



## Health effects of viewing landscapes – Landscape types in environmental psychology

M<sup>a</sup>.D. Velarde<sup>a,\*</sup>, G. Fry<sup>b</sup>, M. Tveit<sup>b</sup>

<sup>a</sup>School of Experimental Sciences and Technology, Rey Juan Carlos University of Madrid, C/Tulipan s/n, 28933 Móstoles, Madrid, Spain

<sup>b</sup>Department of Landscape Architecture and Spatial Planning, Norwegian University of Life Sciences, PO Box 5003, N-1432 Aas, Norway

---

### Abstract

The visible landscape is believed to affect human beings in many ways, including aesthetic appreciation and health and well-being. The aim of this paper is to analyse the range of landscapes used in environmental psychology studies, and the evidence of health effects related to viewing these landscapes. A literature review of publications linking landscapes and health effects was conducted. This reported evidence of health and well-being effects related to exposure to visual landscapes. The results of the review include an overview of the types of landscape used in the studies, the evidence on health effects, the methods and measures applied and the different groups of respondents. The analysis reveals a predominance of studies using only coarse categories of landscapes. Most landscape representations have been classed as “natural” or “urban”. Few studies were found to use subcategories within these groups. Generally, the natural landscapes gave a stronger positive health effect compared to urban landscapes. Urban landscapes were found to have a less positive and in some cases negative effect on health. Three main kinds of health effects have been identified in the study; short-term recovery from stress or mental fatigue, faster physical recovery from illness and long-term overall improvement on people’s health and well-being.

The study provides an overview of the relationships between health and landscapes arranged in an accessible format, identifying gaps in our knowledge requiring further research. The identification of quantifiable landscape attributes that affect health is seen as an important factor in enabling future landscape design to be of benefit to human health.  
© 2007 Elsevier GmbH. All rights reserved.

**Keywords:** Evidence-based; Healing; Nature; Restoration; Therapeutic

---

### Introduction

The links between landscape and health are increasingly recognized as important in research and at the policy level. The European Landscape Convention (Council of Europe, 2000, p. 2) aims to promote landscape protection, management and planning, considering landscape as

“a key element of individual and social well-being”. The World Health Organization (1946, p. 1) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. This understanding of landscape and health provides the background for our approach to investigating the evidence for the role of exposure to the visual landscapes for individual and social health and well-being. Our definition of health effects reflects the broad health definition of the WHO, encompassing effects on physical, mental and

---

\*Corresponding author.

E-mail address: [mariadolores.velarde@urjc.es](mailto:mariadolores.velarde@urjc.es) (M<sup>a</sup>.D. Velarde).

social well-being. Society is facing increasing challenges with stress-related diseases, and knowledge about the way the visual landscape affects health and well-being can help mitigate stress and increase restoration. Knowledge about how different landscapes and landscape elements contribute to health improvement is needed to provide new design solutions beneficial to human health.

Links between landscape and health have been observed for a long time and in many different cultures and societies. The belief that viewing vegetation, water and other natural elements can ameliorate stress and is beneficial for patients in healthcare environments dates as far back as the earliest large cities in Persia, China and Greece. In the Middle Ages, the first hospitals in Europe were infirmaries in monastic communities where a cloistered garden was an essential part of the environment used to bring relief to the ill (Cooper-Marcus and Barnes, 1999; Ulrich, 2002).

Through history, the connection between nature and healing was gradually superseded by increasingly technical approaches and the idea that access to nature could assist in healing lost much of its significance (Cooper-Marcus and Barnes, 1999; Ulrich, 2002). However, in the last 25 years these traditional ways of linking nature and health effects have re-emerged as a topic of interest in the field of human health. Research has generated a relatively rich literature to explain the ways in which natural and other environments have an effect on human health.

A range of theories and approaches have been forwarded in order to explain and assess the influence of landscapes on human health. Contemporary theories, such as Ulrich's "Stress Recovery Theory" (Ulrich, 1984, 1999), predict that natural scenes tend to reduce stress, whereas settings in the built environment tend to hinder recovery from stress. Researchers have provided possible explanations for this relationship. Evolutionary theories of landscape preferences explain the benefits of natural scenes as reflecting landscape qualities that satisfy human biological needs. Researchers within environmental psychology have evaluated whether the restorative effect of natural landscapes is one of the reasons why people prefer natural landscapes over urban ones (e.g., Hartig and Staats, 2006; Van den Berg et al., 2007). Other authors suggest that people have a more general innate bond with nature, implying that certain kinds of contact with the natural world may be directly beneficial to health (Kellert and Wilson, 1993).

One of the research approaches relating to health effects of landscapes is known as "Healing Gardens". If the view from a hospital window is important in terms of improving recovery (Ulrich, 1984) then the design of hospital gardens becomes a new and significant topic. This topic has been investigated in recent studies of gardens and parks, particularly those around hospitals

and residential areas. Such studies assess whether healing gardens aid restoration from stress and improve comfort and well-being (Stigsdotter and Grahn, 2002; Ulrich, 2002; Stigsdotter, 2004; Ottosson and Grahn, 2005; Sherman et al., 2005).

As a result of more than 20 years of research, Rachel and Stephen Kaplan developed the Attention Restoration Theory that describes the restorative effect of natural environments on human mental fatigue (Kaplan and Kaplan, 1989). "Restoration" has been defined as "the process of renewing physical, psychological and social capabilities diminished in ongoing efforts to meet adaptive demands", i.e. not only attentional (Hartig, 2004, p. 2). Kaplan and Kaplan (1989) examined the factors that make a restorative experience more likely. Natural environments are thought to be especially effective as restorative settings, as they usually possess the key factors in achieving restoration. Kaplan (2002) describes the "Attention Restoration Theory" in terms of the central role of attention and attention fatigue in determining quality of life.

Another approach to studying health effects of landscapes relates to the concept "Therapeutic Landscapes". This is linked to the idea of place identity, and to the use of particular places for the maintenance of health and well-being. The concept was introduced at the beginning of the 1990s by the health/medical geographer Gesler (1992), who employed an expanded definition of the concept of landscape taken from cultural geography with the aim of exploring the positive, healing or therapeutic characteristics of place (Williams, 1999; Gesler, 2005).

The terms "healing" or "therapeutic" generally refer to a beneficial process that promotes overall well-being. According to Cooper-Marcus and Barnes (1995) they are used to describe either one or a mixture of the three following processes: relief from physical symptoms, illness or trauma (e.g., a recovering postoperative patient); stress reduction and increased levels of comfort for individuals dealing with emotionally and/or physically tiring experiences; and an improvement in the overall sense of well-being.

