = 5.30, *SD* = 1.16) than those in the room with green walls (*M* = 4.56, *SD* = 1.38).

Discussion

In this experiment, we tested the effects of wall color in the counseling room. Our results suggest that a white counseling room results in greater self-disclosure by participants. Furthermore, the perceived attractiveness, trustworthiness, and expertness of the counselor were higher in the white room. The counseling room itself was also perceived as more professional when it had white walls.

Research in a different clinical setting demonstrated that colored walls are more beneficial to patients (Dijkstra et al., 2008), while the current research demonstrated that white walls lead to more favorable outcomes. While these results appear to contradict each other, it should be noted that the outcome variable of interest is rather different. The study by Dijkstra et al. (2008) investigated the effects of a green wall on stress, while this study focused on self-disclosure as the main outcome of interest. This result suggests that environmental effects can be rather dependent on the context in which the healthcare situation occurs; positive effects of an environmental characteristic in one setting should not be blindly followed by changes in a different context.

One might argue that the findings of these simulation experiments cannot be translated into actual healthcare settings. There is evidence available, however, that photographs can accurately simulate real environments, and such studies show results similar to field experiments (Bateson & Hui, 1992; Stamps, 1990). If

exposure to a photograph is capable of generating behavioral effects, these results can be considered promising for actual exposure in an environment. On the other hand, the generalizability of the results to actual counseling situations must be considered with caution. The duration of the simulated contact between counselor and client was limited, and it remains unclear whether actual clients with various mental problems would respond in a similar manner. Nevertheless, in addition to previous research in this field, we demonstrated that the physical environment in which counseling occurs can affect a variable that is highly relevant for the counseling process, namely, self-disclosure.

Several researchers stress that it is possible that a portion of the environmental effects on clients may be indirect, through the counselor (Miwa & Hanyu, 2006; Pressly & Heesacker, 2001). If the physician is in a better mood due to a more pleasant work environment, this may result in more patience, attention, and empathy in interactions with patients and thus in more pleasant interactions. Although this may be a partial explanation of environmental effects, our study clearly demonstrates that the environment also directly affects clients. The video clips from the counselor were identical for both conditions, yet participants responded differently in both situations. Therefore, this effect is caused by the differences in wall color of the counseling room, demonstrating that the environment also directly influences the attitudes and behavior of clients.

Previous research on this topic has suggested a rather different line of reasoning. An attractive, soft room might be more similar to the environment in which friends interact, thereby facilitating self-disclosure (Chaikin et al., 1976). It has been argued that the counseling environment should be beautiful (Vielhauer Kasmar et al., 1968) and that it should not be 'hard architecture' but a more intimate environment (Chaikin et al., 1976). These less alienating environments were created by using, for example, new furniture, pictures on the walls, colors, carpeting, and soft lighting. However, it has also been indicated that the use of colors, for example, can be perceived as cosmetic without professional substance (Mahnke, 1996). Therefore, it can affect the impression of the professionalism of the environment (Dijkstra et al., 2008). Furthermore, white has been widely associated with the medical profession (Kaya & Crosby, 2006). This suggests that creating beautiful and intimate rooms may not necessarily be effective and that white walls may generate beneficial effects. Our results demonstrated that the counseling room with white walls led to favorable outcomes that are in line with these associations with professionalism. The counseling room with white walls was perceived as being more professional, and the counselor in the room with white walls was perceived to be more trustworthy and rated higher on expertness. Our results suggest that applying colors to a counseling room may not necessarily lead to more favorable outcomes simply because it results in a more calming and intimate environment. It is even conceivable that in the course of a multi-session treatment, the function of the counseling environment changes and that in the initial stage, a different ambiance is required than that later in the treatment process. Future research should therefore focus on understanding the underlying processes of these effects. Will creating a more pleasant and intimate environment be advisable in a counseling context, or should the environment simply radiate

professionalism? Is it possible to create a counseling environment that is pleasant and intimate while closely monitoring the professional outlook of the environment?

In spite of some contradictory results, the previous studies on this topic and the current study demonstrate that the effects of the physical counseling environment should not be overlooked. The interior design of the counseling room can influence the communication that occurs. This implies that counseling effectiveness can be improved by means of the physical counseling environment.

7

General Discussion

This final chapter begins with an overview of the main findings reported in this dissertation. Next, the theoretical implications of the results will be presented, which will be followed by limitations and possible directions for future research. This chapter will conclude with practical implications and an overall conclusion.

Encounters with healthcare situations are generally characterized by fear, anxiety, stress, and uncertainty. When examining most environments in which these encounters take place, one might rightfully ask how well these healthcare environments satisfy the psychological needs of patients. These healthcare environments may shape adequate conditions for providing high quality medical care, but what about patient needs such as relaxation, comfort, and well-being? The physical healthcare environment can be utilized to influence these needs. The present dissertation examined effects of the physical healthcare environment on patients' health and well-being and investigated how these effects come about.

Summary of main findings

Chapter 2 reported a systematic review of the existing research to determine the effects of physical environmental stimuli on the health and well-being of patients. The review was conducted using the Cochrane Collaboration Method. Studies were included if they concerned interventions involving the health effects of environmental stimuli in healthcare settings on patients and were based on controlled clinical trials published in peer-reviewed journals. Of the over 500 potentially relevant studies indentified, only 30 studies met all criteria and were included in the review. This critical overview of methodologically rigorous studies showed that predominantly positive effects were found for sunlight, windows, odor, and seating arrangements. Inconsistent effects were found for variables such as sound, nature, and spatial layout. There were no studies available that investigated the effects of color, plants, and room size in isolation from other environmental stimuli. In general, both the size and direction of effects seem highly dependent on characteristics of patient populations and the context of the healthcare settings. Studies that manipulated several environmental stimuli simultaneously clearly support the general notion that the physical healthcare environment affects the well-being of patients. However, when scrutinizing the effects of specific environmental stimuli, conclusive evidence is still limited and difficult to generalize. The main conclusion of this review is that the field appears to be in urgent need of well-conducted, controlled trials. Nevertheless, the concept of healing environments remains a promising field for future research.

In Chapter 3, two field studies investigated the effects of music on stress and anxiety in a waiting room. Exposure to music has been associated with positive changes in emotional states and cognitive processing (Garlin & Owen, 2006). Furthermore, music has also been shown to be an effective therapeutic intervention (Evans, 2002). Despite these potentially beneficial effects, there were no studies available that investigated the effects of music on stress and anxiety in waiting

rooms. The waiting room can be an appropriate place to apply anxiety-reducing techniques (Leather et al., 2003). Study 3.1 demonstrated that playing classical music in a dentist's waiting room results in reduced feelings of stress and anxiety, as well as higher perceived attractiveness and professional quality of the waiting room. Study 3.2 shed light on the underlying process that causes the stress-reduction by classical music. The results of study 3.1 were also extended to a different setting. This second study replicated the beneficial effects of classical music in the waiting room of a general practitioner. Moreover, this study demonstrated that the calming effects of classical music are the result of patients experiencing a more positive emotional state after exposure to classical music. These two field studies demonstrated that relatively easy and inexpensive environmental interventions can alter the atmosphere of a healthcare environment and lead to beneficial effects for patients.