The term "therapeutic landscape" has traditionally been used to describe landscapes with "enduring reputation for achieving physical, mental and spiritual healing" (Gesler, 1993). Research focused on places that had achieved this reputation for healing such as Lourdes, Bath or the Navajo territory (Gesler, 1996, 1998; Dobbs, 1997) but the concept is being adapted and expanded to cover not only healing places, but places that promote well-being and maintain health with the goal of analysing what it is that influences visitor experience (Palka, 1999; Williams, 1999).

Environmental perception is clearly multi-sensory, and not restricted to vision. However, vision is by far our most important sense in terms of yielding

information about outdoor environments (Ulrich, 1979). A significant part of the satisfaction derived from nature does not require being in the natural setting, but rather having a view of it. Several studies that have shown health benefits related to experiencing nature have been based on opportunities for noticing and observing it, rather than on performing activities in nature (Kaplan, 1992).

Health effects related to exposure to natural environments have received much focus in the literature, and not only for positive aspects. The field of environmental health has focused broadly on overcoming negative health effects of nature, (e.g., exposure to poisonous plants and animals, natural disturbances such as storms, floods and avalanches and dangerous landscapes such as cliff edges or deserts), and investigating the interaction between health hazards in the physical environment and individual risk factors for a range of diseases, physical disorders, allergies, or accidental injuries (Frumkin, 2003, 2005; Morris, 2003).

Such collateral effects related to being in the landscape will not be assessed in this paper. Our study focuses on the effects of visual exposure to landscapes. Some of the reported studies use methods and designs including accessing nature, but with emphasis on the visual aspects of the experience. However, this paper includes only studies where the differences in treatment lie in exposure to different landscapes and not in different tasks or actions performed by the survey participants (e.g., a walk in nature versus a walk in an urban setting is included, but a walk in nature versus staying inside is outside the scope of this study). In studies dealing with greenery in residential areas, air quality might influence well-being as well as visual aspects, but in those studies considered here, the visual is considered the main focus in the analysis. Studies of health effects of plants in an indoor-setting are not included in the review.

## Aims and objectives

Our study aims to identify the landscape and scene types used in environmental psychology studies of their effects on human health and well-being. The need for studies relating visual characteristics of environments to psychological and physiological well-being, work satisfaction and so forth was stated by Ulrich (1979). We aim to investigate what we know and do not know regarding the physical attributes of landscapes important for human health. The approach contributes to the theoretical basis for landscape design beneficial to human health, and is a starting point for further research on the relationship between different elements and patterns in the visual landscape and human health and well-being.

A literature review was conducted to provide the following information:

- the landscape types used in studies;
- the reported health effects of viewing landscapes;
- the methods used and measures applied to assess health effects;
- the characteristics of respondents that have been studied.

## Method

We reviewed the major ecology, health and psychology journals, using the full text electronic access at the Norwegian University of Life Sciences library, which subscribes to more than 3800 journals, including those from BioOne, Blackwell, Oxford, Science Direct, Springer, Elsevier and Academic Press. Hard copies were requested through the Library when not available electronically. The majority of the sources are peer-reviewed journal papers, although supplemented by books and conference proceedings presenting original research.

Only articles presenting evidence of health effects related to viewing landscapes are reported in this paper. The literature reviewed covered a much broader scope, including review and analytical papers, but our main focus was to identify the different landscape types assessed in the studies and the reported health effects linked to visual exposure to these. The differences in landscape types were not necessarily the research focus in the original studies. The visual exposure includes active viewing in the majority of the studies, however some relate to availability of visual landscape stimuli rather than active viewing (e.g., Maas et al., 2006). More than 100 articles have been reviewed in detail, of which 31 were found to present evidence of health effects of landscape views. Summary tables and figures organised according to the research objectives provide an overview of the findings (see Tables 1 and 2 and Figs. 1–4).

In the review, each article was logged in a database using the following headings:

- *Categories of landscapes*: this described the content of the landscapes in the categories of natural/urban and landscape/no-landscape in the reviewed papers.
- *Reported health effects*: the effects recorded for the different landscape categories in each study.
- *Kind of stimulus*: the landscape stimulus used in the studies (window view, video, photographs, and presence of nature in residential area, etc.).
- *Method*: how the study was conducted.
- *Measures*: how health effects were measured.
- *Groups of respondents*: who the participants were (general public, students, and hospital patients, etc.).

All papers used included data on authors and the country where the study took place. This provided

**Table 1.** Findings from the literature review: categories of landscapes and reported health effects<sup>a</sup>

No.	Authors	Categories of landscapes compared	Reported health effects
1	Ulrich (1979)	<b>Nature (in roman) versus urban (in italics)</b> Nature scenes; dominated by green vegetation including cultivated fields <i>Urban scenes; commercial landscapes and industrial areas</i>	Improved well-being and reduced anxiety: increased positive affect factors and reduced fear arousal factor. <i>Increase in sadness, decline in attentiveness.</i>
2	Moore (1981)	Rolling farmland and trees  <i>Prison courtyard</i>	Stress reduction compared to prisoners viewing prison courtyard. <i>Prisoners viewing prison courtyard had a 24% higher frequency of sick-call visits, compared to those viewing farmland.</i>
3	Ulrich (1984)	Natural scene; trees  <i>Brick building wall</i>	Shorter post-operative hospital stays, lower scores for minor post-surgical complications, received fewer negative comments in evaluative nurses' notes and took fewer strong analgesics than the patients looking at brick wall. <i>Longer post-operative hospital stays, higher scores for minor post-surgical complications, higher frequency of negative evaluative comments from nurses' notes, higher number of doses of strong analgesics than patients looking at natural scene.</i>
4	Laumann et al. (2001)	Nature scenes: forest with lakes and creeks; park with various plant species and artificial creek; sea area with coastline, grass, cows and birds; mountain with snow and ice  <i>Urban scene: major pedestrian street, bus/train station, rush hour</i>	Restorative effect: environments with nature elements generally scored higher rating scale measures of restoration than city environments.  <i>Restorative effect: city environment scored lower rating scale measures than natural environments.</i>
5	Hartig et al. (2003)	Natural environment: tree views/nature reserve (1600 ha of vegetation and wildlife)  <i>No view/urban environment with medium density professional office and retail development</i>	Reduced stress and improved mood: reduced stress levels/lower blood pressure. Increase in positive affect and decrease in anger/aggression. <i>Increase in blood pressure, reduced positive affect and increased anger/aggression.</i>
6	Laumann et al. (2003)	Natural environment: waterside/coast environment with grazing cows  <i>Urban environment: pedestrian street, bus station, streets with traffic</i>	Restorative effect: lower heart rate than subjects who watched the urban environment. <i>Higher heart rate than the group watching the natural environment.</i>
7	Staats et al. (2003)	Natural environment; dense and open forest, path, no people  <i>Urban environment; inner city, shopping streets, traffic, residential areas, urban park, people</i>	Attentional fatigue gave higher preference for the natural environment over the urban environment. <i>Attentional fatigue gave lower preference for urban environment.</i>
8	Tennessen and Cimprich (1995)	Natural or mostly natural view (trees, grass, bushes and/or lakes, no evidence of human influence)  <i>Built or mostly built view (city street, other buildings, brick wall)</i>	Natural views gave higher scores on directed attention than built views. Natural views had no effect on mood state. <i>Built views gave lower scores on directed attention than natural views.</i>

**Table 1.** (continued)

No.	Authors	Categories of landscapes compared	Reported health effects
9	Kaplan et al. (1988, reported in Kaplan, 1993)	View including natural elements  <i>No view or view without natural elements</i>	Fewer ailments and higher job satisfaction with nature in view.  <i>Higher number of ailments and lower job satisfaction among workers with no view or view without nature than among workers with nature in view.</i>
10	Kaplan (1993)	View including natural elements  <i>View without natural elements</i>	Availability of nature in the view strongly affected satisfaction and restorative ratings; less frustration and more patience, higher enthusiasm and life satisfaction as well as overall health.  <i>No view or no access gave lower values of satisfaction and restorative ratings.</i>
11	Grahn et al. (1997)	School playground with high degree of naturalness  <i>School playground with low degree of naturalness</i>	Fewer sick-days, fewer attentional problems, fewer concentration problems, improved motor function.  <i>Higher number of sick days, attentional problems, higher degree of concentration problems and lower motor function than children playing in "natural" playground.</i>
12	Parsons et al. (1998)	<b>Subcategories of nature (in roman) and urban (in italics)</b> Natural scenes; forest (1) and golf (2)  <i>Urban scenes; mixed residential and light development (1) and urban (2)</i>	Inter-beat interval: golf more complete recovery than urban (passive stressor). Blood pressure: forest and mixed more complete than urban (passive stressor). Golf quicker recovery than urban (passive stressor), urban quicker recovery than golf (active stressor). Skin conductance level: golf more complete recovery than others. Immunization: forest/golf less responsive than mixed/urban. Facial electromyography (EMG) activity; forest greater than others.  <i>Skin conductance level: urban greater than others. Urban slower recovery than mixed.</i>
13	Ulrich et al. (1991)	Natural scene: vegetation and vegetation with water  <i>Urban scenes; with light or heavy traffic, few or many pedestrians (mall)</i>	Lower fear and anger, higher levels of positive affects and intake/attention, faster and more complete recovery, greater stress reduction heart period deceleration (non-significant differences between scenes with and without water).  <i>Slower and less complete recovery, lack in recovery in pulse transit time (PTT) for traffic environments, heart period acceleration. The traffic settings produced more recuperation than did the pedestrian mall exposures.</i>
14	Ulrich (1981)	Nature scenes; dominated by vegetation including cultivated fields  Nature scenes with water  <i>Urban scenes; commercial landscapes and industrial areas</i>	Positive influence on psycho-physiological state; significantly higher alpha; positive influence on emotional state.  Positive influence on psycho-physiological state; significantly higher alpha; particularly positive influence on emotional state.  <i>Less positive influence on psychophysical state; lower alpha, less positive influence on emotional state.</i>
15	Herzog and Chernick (2000)	Natural scene: field/forest with high and low degree of openness  <i>Urban scenes with high and low degrees of openness</i>	Higher tranquillity, lower feeling of danger.  <i>Lower tranquillity, higher feeling of danger.</i>

**Table 1.** (continued)

No.	Authors	Categories of landscapes compared	Reported health effects
16	Lohr and Pearson-Mims (2006)	Urban background with trees with varying canopy form (spreading, rounded and conical)	Positive emotional responses to urban with trees versus urban with inanimate object. Lower blood pressure and positive emotional response to trees with spreading shape compared to trees with rounded or conical forms. Positive response and lower blood pressure when viewing dense canopies. No significant differences in skin temperature or blood pressure when seeing trees than when viewing scenes with inanimate objects. <i>Urban with inanimate object less positive response versus urban with trees.</i>
17	Staats et al. (1997)	Forest landscapes of different density (dense versus half open) and accessibility (path versus interrupted path)	Higher pleasure for higher accessibility, no significant difference related to density, indication that low density gave rise to more pleasure.
18	Van den Berg et al. (2003)	Park-like forest area with and without creek	Restoration; higher happiness, lower stress, anger, depression and tension. Improved mood and concentration. No difference was detected between environments with and without water. <i>No affective restoration with respect to overall happiness and stress. Less restoration with respect to depression, anger and tension.</i>
19	Heerwagen (1990)	<b>Landscape (in roman) versus no view (in italic)</b> Painting of natural scene; distant mountains, sunset, clustered trees and open grassy areas, path (mystery)	Stress reduction: patients felt calmer and less tense in the mural condition than in the plain waiting room. The restorative benefits of the nature scene were evident both in heart rate data and self-reports of emotional states. <i>Patients watching white wall had higher heart rate increase during waiting period, were feeling less calm and more tense than patients watching landscape painting.</i>
20	Nakamura and Fujii (1992)	Hedge <i>Concrete block fence</i>	Relaxing effect: the EEG data supported the conclusion that the greenery elicited relaxation. <i>Watching the concrete block fence brings sensory stress.</i>
21	Ottosson and Grahn (2005)	Garden, with old fruit trees and a variety of flower species	Increased powers of concentration after resting in a garden outside the geriatric home, compared to that after resting indoors in their favourite room. The results did not show any effects on blood pressure or heart rate. <i>Lower power of concentration after resting inside (in favourite room) compared to resting in garden.</i>
22	Diette et al. (2003)	Nature scene; mountain stream in spring meadow, plus nature sound <i>Without any scene or sound</i>	Significantly reduced pain for the participants exposed to nature scene and sound. No difference in mean level of anxiety. <i>Control group reported higher levels of pain. No difference in mean level of anxiety.</i>
23	Kuo et al. (1998)	<b>Range of greenery</b> Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4)	Stronger social ties, higher sense of safety and adjustment. <i>Weaker social ties, lower sense of safety and adjustment than residents with higher degree of greenery.</i>