Chapter 4 reported two laboratory studies that dealt with the question of whether the stress-reducing effects of environmental stimuli are mediated by a cognitive response, namely, perceived attractiveness. Research on restorative environments suggests that natural settings are especially capable of promoting recovery from stress (Hartig et al., 1996). Moreover, humans have an innate tendency to pay attention and respond positively to natural elements and they prefer such natural elements over man-made objects (Ulrich, 1991). Considering the potential healing effects of nature, exposing patients to natural elements may be an effective way to reduce stress associated with hospitalization. Since most healthcare facilities are built in urban environments and lack natural resources, bringing nature into the hospital might reduce stress and, in turn, aid recovery. Participants in both studies were presented with a scenario describing hospitalization with a possible legionella infection (study 4.1) or appendicitis (study 4.2). Subsequently, they were exposed to a photo of the hospital room to which they were admitted. Study 4.1 demonstrated that the stress-reducing effects of indoor plants are partially mediated by perceived attractiveness of the patient room. This study, thus, confirmed the stress-reducing properties of natural elements in the built environment. Moreover, it explained the underlying mechanism that causes this stress-reduction. This mediating effect of a cognitive response was replicated in a second study. Study 4.2 included a new condition with a painting of a tree to investigate whether exposure to 'non-real' nature could lead to similar stress-reducing effects. This second study showed that not only is stress reduced by indoor plants, but by a painting of nature as well. Apparently, both real plants and a painting of a tree activate the concept of nature, as was revealed by a word fragment completion task. These two studies demonstrated that participants exposed to indoor plants or a painting of nature reported less stress than those in the control conditions. Moreover, they explained the underlying mechanism that causes the stress-reduction. Nature in a hospital room reduced feelings of stress through the perceived attractiveness of the room.

Chapter 5 demonstrated that the same interior design can affect people rather differently depending on an individual characteristic. Two studies focused on the moderating effects of a personality trait, namely, stimulus screening ability. The importance of individual differences in the effects of environmental settings has been emphasized for a long time (Samuelson & Lindauer, 1976), but there is little

available research that tested this proposition. Therefore, in two laboratory studies, the moderating effects of stimulus screening ability on the effect of wall color on stress and arousal in a patient room were studied. Color is an important variable in interior design as it provides a relatively easy way to alter the atmosphere of an environment. Much fundamental research on the effects of color is available, but applied research on color as an environmental factor is limited, especially in healthcare settings. Furthermore, results from color research are not always consistent and at times, even contradictory. A possible explanation lies in the way individuals process or perceive their environment. This could be referred to as the ability to screen out irrelevant stimuli within the environment, people's stimulus screening ability. Individual differences in sensitivity to environmental stimuli have not received much attention. In two experiments, participants were presented with a scenario describing hospitalization with appendicitis and were exposed to a photo of a hospital room. Study 5.1 compared the effects of green and white walls on stress; study 5.2 compared orange and white walls and looked at effects on arousal and cognitive appraisals of the room. Results demonstrated that the stress-reducing effects of green and arousal-inducing effects of orange were both more pronounced for people scoring low on stimulus screening ability than for those who are able to effectively screen out complexity in their environment. These results may partially explain why research on color is still inconclusive.

Chapter 6 demonstrated that the physical healthcare environment can have an effect on actual health-related behavior. This study investigated the effects of wall color in a counseling room on participants' self-disclosure. Most studies that investigated effects of the environment in psychiatric settings focused on public areas, such as common rooms of psychiatric facilities, rather than on private counseling rooms (Pressly & Heesacker, 2001). Research demonstrated that the counseling environment may affect and facilitate counseling-relevant processes (Chaikin, Derlega & Miller, 1976; Lecomte, Bernstein & Dumont, 1981), but no studies were available that tested the effects of environmental coloring. Clients' self-disclosure is considered to be a vital component of counseling (Cohen & Schwartz, 1997) and was, therefore, chosen as the main outcome measure of interest in this study. Clients' impressions of both the counseling room and the counselor were also measured. In study 6.1, participants were asked to take part in a simulated consult with a counselor and were exposed to a photo of the counseling room. They interacted with the counselor by typing in their responses to questions that the counselor asked in video clips. Participants in a white room (as compared to a room with green walls) were found to disclose more information about themselves. Furthermore, they rated the room with white walls higher on professional quality and perceived the counselor in the white room as being more attractive and rated her higher on trustworthiness and expertness. This study demonstrated that the room in which counseling interviews take place plays a role in the counseling process. By affecting self-disclosure, it is suggested that the physical environment can influence the effectiveness of therapeutic treatment.

Understanding healing environments

Each of the empirical chapters provides evidence that confirms the propositions of our theoretical model (see figure 7.1), as proposed in chapter 1. Health-related effects of environmental stimuli were demonstrated in both field studies (music) and laboratory experiments (color, indoor plants). Music, wall colors, and indoor plants all appear to have beneficial effects. Moreover, several studies demonstrated the proposed mediating and moderating processes. Both cognitive and affective responses were shown to mediate the effects of environmental stimuli on stress. Study 3.1 showed that the stress-reducing effect of classical music was mediated by an affective response: patients' feelings of pleasure. In studies 4.1 and 4.2, the stress-reducing effects of indoor plants were mediated by a cognitive response: participants' perceived attractiveness of the room. Additionally, studies 5.1 and 5.2 demonstrated that the effects of wall color on stress and arousal were moderated by people's ability to screen out irrelevant stimuli.

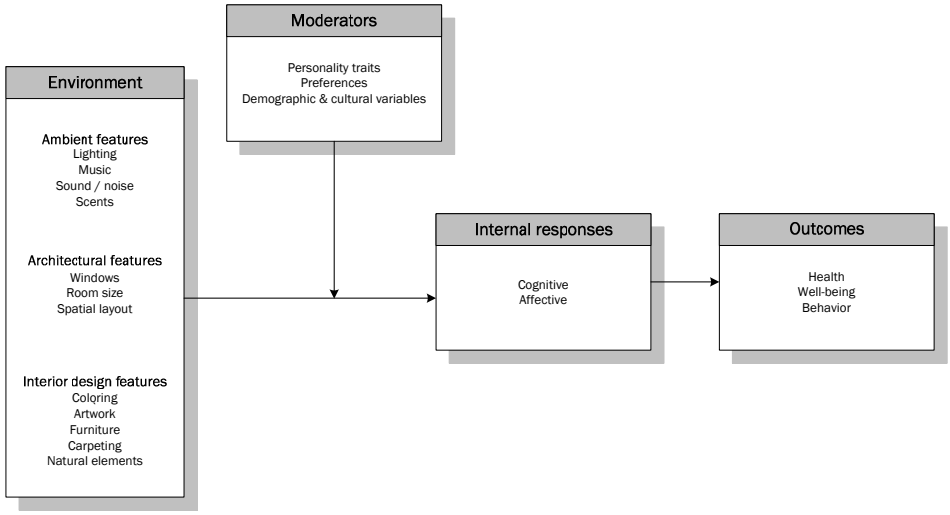

Figure 7.1 A framework for understanding healing environments

These results demonstrate and underline the importance of the physical environment in which healthcare encounters take place. The concept of healing environments received a large amount of attention in the last decade. There are several overviews of the existing evidence available and although these reviews differ in some respects (see chapter 1 for an overview of these reviews), they all come to the same overall conclusion: the physical environment in healthcare settings can influence patients' health and well-being. When examining the systematic review in chapter 2, it becomes clear that for a large variety of environmental stimuli, there is little evidence available. Furthermore, in most of the available research, how the beneficial effects came about remains unclear. Why are certain environmental stimuli capable of, for example, reducing stress?

In several of our studies, we focused on identifying mediating variables that can influence an important indicator of health and well-being: stress. Effects of music and indoor plants on stress were found to be mediated by affective and cognitive responses. The stress-reducing effects of music were mediated by feelings of pleasure (study 3.2) and the stress-reduction of indoor plants was caused by the perceived attractiveness of the room (studies 4.1 and 4.2). However, not all environmental variables will behave in the same fashion; some stimuli are more likely to be mediated by affective responses while other cues will stimulate cognitive processing (Michon & Chebat, 2004). As Russell and Snodgrass stated (1987, p. 252), "an environmental variable need not to relate to emotional behavior, physiological activation, affective appraisal, mood, and emotional experience in exactly the same way". The characteristics of the stimulus itself can possibly determine whether an effect is mediated by an initial cognitive or affective response or even causes a direct effect on health and behavior. Environmental stimuli can be distinguished based on the senses through which they have an effect on people. In our studies, we investigated the effects of visual and auditory stimuli, but the senses of smell, taste, and touch can also have an effect. According to Kopec (2006, p. 40), "a better understanding of the environmental stimuli related to the secretion, absorption, and interaction of neurochemicals may enable us to predict more precisely human behavioral responses to certain environments". It may be the nature of the stimulus that defines the mechanism through which people's feelings and actions are affected.

Patient groups or even individual patients may have different environmental needs (Rachid & Zimring, 2008). The framework of understanding healing environments also includes potential moderating variables. Variables such as gender, age, illness, and personality characteristics can all influence the relationship between the environment and health and well-being. In studies 5.1 and 5.2, we investigated the moderating effect of stimulus screening ability. The construct of stimulus screening ability may be a construct that varies with people's wellness (Mehrabian & Ross, 1979; Mehrabian, 1995) and might, thus, be of great importance in healthcare situations. Our research demonstrated that this personality trait moderated the relationship between wall color and stress or arousal. The main effect of wall color on health-related outcomes appeared to be marginal, but when people's stimulus screening ability is taken into account, the effects are larger. This result may partially explain why research on environmental coloring is still inconclusive and at times, even contradictory. It is advisable to include a measure of stimulus screening ability in future studies in order to control for an individual difference that is closely related to the way people perceive their surrounding environment. Hospitalization is generally associated with feelings of stress and anxiety (Newman, 1984). The feelings people experience when hospitalized are closely related to stimulus screening ability (Mehrabian, 1995). People's ability to screen out information could be impaired due to their medical condition, which suggests that the influence of the physical environment could be of greater importance in healthcare settings than in other settings.

Effects of the environment on patients can also occur because the medical professional is influenced by the environment. If the physician is in a better mood

because of a more pleasant work environment, this may result in more patience, attention, and empathy in interactions with patients and, thus, in higher quality interactions. This suggests that some environmental effects on patients may be indirect effects. Research in the field of counseling attempts to explain the effects of the environment on clients in such a manner (Miwa & Hanyu, 2006; Pressly & Heesacker, 2001). Study 6.1, which investigated the effects of environmental coloring in a counseling room, demonstrated that this can only be a partial explanation for environmental effects; the environment also directly influences clients. The video clips of the counselor used in this study were identical for the conditions, yet participants responded differently in the counseling environments. Thus, this effect must be directly caused by the counseling environment, regardless of counselor responses to the environment, and demonstrates that the environment also directly influences attitudes and behavior of clients.

Our theoretical framework can be placed in a larger context on variables that have an effect on patients' health outcomes. Such a working theory is needed in order to interpret the results of research on the influence of the physical environment (Rubin et al., 1998). Rubin et al. (1998) describe a model that includes four factors that determine clinical outcomes for patients. The first factor is the medical treatment provided, which includes technical and interpersonal aspects. The second factor consists of patients' personal characteristics, such as age and gender, but also personality traits. The third factor comprises the illness factors such as the stage of the disease. The last factor consists of the features of the physical environment. But, how does the physical environment interrelate with medical care, illness, and patient's attributes to influence health? The healthcare setting can either magnify or diminish the effects of medical interventions, causes of illness, and personal characteristics to influence the ultimate health outcomes (Rubin et al., 1998).

Limitations and directions for future research

The value of the studies in this dissertation is increased by the incorporation of a variety of healthcare settings and environmental stimuli, addressing diverse patient responses, emphasizing underlying mechanisms, and the use of both lab and field studies. These studies added to the evidence-base that is urgently needed in the field by providing evidence on effects of music, color, and indoor plants. Moreover, they shed light on the underlying mechanisms that explain the effects of the environment. However, it is also important to be aware of some limitations of these studies and the input they provide for future research in this field.

One might argue that the findings of the simulation experiments in this dissertation cannot be translated into actual healthcare settings. There is evidence available, however, that photographs can accurately simulate real environments and such studies show results similar to field experiments (Stamps, 1990; Bateson & Hui, 1992). A meta-analysis by Stamps (1990) demonstrated a 0.86 correlation between environmental preferences obtained by photographs and preferences obtained by exposure to real environments. In study 6.1, we demonstrated that a simulation study shows effects on a behavioral outcome measure, namely,

participants' self-disclosure. If exposure to an imaginary hospitalization and a photo of a hospital room is capable of generating such a clear effect, this may be promising for actual exposure of hospitalized patients. Even if these effects only appear to be moderate in actual healthcare settings, such simple and low-cost interventions may still be highly cost-effective.