**Table 1.** (continued)

No.	Authors	Categories of landscapes compared	Reported health effects
24	Kuo and Sullivan (2001a)	Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4)	Less aggressive behaviour, fewer crimes reported to the police (both property crimes and violent crimes) than in areas without greenery.  <i>More aggressive behaviour, more crimes reported to the police (both property crimes and violent crimes) than in areas with greenery.</i>
25	Kuo (2001)	Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4)	Lower mental fatigue: residents with nearby nature were more likely to be able to deal with the major issues of their lives. Such residents felt more hopeful and less helpless about the issues facing them.  <i>Higher mental fatigue: residents without nearby nature were less likely to be able to deal with the major issues of their lives. Such residents felt less hopeful and more helpless about the issues facing them.</i>
26	Taylor et al. (2002)	Amount of window view of nature (0–4 scale)	Improved self-discipline in inner city girls: For girls, view accounted for 20% of the variance in scores on the combined self-discipline index. For boys, view from home showed no relationship to performance on any measure.  <i>Lower self-discipline ratings for girls with less greenery in the window view.</i>
27	Stigsdotter (2004)	Workplace greenery; four levels from no view of and no access to garden to view of and access to garden at workplace	View or access to garden gave improved comfort, pleasure and well-being (“trivsel” in Swedish) and lower stress levels.  <i>No view or no access gave lower values of comfort, pleasure and well-being (trivsel) and higher stress levels than employees with access to or view of garden.</i>
28	Maas et al. (2006)	Amount of green space within a radius of 1 km and 3 km from residence	Better perceived general health – higher amount of green space.  <i>Worse perceive general health – lower amount of green space.</i>
29	Leather et al. (1998)	Percentage of the view from window with rural elements (trees, vegetation, plants, and foliage)	A view of natural elements was found to buffer the negative impact of job stress, intention to quit and a marginal positive effect on general well-being.  <i>Higher stress values; lower job satisfaction, higher intention to quit when no or low percentage of rural view.</i>
30	Wells (2000)	Amount of nature in window view (different rooms in the house) on a naturalness scale 1–5. Yard material; 4 naturalness categories	Higher naturalness score post-move gave better cognitive functioning.  <i>Lower naturalness score on the view from the window related to lower cognitive functioning.</i>
31	Kuo and Sullivan (2001b)	Varying levels of nature (trees and grass) surrounding public housing (scale 0–4)	Residents in buildings with nearby nature had lower levels of mental fatigue and reported less aggression and violence.  <i>Residents in buildings without nearby nature had higher levels of mental fatigue and reported higher levels of aggression and violence.</i>

<sup>a</sup>Note that rows in roman show positive effects whereas rows in italics show less positive or negative effects

a quick overview of the existing evidence for health effects of viewing landscapes, as well as helping identify areas of knowledge requiring further empirical evidence.

We use the word “landscape” as defined by the European Landscape Convention: “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000, p. 3).

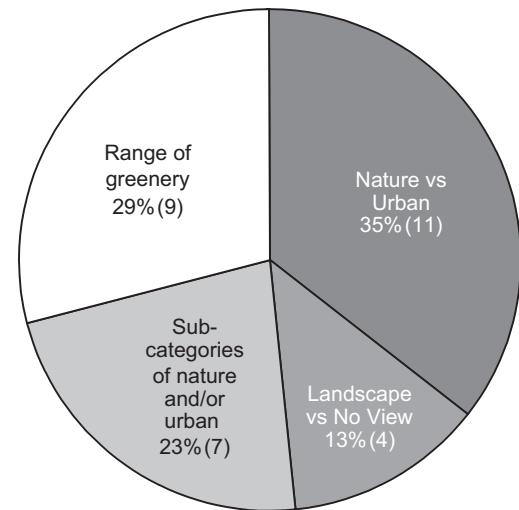
## Results

The findings from the literature review are summarised in Table 1.

### Landscape categories assessed in nature and health research

Through the literature review, we have identified the landscape categories assessed in studies of health effects of viewing landscapes; 48% assessed two contrasting categories of landscapes, natural versus urban or landscape versus no view (e.g., white wall); 29% of the

studies applied different levels of greenery, assessed as a percentage of the view from a window or estimated on a five-point scale; 23% of the studies reviewed applied subcategories within the urban or natural landscape