Rather than actual health outcomes, stress was used as an immediate health-related measure. There is ample evidence available that stress is related to well-being and health outcomes (Kiecolt-Glaser, Marucha, Malarkey, Mercado & Glaser, 1995; Broadbent, Petrie, Alley & Booth, 2003; Christian, Graham, Padgett, Glaser & Kiecolt-Glaser, 2006), suggesting that stress can be used as an indicator of health and well-being. According to Cox (1985), the measurement of stress should focus on the individual's psychological state, as related to their perception of the environment and emotional reactions to it. The measurement of mood may offer one direct method of tapping the individual's experience of stress. For this purpose, Cox (1985) created the stress arousal checklist, the measure of self-reported stress used in most of our studies. This instrument describes the experience of stress in terms of several commonly used mood-describing adjectives. On the other hand, various researchers argue that stress should be measured physiologically (Ulrich et al., 1991; Baum et al., 1985). There is evidence, however, that these physiological measures are correlated with self-reported feelings of stress (Ulrich et al., 1991). A possible advantage of using physiological measures is that they allow for continuous monitoring of participants' responses. This continuous monitoring can provide insight into the development of the stress response and how much time it takes before exposure to a calming stimulus becomes effective and how long it takes before these effects diminish. This knowledge could also provide more insight into the exact mediating processes that take place in environmental influence. The mediation analyses in this dissertation have one limitation: the mediator and dependent variable were assessed cross-sectionally. A continuous measure of stress would enable analyses of time-dependent associations with possible mediators. The combined use of self-reported measures and physiological measures of stress can, thus, provide new insights and should be considered in future research.

Our systematic review (see chapter 2) demonstrated that there is little evidence available on the effects of specific environmental stimuli. There were no studies available that tested the effects of stimuli such as color, art, plants, and room size in isolation from other environmental stimuli. Other environmental stimuli have been studied in only one or two trials or in the context of renovation projects that studied a large variety of stimuli simultaneously. In order to contribute to the available evidence-base, we chose to study the effects of single environmental stimuli. According to Babin, Chebat and Michon (2004, p. 287), "perceived differences in even a *single* cue can potentially affect consumers' interpretations of the *entire* environment". People respond to their surrounding environment in a holistic manner. Individuals perceive discrete stimuli, but it is the total composition of all stimuli that determines their responses to the environment (Bitner, 1992). Possible interactions between environmental stimuli, thus, need further exploration in future research. Bitner (1992) even suggests that it may be necessary to vary

several environmental stimuli simultaneously to achieve an overall perception of the surrounding environment that will significantly influence behavior. However, in order to be able to predict the ways in which environmental stimuli can reinforce or weaken one another, the knowledge of single environmental stimuli is necessary.

We investigated the effects of different environmental stimuli: color, music, and indoor plants. All of these stimuli provide some form of distraction for patients. It gives them something to look at or listen to. It is possible that the mere effect of providing distraction explains the beneficial effects of these environmental variables found in the current studies. The most commonly accepted theory for explaining the beneficial effects of music is that it acts as a distracter by focusing the patient's attention away from a negative situation to something that is pleasant and encouraging (Nilsson, 2008). Distraction is one of the most important uses of cognitive-behavioral techniques to relieve pain (Tse, Ng, Chung & Wong, 2002), as suggested by the gate control theory (Melzack & Wall, 1965). As Melzack (1996) argued, cognitive processes have the property of modulating the spinal gating mechanism. A cognitive activity, such as distraction, can close this gate and prevent or modulate the sensation of pain (Melzack, 1996). In one study, we explicitly attempted to provide a similar level of distraction in the control condition. The control condition in study 4.1 consisted of the same room without indoor plants, but with a painting of a city. This painting was added to make sure that the indoor plants were not effective in reducing stress merely because they provided distraction. The assumption that this painting would generate a similar amount of distraction, however, was not tested. Moreover, the stress-reducing effects of indoor plants were mediated by perceived attractiveness. Perceived attractiveness can be seen as an indicator of the level of distraction provided. This suggests that distraction must be offered with positive stimuli; however, this may not necessarily be the case. The gate control theory suggests that any form of distraction can prevent sensations of pain. If any form of distraction is suitable to reduce stress in patients, a large variety of environmental stimuli may possess stress-reducing properties because they serve as distracters from negative feelings and experiences. This distraction hypothesis should, thus, be tested in future research.

Besides environmental stimuli functioning as a simple distraction, most of the environmental changes or additions studied in this dissertation differ from our image of healthcare settings' appearance. The typical hospital room has white walls and no indoor plants. Changing colors or adding indoor plants could create an environment that disconfirms our expectations. The prototypicality paradigm (Swan et al., 2003) can be seen as a special case of this disconfirmation of expectations. The physical environment of a facility can be more attractive and appealing than that of the typical facility such that the facility exceeds expectations, which should result in positive responses (Ward, Bitner & Barnes, 1992). Changing wall colors or adding interior plants to environments may create a situation that exceeds participants' expectations and, thus, results in favorable outcomes. However, study 6.1 found that a counseling room with white walls led to more positive outcomes than a room with green walls. These effects were explained by the perceived professional quality of the room and ratings of trustworthiness of the counselor. It could be that the white walls met the expectations of the participants, which shaped

their impressions of professionalism. This can be explained by the idea of processing fluency, which suggests that the ease of processing a stimulus increases liking (Reber, Schwarz & Winkielman, 2004). Consistent with this observation, prototypical stimuli are easier to process and as a consequence, evaluated more positively. According to the idea of processing fluency, the control conditions in the various studies should have led to more favorable responses. The concept of prototypicality can, thus, not exclusively account for our findings. However, future research should take into account the expectations with which participants encounter the healthcare situations.

The importance of a healthcare environment that promotes health and well-being is evident, but this healing environment should not negatively affect healthcare personnel (Dijkstra et al., 2006). The healthcare environment has different functions for the two main user groups, patients and healthcare personnel. Where the first group must recover as quickly as possible or adapt to specific acute and chronic conditions, the second group must work in this environment on a daily basis. The physical healthcare environment is part of the personnel's 'workscape'. This can make the environment an important determinant of job satisfaction, functionality, and judgments regarding functionality of the work environment. Work-related outcomes such as job satisfaction or employee well-being have been associated with work performance, productivity, and, ultimately, with the quality of healthcare (Lundstrom, 2002). In order to effectively build or renovate healthcare facilities, it is necessary to pay attention to the needs of both patients and healthcare personnel.

For the purpose of the current studies, the effects of the physical healthcare environment were studied in isolation from all other variables that could potentially impact health and well-being. Health and well-being are assumed to be influenced by facets of both the physical environment and the social environment (Stokols, 1992). Previous research demonstrated direct physiological effects of the physical environment on health (Rubin et al., 1998; Ulrich, Zimring, Quan & Joseph, 2004) and effects on healthcare staff (Ulrich et al., 2008). As discussed in the section on understanding healing environments, our framework must be placed in a larger context of variables that affect patients' health outcomes. Factors such as medical treatment, illness, and patient characteristics are all of importance in the healthcare process. The physical environment interrelates with these factors and can either magnify or diminish the effects of the other variables (Rubin et al., 1998).

Practical implications

Can physical environmental stimuli turn healthcare facilities into healing environments? There is evidence that underlines the potential impact of the physical environment on health and well-being. Several literature reviews are available that demonstrate the effects of environmental features on medical outcomes (Rubin et al., 1998; Ulrich et al., 2004). After appraising the available

research in a very critical manner (see chapter 2), there was still sufficient evidence that supports the concept of healing environments.
When staying in a more appealing hospital room, patients rated the attending medical professionals more positively and evaluated the food service and overall evaluation of the hospital more positively (Swan et al., 2003). Affective appraisals and satisfaction were higher in a redecorated waiting area as compared to a traditional waiting space (Leather et al., 2003). Depressed patients and patients with a first myocardial infarction had a shorter length of stay in sunny hospital rooms as opposed to dull rooms (Beauchemin & Hays, 1996; Beauchemin & Hays, 1998). Staying in patient rooms on the bright side of the hospital led to less stress, taking less analgesics, and marginally less pain (Walch et al., 2005), and the presence of windows and a natural view from a window had positive effects on clinical outcomes such as delirium and length of stay (Wilson, 1972; Ulrich, 1984).

Following our definition of environmental stimuli (see chapter 1), we investigated psychologically mediated effects of the environment. However, it is evident that the direct physiological effects of the environment also play an important role (Rubin et al., 1998; Ulrich et al., 2004). Together, these effects determine how the built healthcare environment affects patients and healthcare staff. Variables such as indoor air quality, infection control measures, and noise reducing interventions must be according to the required standard in order to deliver high quality medical care. For the purpose of our research, we assumed that the healthcare environment fulfills these standards and could be labeled as a *healthy* environment. Our research focuses on the additional effect the physical environment can play in the healing process, on how *healthy* environments can become *healing* environments. However, when designing healthcare facilities, it is evident that all aspects should receive adequate attention.

Environmental stimuli were classified into three categories, architectural (e.g., spatial layout, room size), ambient (e.g., scent, music), and interior design (e.g., color, indoor plants) features (Harris et al., 2002). Both the large majority of previous research and the studies in this dissertation investigated the effects of ambient and interior design features. These features can be changed relatively easy, even in existing healthcare environments. This suggests that adding some healing potential to existing facilities is possible with minor changes. Making changes in architectural features is far more complicated and this knowledge can only be used when designing new buildings or in large renovation projects. It is likely that this is the reason that the effects of architectural features have rarely been studied rigorously. It is very complicated to include a proper control condition that only differs on the architectural feature that is under investigation. With the development of virtual reality techniques, the knowledge of the impact of these features can more easily be studied.

The environmental interventions studied in this dissertation can all be described as relatively simple and low-cost interventions. Our research suggests that environmental factors that can be easily manipulated may have a considerable impact on health-related outcomes. It should be noted that most research in this dissertation consisted of simulation experiments. However, even if the effects

appear to be far more subtle in real healthcare settings, such simple and low-cost interventions may be highly cost-effective. In their review, Ulrich et al. (2004) concluded that many of the improvements suggested by evidence-based design are only slightly more expensive than traditional solutions. Painting the walls in a color will hardly be more expensive than painting those walls white.

A current trend in healthcare design is the creation of home-like environments. Several studies investigated the effects of renovation projects that aimed to create home-like environments (Holahan & Saegert, 1973; Olsen, 1984; Christenfeld et al., 1989). These studies simultaneously manipulated several environmental stimuli, such as furniture, decorations, wall colors, carpeting, artwork, and indoor plants. All of these stimuli are applied in order to create environments that appear less institutional and feel more like home. However, this does not necessarily lead to improved outcomes. Study 6.1 demonstrated that a counseling room with white walls led participants to disclose more information about themselves than a counseling room with green walls. Creating a less institutional atmosphere may have an effect on impressions of the professionalism of the medical professionals and the healthcare facility. For example, excessive colorfulness can be quickly unmasked as being cosmetic and lacking professional substance (Mahnke, 1996). The positive effects of white walls in study 6.1 are contradictory to other studies in the field of counseling that all suggest that the counseling room should be an intimate and beautiful environment. Moreover, the results of study 5.1 showed that white walls led to an increase of stress for low-screeners, as opposed to the hypothesized stress-reducing effect of the green walls. These results suggest that white might not be a neutral color and it may have distinct effects on people. Seemingly neutral environments may have both desired and undesired effects on patients.

Some patients even appear to prefer white walls in dental office settings. A study by Bare and Dundes (2004) showed that most respondents (89 percent) preferred the walls to be decorated. However, the few respondents who preferred white, unadorned walls were more likely to be anxious respondents (12 percent versus 3 percent of non-anxious respondents). This study demonstrated that respondents had clear preferences about desired attributes of a dental office. Environmental preferences can, thus, also be an interesting variable in explaining environmental effects. Preferences can be seen as an indicator of aesthetic judgment (Kaplan, 1988) and preferred environments are more likely to be restorative environments (Kaplan & Kaplan, 1989). This aesthetic judgment is closely related to the perceived attractiveness measured in studies 4.1 and 4.2. In those studies, we found that perceived attractiveness explained the stress-reducing effects of indoor plants. This implies that by basically making the environment more attractive and, thus, more preferred, it could become a healing environment. There are numerous ways to improve the attractiveness of healthcare facilities. Considering the fact that people generally prefer natural elements, the use of indoor plants seems to be a straightforward way to improve outcomes. People vary more in their preferences for other environmental stimuli, for example, color (Grossman & Wisenblit, 1999). The relationship between color and emotion was shown to be closely tied to color preferences (Kaya & Epps, 2004). This makes it more difficult to design a color

scheme that is universally attractive and, thus, preferred. Research also indicated that people cannot consistently produce a set of well-ordered preferences (Kahneman & Tversky, 1984). Nevertheless, preferences for a specific environmental stimulus can moderate the effects of the stimulus on health-related outcome measures. As Kaplan (1988) stated, "the cliché 'There is no accounting for tastes' implies that it is probably not very important to do so anyway". However, from the context of evolution, preferences guide behavior and learning (Kaplan, 1988). It might, thus, be advisable to consider the preferences of future users when designing healthcare facilities.