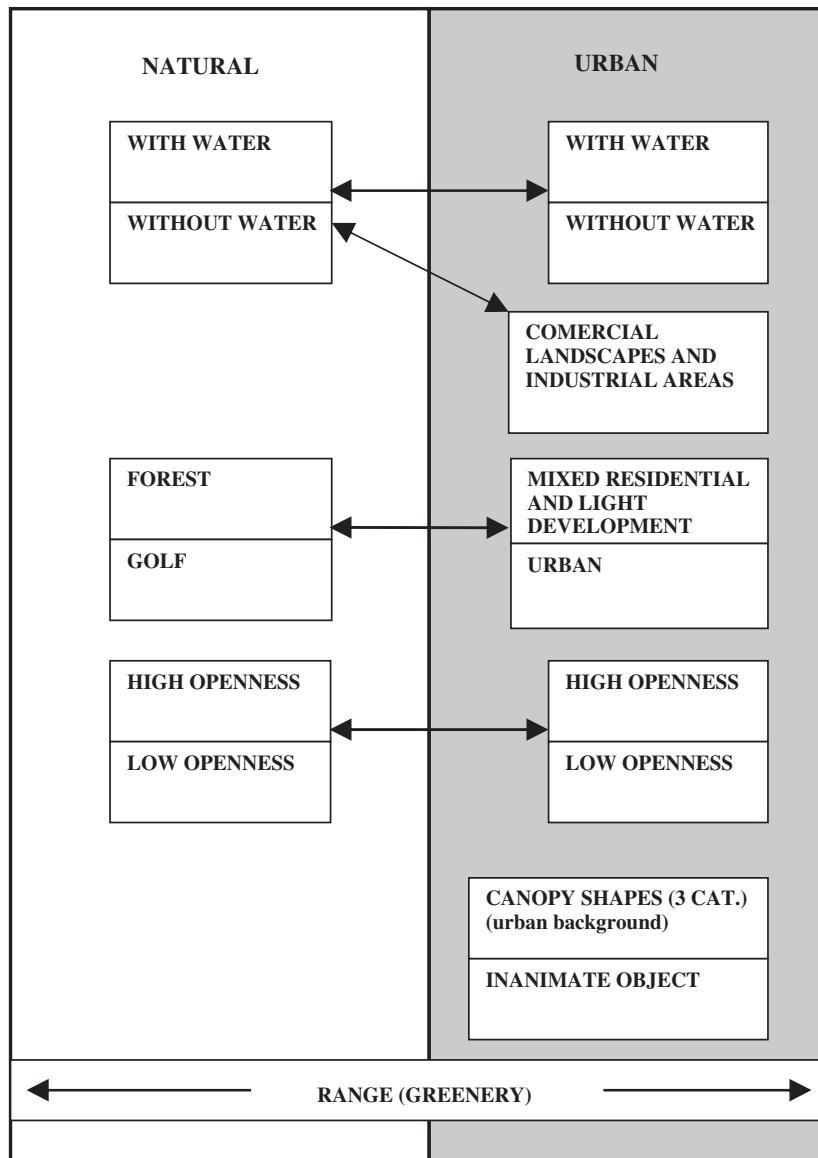


**Fig. 1.** Landscape categories used in the studies (in brackets: number of studies).

**Table 2.** Types of measures applied in the studies

Type of measure <sup>a</sup>	Authors
Frequency of sick-call visits	Moore (1981)
Number of days in hospital after surgery	Ulrich (1984)
Crime rates reported to the police	Kuo and Sullivan (2001a) and Kuo and Sullivan (2001b)
Doses of pain-killers during recovery	Ulrich (1984)
Attention-tests	Tennessen and Cimprich (1995), Grahn et al. (1997), Kuo (2001), Taylor et al. (2002), Hartig et al. (2003), Laumann et al. (2003), Van den Berg et al. (2003), and Ottosson and Grahn (2005)
Blood pressure	Ulrich (1981), Ulrich et al. (1991), Hartig et al. (2003), Ottosson and Grahn (2005), and Lohr and Pearson-Mims (2006)
Heart rate	Ulrich (1981), Heerwagen (1990), Ulrich et al. (1991), Laumann et al. (2003), and Ottosson and Grahn (2005)
Brain activity (Electroencephalogram)	Ulrich (1981) and Nakamura and Fujii (1992)
Skin conductance	Ulrich et al. (1991) and Lohr and Pearson-Mims (2006)
Muscle tension	Ulrich et al. (1991)
Tests of motor function	Grahn et al. (1997)
Emotion-tests	Hartig et al. (2003) and Van den Berg et al. (2003)
Behavioural observation	Grahn et al. (1997), Wells (2000), and Taylor et al. (2002)
Neighbourhood social ties-test	Kuo et al. (1998)
Self-reports of emotional state	Ulrich (1979), Kaplan et al. (1988 reported in Kaplan, 1993), Heerwagen (1990), Kaplan (1993), Staats et al. (1997), and Leather et al. (1998)
Interviews/questionnaires	Ulrich (1981), Herzog and Chernick (2000), Kuo (2001), Laumann et al. (2001), Staats et al. (2003), and Stigsdotter (2004)
Self-rating of perceived health	Maas et al. (2006) and Diette et al. (2003)

<sup>a</sup>Note that some of the studies have combined different measures.



**Fig. 2.** Subcategories of landscapes compared in studies of health effects of viewing landscapes. (Boxes indicate identified subcategories within the natural and urban landscape categories. Arrows indicate the subcategories compared in each study.)

categories (see Fig. 1). The subcategories identified are shown in Fig. 2.

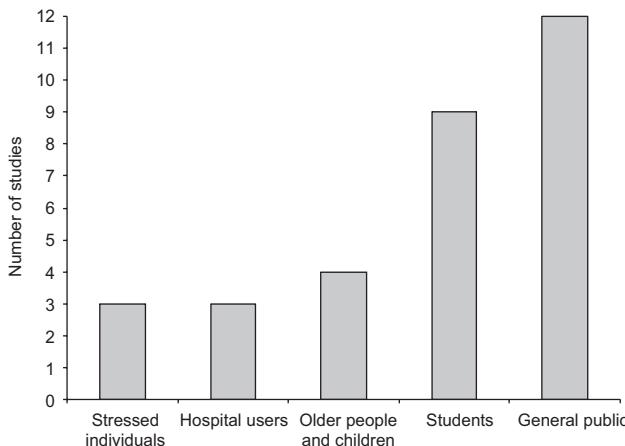
The landscape stimuli used in the studies were views from the window, views of a video clip or still images on a screen, or walks through different types of landscape with varying amounts of greenery in residential neighbourhoods or at a working place.

Approximately half of the studies reported in the review were conducted using images of landscapes (from a window, a video, and a photograph, etc.) but no exposure to real landscapes. The remaining studies were based on activities in real landscapes where the differences in treatment were the landscape type where activities were performed.

#### Reported health effects of exposure to the landscape view

Table 1 shows the landscape categories identified and the reported health effects related to each of them. Most of the health findings related to the urban/nature and landscape/no-landscape comparisons, where views of nature were found to provide greater positive health effects compared to urban views. Comparisons between subcategories of landscapes within the natural and urban landscape categories showed less clear results.

The identified health effects fall into three main types: Firstly, short-term recovery from stress or mental fatigue (psychological); secondly, the physical



**Fig. 3.** Groups of respondents in landscape-health investigations.

recovery from an illness or reduced incidence of physical illness; and, thirdly, a long-term behavioural change and an overall improvement in well-being (increased social interaction and reduction of aggressive behaviour).

### Research methods and measures used to assess health effects

A wide range of research designs were used in the reviewed studies, reflecting the range of health effects that have been investigated. Both quantitative and qualitative methods have been used. The quantitative methods include observations such as frequency of sick-call visits, number of days in hospital, doses of analgesics needed, motor function tests, attention-tests or quantitative emotional tests as well as physical measures including blood pressure, skin conductance, brain activity, heart rate and muscle tension. Among the qualitative methods are observations of behaviour as well as surveys, including self-reports (Table 2).

Behavioural changes were mainly assessed through observations, self-reports, questionnaires, structured interviews or by parent ratings and direct observation in the case of children.

### Groups of respondents

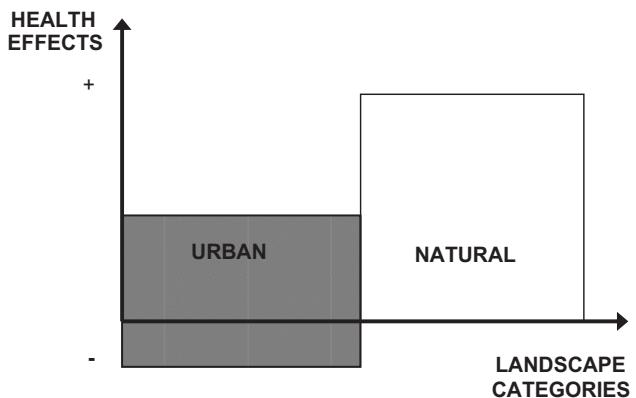
The target individuals varied widely among the studies. Most studies addressed the general public (37%) or students (28%). In 13% of the studies “stressed individuals”, were respondents exposed to a stressor before exposure to landscapes. In 9% of the studies the respondents were hospital patients, their families or hospital staff (Fig. 3).

## Discussion

### Landscapes used in environmental psychology investigations of nature and health

The review has revealed that in studies comparing the health outcomes of visual exposure to different categories of landscapes, the categories compared were generally very coarse. The majority of studies used only two categories (e.g., exposure to natural landscape versus urban or comparing landscape view versus no view. Less than 25% of the studies applied subcategories of natural and urban. These coarse categories clearly fail to reflect the vast variety of landscapes and landscape elements that are important in defining the character of “natural” or “urban” landscapes. Even though there was a wide range of landscape elements used in the reviewed studies, they still provide us with little information about which landscape elements have contributed most to the reported health effects. In the two studies subcategories are related to the presence or absence of water in natural and urban scenes. A further two studies assessed the effect of openness in natural and urban settings. Other detailed studies were not related directly to specific elements (e.g., comparing golf landscapes to forests) and only one study analysed responses to specific landscape elements by comparing the effects of different tree canopy shapes.

Natural landscapes were found to have a more positive effect on health than urban landscapes (see Fig. 4). However, because of the coarseness of the categories compared we cannot distinguish which of the urban landscapes were worse or better or which of the natural ones gave the strongest positive health effect. The results indicate that the presence of water gives a positive health effect, but the results are rather weak. No clear relationship was identified between openness and health effects.



**Fig. 4.** Schematic diagram showing health effects of viewing landscapes; natural scenes generally gave a more positive effect compared to urban scenes.

Twenty-nine per cent of the studies assessed the effects of varying amounts of greenery in residential or working environments. All of these environments are urban with varying amounts of natural elements present. These studies investigating the health effects of greenery around work or living places indicated that the greener the environment the better. However, they do not provide any information about what kind of greenery produces the greatest benefit, or whether all kinds of natural elements give similar effects.

Most of the reviewed studies report short-term health effects of either psychological or physical nature, e.g., short-term recovery from stress or mental fatigue (psychological). Health and psychological well-being are, nevertheless, not only about not being ill. It is important to consider resources that regularly become diminished, “as when we tire mentally over the course of a work week” (Hartig, 2004, p. 2). Even though some of the measured behavioural changes are apparently short-term effects, the accumulation of such short-term outcomes may have implications for longer-term health outcomes (Hartig, 2004). Such cases thus support the likelihood of long-term health benefits related to behavioural changes associated with social ties (Kuo et al., 1998), improving self-discipline (Taylor et al., 2002), decreasing aggressive behaviour (Kuo and Sullivan, 2001a,b) and generally improved comfort and well-being (Grahn et al., 1997; Kuo, 2001; Milligan et al., 2004; Stigsdotter, 2004).

Our findings that natural landscapes generally create a stronger positive health effect than urban landscapes supports Ulrich’s “Stress recovery theory” (Ulrich 1984, 1999) and the “Attention Restoration Theory” of Kaplan and Kaplan (1989). The latter claim that natural landscapes more often provide the key factors necessary for restoration. Correlations between these key factors of the theory (fascination, being away, extent and compatibility) and measures of perceived restorativeness have been found by several researchers (Korpela and Hartig, 1996; Herzog et al., 1997; Herzog et al., 2003; Ke-Tsung, 2003; Bagot, 2004). Other attempts to test the “Attention Restoration Theory” have also provided empirical support for the approach (Grahn et al., 1997; Kuo et al., 1998; Kuo, 2001; Kuo and Sullivan, 2001a; Taylor et al., 2002; Ottosson and Grahn, 2005). These theories remain open to modification and development in the light of the accumulating evidence (Hartig, 2004).

## Methodological considerations

All the studies reviewed report health effects linked to visual exposure to different landscape types (active viewing or availability of visual landscape stimuli, e.g., in residential area). Most studies (74%) do not report measurements on respondents from before the exposure

**Table 3.** Nature of measurements used in the studies

Nature of measurement	Authors
Relative values	Ulrich (1981), Moore (1981), Ulrich (1984), Heerwagen (1990), Nakamura and Fujii (1992), Kaplan (1993), Tennesen and Cimprich (1995), Grahn et al. (1997), Staats et al. (1997), Kaplan et al. (1988 reported in Kaplan 1993), Kuo et al. (1998), Leather et al. (1998), Herzog and Chernick (2000), Wells (2000), Kuo and Sullivan (2001a), Kuo and Sullivan (2001b), Kuo (2001), Laumann et al. (2001), Taylor et al. (2002), Diette et al. (2003), Staats et al. (2003), Stigsdotter (2004), and Maas et al. (2006)
Absolute values	Ulrich (1979), Ulrich et al. (1991), Parsons et al. (1998), Hartig et al. (2003), Laumann et al. (2003), Van den Berg et al. (2003), Ottosson and Grahn (2005), and Lohr and Pearson-Mims (2006)

Relative versus absolute values.

to the landscape stimuli and therefore they produce only relative values (Table 3). These studies tell us that viewing a natural scene produces a positive health effect compared with viewing an urban scene, but fail to indicate the magnitude of the change or whether the effect of viewing the urban scene is negative or merely less positive.

Some of the studies are, however, experiments or interventions where health measures have been collected before, during and after the exposure to landscape visual stimuli. Some of these studies (e.g., Ulrich, 1979; Hartig et al., 2003) report negative health effects of visual exposure to urban landscapes, e.g., increased blood pressure, reduced positive affects and increased anger and aggression compared to pre-exposure measurements. Reports of such directly negative effects are, however, scarce.

Both quantitative methods (either physical measures or quantitative observations) and qualitative methods (qualitative observations or surveys) have been used in the literature. Some of the studies combine both objective and subjective measures. We accept both as valid approaches, although the strength of the conclusions may vary between studies as a result of the particular design applied. As a general rule, if a subject perceives that he/she feels better, this is an indicator of a positive health effect (Health Council of the Netherlands and Dutch Advisory Council for Research on Spatial Planning Nature and the Environment, 2004).

Researchers have addressed questions related to the validity of the different landscape stimuli. Hartig et al. (1996), for example, compared the evaluations of

restorative quality obtained by on-site visits and simulations (video and photographic slides). He found no statistically significant differences in evaluations between the two treatments. This suggests that simulated landscapes are likely to be a valid means of providing evaluations of their restorative potential. Ulrich (2002) points out that viewing natural settings can produce significant restoration within less than 5 min as indicated by positive changes in blood pressure, heart rate, muscle tension, and brain activity.

Students have been used extensively in studies due to their easy accessibility. Whether students provide results that are reliable representations of the general public requires further validation.