The effects of environmental stimuli appear to be context-dependent. Study 5.1 demonstrated that green walls in a hospital room are more beneficial to patients than white walls. However, study 6.1 demonstrated that in a counseling setting, white walls led to more favorable outcomes than green. It should be noted that both the setting and the outcome variable of interest are rather different. Study 5.1 investigated the effects of wall color on stress in a patient room, while study 6.1 focused on self-disclosure in a counseling setting. This suggests that environmental effects can be rather dependent on the context in which the healthcare encounter takes place. Environmental characteristic that generated positive effects in one setting should not be blindly applied to different contexts.

Moreover, the main outcomes of interest should be carefully defined when determining the physical appearance of a service. Some variables can be more useful in reducing stress, for example, by distracting patients from their feelings of fear and uncertainty. In other contexts, such as a counseling dialogue, distracting patients could have negative consequences. Furthermore, as a consequence of the healthcare context, the length of exposure to environmental stimuli greatly varies. People clearly spend less time in a waiting room than in a patient room in a hospital. Variables that are effective during short exposure in a waiting room are not necessarily effective during longer exposure times when a patient must remain in bed. Conversely, longer exposure times could also be beneficial. There is, however, no research available that investigated the effects of length of exposure.

It is evident that designers of healthcare facilities should be aware of the potential health impact of their design. However, while studies can document how the healthcare environment meets the needs of patients and staff, it is the designer's "skillful manipulation of solutions to the problems that becomes an art" (Malkin, 2008, p.75). The effects of a variety of environmental stimuli are established in research literature, but the skills of the designer will also determine how successful this knowledge can be implemented in designs. When designing healthcare environments, the architect must be aware of the fact that both patients and medical professionals are affected by the same environmental design.

The physical healthcare environment not only affects patients, but also the people that work in these environments, nurses and physicians. The healthcare environment has different functions for the two main user groups, patients and healthcare personnel. Traditionally, healthcare facilities were designed from a functional perspective (Ulrich, 1995). This emphasis shifted towards a perspective

of designing environments that are beneficial for patients. However, the designers of healthcare facilities should not neglect the perspective of the healthcare professionals. Creating home-like environments with many decorations, soft lights, and nice furniture could give patients a positive feeling, but at the same time it might make the work of the medical team more difficult. On the other hand, efficient and professional environments can be very useful for nurses and physicians, but patients may feel less comfortable. Ideally, the environment should support the needs and preferences of both groups simultaneously. According to Bitner (1992), the first step in purposeful design of service environments is to identify desirable behaviors of both groups. Healthcare organizations should be concerned with patient and staff behavior as well as the effects of the physical setting on patients' health and behavior, and the interactions between patients and staff.

Research demonstrated that the surrounding environment has a constant effect on the way people feel and behave. When we are in school, the environment plays a role in how we learn and it can even influence how well we learn (Wollin & Montagne, 1981). At work, the office environment determines our mood and can affect how well we perform on the tasks we must perform (Kwallek & Lewis, 1990). While shopping, the retail environment impacts which stores we choose to spend our money, how much money we will spend, and whether we are willing to return to the store (Turley & Milliman, 2000). When we visit our dentist or general practitioner, the ambiance of the waiting room can influence how stressed we feel (see chapter 3). If we are visiting a psychologist, the counseling room can have an effect on how much we disclose about ourselves (see chapter 6). If we are hospitalized, the patient room we will be admitted to may influence stress and arousal (chapters 4 and 5) and ultimately affect how much time we must spend there before being sent home (Ulrich, 1984).

Conclusion

The concepts of healing environments and evidence-based design are widely used, but a critical appraisal of the existing research demonstrated that there is little evidence available on psychologically mediated effects of the physical healthcare environment. Seven experiments, both lab and field studies, that added to this evidence-base were conducted. Moreover, these studies also shed light on the underlying processes that caused the environmental effects.

Stress-reducing effects were found for indoor plants and a painting of a tree in a hospital room, as well as for playing classical music in waiting rooms. The stress-reducing effects of indoor nature were caused by a higher perceived level of attractiveness of the hospital room. Classical music appeared to be stress-reducing by increasing patients' positive emotional state. Studies on the effects of wall color in patient rooms demonstrated that the same interior design can affect people rather differently depending on a personal characteristic. Moreover, designers should be aware of the possible desired or undesired effects that seemingly neutral environments might have on people. We also demonstrated that the physical

environment can affect actual health-related behavior. White walls (as opposed to green walls) in a counseling room lead participants to disclose more information about themselves. The room in which the counseling dialogue takes place plays a role in the counseling process and it can potentially influence the effectiveness of therapeutic treatment.

The research in this dissertation contributes to the growing body of evidence that the physical healthcare environment can make a difference in how quickly patients recover or adapt to specific acute and chronic conditions. Understanding specific environmental stimuli and their effects on health and well-being may facilitate atmospheric changes in an environment. In addition, a clearer understanding of the exact mechanisms involved is desirable before efficiently implementing such designs on a larger scale. Our results demonstrate that environmental factors that can be easily manipulated, that are relatively simple, and that are low-cost interventions may have a considerable impact on health-related outcomes.

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Samenvatting
(Summary in Dutch)

Situaties in de gezondheidszorg worden gekenmerkt door gevoelens van onzekerheid, angst en stress. Als u kijkt naar de omgevingen waarin deze gebeurtenissen doorgaans plaatsvinden, dan kunt u zich afvragen hoe goed deze zorgomgevingen beantwoorden aan de psychologische behoeften van patiënten. De meeste zorgomgevingen scheppen de voorwaarden om kwalitatief hoge medische zorg te kunnen bieden, maar hoe zit het met behoeften als ontspanning, comfort, en welbevinden van patiënten? Anno 2008 is een typische ziekenhuiskamer nog steeds wit geschilderd, is er nauwelijks decoratie aanwezig, en is deze ruimte minimaal gemeubileerd. Maar hoe kunnen zorgomgevingen ontworpen worden die geschikt zijn voor hoogstaande medische zorg en tegelijkertijd aangenaam zijn om te verblijven, zodat ze gezondheidsbevorderend werken in plaats van het gezondheidsproces te hinderen? Dergelijke omgevingen worden ook wel helende omgevingen genoemd, *healing environments*. Dit concept suggereert dat de fysieke zorgomgeving het verschil kan maken in hoe snel een patiënt herstelt of zich aan kan passen aan bepaalde chronische of acute condities.

De fysieke zorgomgeving kan gebruikt worden om tegemoet te komen aan hiervoor genoemde behoeften. Goed ontworpen zorginstellingen kunnen leiden tot positieve effecten op de gezondheid en het welbevinden van patiënten. In dit proefschrift is gekeken naar de effecten van de fysieke zorgomgevingen op gezondheid en welbevinden van patiënten, en is onderzocht hoe deze effecten tot stand komen. Deze kennis kan helpen in het efficiënter ontwerpen van healing environments.

Dit proefschrift begon met een systematische review (hoofdstuk 2) van het beschikbare onderzoek over effecten van de fysieke zorgomgeving op de gezondheid en het welbevinden van patiënten, met als doel het identificeren van de tekortkomingen in onze kennis over healing environments. Gebaseerd op de inzichten uit deze review, is een serie empirische studies uitgevoerd. Deze dragen bij aan de kennis over healing environments doordat ze laten zien dat verschillende aspecten van de fysieke omgeving, in diverse zorgomgevingen, effect hebben op gezondheid en welbevinden. De effecten van kleur, muziek en planten zijn onderzocht in de context van behandelruimten, wachtkamers, en patiëntenkamers. Naast het aantonen van omgevingseffecten, waren de studies gericht op het identificeren van de onderliggende mechanismen die deze effecten veroorzaken, alsook inzicht te verkrijgen in individuele verschillen met betrekking tot reacties op de fysieke zorgomgeving.

Hoofdstuk 2

In dit hoofdstuk is een systematische literatuurreview gerapporteerd dat een overzicht biedt van het beschikbare onderzoek op het gebied van healing environments. De review is uitgevoerd volgende de methode van de Cochrane Collaboration. Studies werden geincludeerd wanneer het interventies betrof die gericht waren op gezondheidseffecten van omgevingsstimuli op patiënten in zorgsettingen, en als het gecontroleerde klinische trials gepubliceerd in peer-reviewed tijdschriften betrof. Van de ruim 500 geïdentificeerde onderzoeken, waren er maar 30 die aan alle criteria voldeden en deze werden in de review opgenomen.

Dit kritische overzicht van methodologisch goede studies liet zien dat er voornamelijk positieve effecten gevonden werden voor zonlicht, ramen, geur, en meubelopstellingen. Inconsistente effecten werden gerapporteerd voor variabelen zoals geluid, natuur en spatial layout. Er werden geen studies gevonden die enkel het effect van kleur, planten, en kamergrootte onderzochten. Over het algemeen kan gesteld worden dat de grootte en de richting van de effecten sterk afhankelijk is van kenmerken van de patiëntenpopulatie en de context van de gezondheidssituatie. Studies die tegelijkertijd verschillende omgevingsvariabelen manipuleerden, lieten zien dat het algemene idee van de invloed van de fysieke zorgomgeving op het welbevinden van patiënten, bevestigd werd. Bewijs voor effecten van specifieke omgevingsvariabelen is zeer beperkt en moeilijk te generaliseren. De belangrijkste conclusie van deze review is dan ook dat het veld behoefte heeft aan gecontroleerde trials. Echter, het concept van healing environments blijft een veelbelovend veld voor toekomstig onderzoek.

Hoofdstuk 3

In hoofdstuk 3 zijn twee veldstudies gerapporteerd die het effect bestudeerden van muziek op stress en angst in wachtkamers. Blootstelling aan muziek is geassocieerd met positieve veranderingen in emotionele staat en cognitieve verwerking van mensen. Daarnaast is muziek ook een effectieve therapeutische interventie gebleken. Ondanks deze potentieel gunstige effecten, zijn er geen studies beschikbaar die het effect van muziek op angst en stress in de wachtkamer hebben onderzocht. De wachtkamer kan beschouwd worden als een geschikte ruimte om angstreducerende technieken toe te passen. Studie 3.1 liet zien dat het draaien van klassieke muziek in de wachtkamer van een tandarts resulteerde in minder angst en stress, alsook een hogere aantrekkelijkheid en professionele kwaliteit van de wachtkamer. Studie 3.2 gaf inzicht in het onderliggende proces dat de stressreducerende werking van klassieke muziek kan verklaren. De bevindingen van studie 3.1 werden tevens uitgebreid naar een andere setting. Deze tweede studie repliceerde de gunstige effecten van klassieke muziek in de wachtkamer van een huisarts. Daarnaast liet deze studie zien dat het kalmerende effect van klassieke muziek veroorzaakt werd doordat patiënten in een meer positieve emotionele staat waren na blootstelling aan klassieke muziek. Deze twee veldstudies lieten zien dat relatief eenvoudige en goedkope omgevingsinterventies de sfeer van een zorgomgeving kunnen veranderen en tot gunstige effecten voor patiënten kunnen leiden.

Hoofdstuk 4

Hoofdstuk 4 rapporteerde twee simulatie-experimenten over de vraag of de stressreducerende werking van omgevingsstimuli gemedieerd worden door een cognitieve respons, te weten de aantrekkelijkheid van een ruimte. Onderzoek naar herstellende omgevingen liet zien dat vooral natuurlijke settingen in staat zijn tot herstel van stress. Daarnaast hebben mensen een aangeboren neiging om aandacht te hebben voor en positief te reageren op natuurlijke elementen en

prefereren ze deze boven door de mens gecreëerde objecten. Gezien deze potentieel helende effecten van natuur, zou het blootstellen van patiënten aan natuurlijke elementen een effectieve manier zijn om stress te reduceren die gepaard gaat met hospitalisatie. De meeste zorginstellingen zijn gebouwd in stedelijke omgevingen en hebben daardoor een tekort aan natuurlijke elementen waaraan patiënten blootgesteld kunnen worden. Het introduceren van natuur in het ziekenhuis kan een goed alternatief zijn om stress te reduceren en daardoor het herstel te bevorderen.

Deelnemers in beide studies kregen een scenario gepresenteerd waarin beschreven werd dat ze opgenomen waren in het ziekenhuis met een mogelijke legionella-infectie (studie 4.1) of blindedarmontsteking (studie 4.2). Vervolgens werden ze blootgesteld aan een foto van de ziekenhuiskamer waarin ze opgenomen waren. Studie 4.1 liet zien dat het stressreducerende effect van planten gedeeltelijk gemedieerd werd door de waargenomen aantrekkelijkheid van de patiëntenkamer. Deze studie bevestigde de stressreducerende werking van natuurlijke elementen in de gebouwde omgeving. Daarnaast verklaarde deze studie het onderliggende mechanisme dat de stressreductie veroorzaakt. Dit medierende effect van een cognitieve respons werd gerepliceerd in een tweede studie. Studie 4.2 bevatte een nieuwe conditie, een schilderij van een boom, om te onderzoeken of blootstelling aan 'onechte' natuur kon leiden tot vergelijkbare stressreducerende effecten. Deze tweede studie liet zien dat niet alleen planten, maar ook een schilderij van een boom stress reduceert. Zowel echte planten als een natuurlijke afbeelding bleken het concept van natuur te activeren. Deze twee studies lieten zien dat blootstelling aan zowel planten als aan een schilderij met een boom resulteerde in minder stress. Daarnaast werd er inzicht verkregen in het onderliggende mechanisme dat de stressreductie veroorzaakt. Natuur in een ziekenhuiskamer vermindert stressgevoelens door een verhoogde aantrekkelijkheid van de kamer.