### **Knowledge gaps requiring further research**

Theories explaining the relationships between landscape and health, especially those exploring the potential restorative qualities of landscapes, have increasingly focused on how to use research results in planning (Hartig et al., 2007). There is much interest in employing environmental psychology to inform the design of urban open spaces to improve attention restoration and other health goals. Most of these design approaches have focused on hospitals and health facilities, and to a lesser extent to urban design and the design of gardens (Dilani, 2001; Ulrich, 2002; Gesler et al., 2004). Recent research has focused on the relationship between residential design and human well-being, employing urban design as a tool to improve human health (Kuo et al., 1998; Sullivan et al., 1998; Dilani, 2001; Kuo and Sullivan, 2001a; Taylor et al., 2002; Jackson, 2003). As gardens and urban parks have been noted for their restorative effects on both mental and physical health, several authors have analysed design options that can contribute to improved health outcomes (Cooper-Marcus and Barnes, 1995; Tyson, 1998; Cooper-Marcus and Barnes, 1999; Ulrich, 1999; Frumkin, 2001; Whitehouse et al., 2001; Stigsdotter and Grahn, 2002; Sherman et al., 2005).

We found few articles providing information about the specific landscape elements that can make a difference in terms of health effects. Little, if any, research has been carried out at a scale fine enough to assess which components or characteristics of specific landscapes constitute the most important drivers of human health benefits. Further research is needed to identify these key elements of healthy landscapes. This will help us understand which natural scenes have the strongest positive effects, and what can be done to improve urban settings from a health and well-being perspective. Such understanding would contribute to the search for functional landscape designs beneficial to human health and sustainability.

### **Conclusions**

The study identified the landscape types used in environmental psychology studies that examine the effects of visual exposure to such landscapes on human health. We found that the landscapes used in such studies were described loosely and in coarse categories, mainly reflecting a broad “nature” versus “urban” dichotomy. Much less information was supplied by the literature regarding specific landscape elements, structures and patterns within the urban and natural categories.

The literature review identified that the main health aspects of exposure to landscapes related to reduced stress, improved attention capacity, facilitating recovery from illness, ameliorating physical well-being in elderly people, and behavioural changes that improve mood and general well-being. These effects have been addressed by means of viewing natural landscapes during a walk, viewing from a window, looking at a picture or a video, or experiencing vegetation around residential or work environments.

There have been major advances in our understanding of the relationship between landscapes and human health. Nevertheless, one of the key questions remains: what are the particular qualities of a restorative landscape? Identifying these qualities in order to apply them to landscape design is one of the major research challenges of the future.

### **Acknowledgements**

The authors would like to thank colleagues at the Norwegian University of Life Sciences (UMB) for valuable comments to the manuscript. UMBs Nature, Health and Well-being research group provided funding.

### **References**

- Bagot, K.L., 2004. Perceived restorative components: a scale for children. *Children, Youth and Environments* 14, 1.
- Cooper-Marcus, C., Barnes, M., 1995. Gardens in Healthcare Facilities: Uses, Therapeutic Benefits and Design Recommendations. The Center for Health Design, Concord, CA.
- Cooper-Marcus, C., Barnes, M. (Eds.), 1999. Healing Gardens. Therapeutic Benefits and Design Recommendations. Wiley, New York, NY.
- Council of Europe, 2000. European Landscape Convention. CETS No. 176. Council of Europe, Florence.
- Diette, G.B., Lechtzin, N., Haponik, E., Devrotes, A., Rubin, H.R., 2003. Distraction therapy with nature sights and sounds reduces pain during flexible bronchoscopy. *Chest* 123, 941–948.