Hoofdstuk 5

Hoofdstuk 5 liet zien dat hetzelfde interieur een verschillende werking op mensen kan hebben, afhankelijk van een persoonlijkheidskenmerk. Twee studies richtten zich op het modererende effect van een persoonlijkheidstrek, te weten stimulus screening ability. Het belang van individuele verschillen in omgevingen is al lang benadrukt, maar er is weinig onderzoek beschikbaar dat dit ondersteunt. Hierom is in twee simulatie-experimenten het modererende effect van stimulus screening ability bestudeerd op effecten van muurkleur op stress en arousal in een patiëntenkamer. Kleur is een belangrijke variabele in interieurdesign, aangezien het op relatief eenvoudige wijze de sfeer van een ruimte kan veranderen. Er is een aanzienlijke hoeveelheid fundamenteel onderzoek over kleureffecten beschikbaar, maar toegepast onderzoek over kleur als omgevingsvariabele is beperkt, vooral in zorgomgevingen. Daarnaast blijken resultaten van kleurenonderzoek niet altijd consistent en soms zelfs met elkaar in tegenspraak te zijn. Een mogelijke verklaring ligt in de manier waarop individuen hun omgeving waarnemen en verwerken. Dit wordt ook wel beschreven als het vermogen om irrelevante informatie in een

omgeving te filteren, stimulus screening ability. Individuele verschillen in de gevoeligheid voor omgevingsstimuli hebben niet veel aandacht ontvangen.

In twee experimenten kregen deelnemers een scenario gepresenteerd waarin beschreven werd dat ze opgenomen waren in het ziekenhuis met een blindedarmontsteking, waarna ze blootgesteld werden aan een foto van de patiëntenkamer waarin ze opgenomen waren. Experiment 5.1 vergeleek het effect van witte en groene muren op stress; studie 5.2 vergeleek oranje en witte muren en keek naar effecten op arousal en cognitieve waardering van de ruimte. De resultaten lieten zien dat het stressreducerende effect van groen en het arousalinducerende effect van oranje meer benadrukt waren bij mensen die laag scoorden op stimulus screening ability dan voor degenen die effectief de complexiteit van de omgeving konden reduceren. Deze resultaten kunnen helpen verklaren waarom eerder kleurenonderzoek geen eensluidende resultaten laat zien.

Hoofdstuk 6

De studie in hoofdstuk 6 laat zien dat de fysieke zorgomgeving effect kan hebben op daadwerkelijk gezondheidsgerelateerd gedrag. Deze studie onderzocht de effecten van muurkleur in een spreekkamer op zelfonthulling. De meeste studies die effecten van de fysieke omgeving in de psychiatrie onderzochten, hadden betrekking op gemeenschappelijke ruimten zoals woonkamers. Er is weinig onderzoek beschikbaar naar effecten van de spreekkamer. Studies lieten zien dat de fysieke omgeving effect kan hebben op therapeutisch relevante processen, maar er waren geen studies die het effect van kleur in de spreekkamer onderzochten. Zelfonthulling wordt gezien als een belangrijke component in het therapeutische proces en was daarom gekozen als belangrijkste uitkomstmaat, daarnaast werd de indruk van de spreekkamer en de behandelend psycholoog gemeten. In studie 6.1 werd de respondenten gevraagd om deel te nemen aan een gesimuleerd consult met een psycholoog en werden ze blootgesteld aan een foto van de spreekkamer. Ze interacteerden met de psycholoog door hun reacties op de vragen die de psycholoog in filmpjes stelde, in te typen. Deelnemers in de witte kamer (in vergelijking met een kamer met groene muren) vertelden meer over zichzelf. Daarnaast vonden zij de ruimte met witte muren professioneler en vonden ze de psycholoog aantrekkelijker, betrouwbaarder, en meer ervaren. Deze studie liet zien dat de ruimte waarin het counseling interview plaatsvindt, een rol kan spelen in het therapeutisch proces. Het effect op zelfonthulling suggereert dat de fysieke omgeving invloed kan uitoefenen op de effectiviteit van het therapeutische proces.

Algemene conclusie

De concepten *healing environments* en *evidence-based design* worden veel gebruikt, maar een kritisch literatuuroverzicht liet zien dat er tot voor kort weinig overtuigend bewijs beschikbaar was voor psychologisch gemedieerde effecten van de fysieke zorgomgeving. Zeven experimenten, zowel veld- als labstudies, zijn

uitgevoerd om bij te dragen aan dit bewijs. Daarnaast geven ze inzicht in de onderliggende processen die omgevingseffecten veroorzaken.

Stressreducerende effecten werden gevonden voor planten en een schilderij met natuurlijke afbeelding in een patiëntenkamer, alsook voor het draaien van klassieke muziek in wachtkamers. De stressreducerende effecten van natuurlijke elementen werden veroorzaakt door een hogere aantrekkelijkheid van de ruimte. Klassieke muziek bleek stress te reduceren door patiënten in een meer positieve emotionele stemming te brengen. Studies die keken naar het effect van muurkleur op patiënten in een ziekenhuiskamer lieten zien dat hetzelfde interieur een verschillende werking op mensen kan hebben, afhankelijk van een persoonlijkheidskenmerk. Daarnaast moeten ontwerpers zich bewust zijn van de gewenste en ongewenste effecten die schijnbaar neutrale omgevingen kunnen hebben. Ook hebben we laten zien dat de fysieke omgeving effect heeft op daadwerkelijk gezondheidsgerelateerd gedrag. Witte muren (vergeleken met groen muren) in een spreekkamer leiden tot meer zelfonthulling. De kleur van de ruimte waarin het psychologisch consult plaatsvindt, speelt een rol in het therapeutische proces en kan mogelijk de effectiviteit van de behandeling beïnvloeden.

Het onderzoek in dit proefschrift draagt bij aan een groeiende hoeveelheid bewijs dat de fysieke zorgomgeving een verschil kan maken in hoe snel patiënten herstellen of zich aanpassen aan specifieke acute of chronische condities. De kennis over omgevingskenmerken en het effect op gezondheid en welbevinden kan helpen om de sfeer in een omgeving effectief te verbeteren. Daarnaast is een beter begrip gewenst van de onderliggende processen, voordat we deze kennis efficiënt kunnen implementeren op grote schaal. Onze resultaten laten zien dat omgevingsfactoren die eenvoudig gemanipuleerd kunnen worden en weinig kosten, een aanzienlijk effect hebben op gezondheidsgerelateerde uitkomsten.

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