- Dilani, A., 2001. Design & Health: the Therapeutic Benefits of Design. Svensk Byggtjänst Förlag, Stockholm.
- Dobbs, R., 1997. Interpreting the Navajo Sacred Geography as a Landscape of Healing. *The Pennsylvania Geographer* XXXV 2, 136–150.
- Frumkin, H., 2001. Beyond toxicity: human health and the natural environment. *American Journal of Preventive Medicine* 20, 234–240.
- Frumkin, H., 2003. Healthy places: exploring the evidence. *American Journal of Public Health* 93, 1451–1456.
- Frumkin, H. (Ed.), 2005. Environmental Health. From Global to Local, San Francisco, CA.
- Gesler, W., 1992. Therapeutic landscapes: medical issues in light of the new cultural geography. *Social Science and Medicine* 34, 735–746.
- Gesler, W., 1993. Therapeutic landscapes: theory and case study of Epidaurus, Greece. *Environment and Planning D: Society and Space* 11, 171–189.
- Gesler, W., 1996. Lourdes: healing in a place of pilgrimage. *Health & Place* 2, 95–105.
- Gesler, W., 1998. Bath's reputation as a healing place. In: Kearns, R., Gesler, W. (Eds.), *Putting Health into Place*. Syracuse University Press, Syracuse, NY.
- Gesler, W., 2005. Therapeutic landscapes: an evolving theme. *Health & Place* 11, 295–297.
- Gesler, W., Bell, M., Curtis, S., Hubbard, P., Francis, S., 2004. Therapy by design: evaluating the UK hospital building program. *Health & Place* 10, 117–128.
- Grahn, P., Mårtensson, F., Lindblad, B., Nilsson, P., Ekman, A., 1997. Ute på dagis (Outdoors at daycare institutions). *Stad och Land* Nr 145 (in Swedish).
- Hartig, T., 2004. Toward understanding the restorative environment as a health resource. In: Open Space: People Space. Engaging with the Environment. Conference Proceedings. OPENspace Research Centre, Edinburgh. Available from: <<http://www.openspace.eca.ac.uk/conference/proceedings/summary/Hartig.htm>> (accessed 29 June 2007).
- Hartig, T., Staats, H., 2006. The need for psychological restoration as a determinant of environmental preferences. *Journal of Environmental Psychology* 26, 215–226.
- Hartig, T., Böö, A., Garvill, J., Olsson, T., Gärling, T., 1996. Environmental influences on psychological restoration. *Scandinavian Journal of Psychology* 37, 378–393.
- Hartig, T., Evans, G.W., Jamner, L.D., Davis, D.S., Gärling, T., 2003. Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology* 23, 109–123.
- Hartig, T., Bringslimark, T., Patil, G.G., 2007. Restorative environmental design: what, when, where and for whom. In: Kellert, S., Heerwagen, J., Mador, M. (Eds.), *Bringing Buildings to Life: The Theory and Practice of Biophilic Building Design*. Wiley, New York, NY.
- Health Council of the Netherlands and Dutch Advisory Council for Research on Spatial Planning Nature and the Environment, 2004. Nature and Health. The influence of nature on social, psychological and physical well-being. Publication No. 2004/09E; RMNO Publication No. A02ae. Health Council of the Netherlands and RMNO, The Hague.
- Heerwagen, J., 1990. The psychological aspects of windows and window design. In: Anthony, K.H., Choi, J., Orland, B. (Eds.), *Proceedings of the 21st Annual Conference of the Environmental Design Research Association*. EDRA, Oklahoma City, pp. 269–280.
- Herzog, T.R., Chernick, K.K., 2000. Tranquility and danger in urban and natural settings. *Journal of Environmental Psychology* 20, 29–39.
- Herzog, T.R., Black, A.M., Fountaine, K.A., Knotts, D.J., 1997. Reflection and attentional recovery as distinctive benefits of restorative environments. *Journal of Environmental Psychology* 17, 165–170.
- Herzog, T.R., Colleen, P., Maguire, M., Nebel, B., 2003. Assessing the restorative components of environments. *Journal of Environmental Psychology* 23, 159–170.
- Jackson, L.E., 2003. The relationship of urban design to human health and condition. *Landscape and Urban Planning* 64, 191–200.
- Kaplan, R., 1992. The psychological benefits of nearby nature. In: Relf, D. (Ed.), *The Role of Horticulture in Human Well-Being and Social Development*, vol. VI. Timber Press, Arlington, pp. 125–133.
- Kaplan, R., 1993. The role of nature in the context of the workplace. *Landscape and Urban Planning* 26, 193–201.
- Kaplan, R., Kaplan, S., 1989. *The Experience of Nature: a Psychological Perspective*. Cambridge University Press, Cambridge.
- Kaplan, S., 2002. Some hidden benefits of the urban forest. In: Konijnendijk, C.C., Schipperijn, J., Hoyer, K.K. (Eds.), 2004. *Forestry Serving Urbanised Societies. Selected papers from the conference held in Copenhagen, Denmark, 27–30 August 2002*. IUFRO World Series, vol. 14. IUFRO, Vienna, pp. 221–232.
- Ke-Tsung, H., 2003. A reliable and valid self-rating measure of the restorative quality of natural environments. *Landscape and Urban Planning* 64, 209–232.
- Kellert, S.R., Wilson, E.O., 1993. *The Biophilia Hypothesis*. Island Press/Shearwater Books, Washington, DC.
- Korpela, K., Hartig, T., 1996. Restorative qualities of favorite places. *Journal of Environmental Psychology* 16, 221–233.
- Kuo, F.E., 2001. Coping with poverty: impacts of environment and attention in the inner city. *Environment and Behavior* 33, 5–34.
- Kuo, F.E., Sullivan, W.C., 2001a. Environment and crime in the inner city. Does vegetation reduce crime? *Environment and Behavior* 33, 343–367.
- Kuo, F.E., Sullivan, W.C., 2001b. Aggression and violence in the inner city. Effects of environment via mental fatigue. *Environment and Behavior* 33, 543–571.
- Kuo, F.E., Sullivan, W.C., Coley, R.L., Brunson, L., 1998. Fertile ground for community: inner-city neighbourhood common spaces. *American Journal of Community Psychology* 26, 823–851.
- Laumann, K., Gärling, T., Stormark, K.M., 2001. Rating scale measures of restorative components of environments. *Journal of Environmental Psychology* 21, 31–44.
- Laumann, K., Gärling, T., Stormark, K.M., 2003. Selective attention and heart rate responses to natural and urban environments. *Journal of Environmental Psychology* 23, 125–134.
- Leather, P., Pyrgas, M., Beale, D., Lawrence, C., 1998. Windows in the workplace. *Environment and Behavior* 30, 739–762.

- Lohr, V.I., Pearson-Mims, C.H., 2006. Responses to scenes with spreading, rounded, and conical tree forms. *Environment and Behavior* 38, 667–688.
- Maas, J., Verheij, R.A., Groenewegen, P.P., de Vries, S., Spreeuwenberg, P., 2006. Green space, urbanity, and health: how strong is the relation? *Journal of Epidemiology and Community Health* 60, 587–592.
- Milligan, C., Gatrell, A., Bingley, A., 2004. “Cultivating health”: therapeutic landscapes and older people in northern England. *Social Science and Medicine* 58, 1781–1793.
- Moore, E., 1981. A prison environment's effect on health care service demands. *Journal of Environmental Systems* 11, 17–34.
- Morris, N., 2003. Health, well-being and open space. Literature Review. OPEN space: the research centre for inclusive access to outdoor environments. Edinburgh College of Art and Heriot-Watt University, Edinburgh.
- Nakamura, R., Fujii, E., 1992. A comparative study of the characteristics of the electroencephalogram when observing a hedge and a concrete block fence. *Journal of the Japanese Institute of Landscape Architects* 55, 139–144.
- Ottosson, J., Grahn, P., 2005. A comparison of leisure time spent in a garden with leisure time spent indoors: on measures of restoration in residents in geriatric care. *Landscape Research* 30, 23–55.
- Palka, E., 1999. Accessible wilderness as a therapeutic landscape: experiencing the nature of Denali National Park, Alaska. In: Williams, A. (Ed.), *Therapeutic Landscapes*. University Press of America, Lanham, pp. 29–52.
- Parsons, R., Tassinary, L.G., Ulrich, R.S., Hebl, M.R., Grossman-Alexander, M., 1998. The view from the road: implications for stress recovery and immunization. *Journal of Environmental Psychology* 18, 113–140.
- Sherman, S.A., Varni, J.W., Ulrich, R.S., Malcarne, V.L., 2005. Post-occupancy evaluation of healing gardens in a pediatric cancer center. *Landscape and Urban Planning* 73, 167–183.
- Staats, H., Gatersleben, B., Hartig, T., 1997. Change in mood as a function of environmental design: arousal and pleasure on a simulated forest hike. *Journal of Environmental Psychology* 17, 283–300.
- Staats, H., Kieviet, A., Hartig, T., 2003. Where to recover from attentional fatigue: an expectancy-value analysis of environmental preference. *Journal of Environmental Psychology* 23, 147–157.
- Stigsdotter, U.A., 2004. A garden at your workplace may reduce stress. *Design & Health*, 147–157.
- Stigsdotter, U.A., Grahn, P., 2002. What makes a garden a Healing Garden? *Journal of Therapeutic Horticulture*, 60–69.
- Sullivan, W.C., Kuo, F.E., Coley, R.L., Brunson, L., 1998. Fertile ground for community: inner-city neighbourhood common spaces. *American Journal of Community Psychology* 26, 823–851.
- Taylor, A.F., Kuo, F.E., Sullivan, W.C., 2002. Views of nature and self-discipline: evidence from inner city children. *Journal of Environmental Psychology* 22, 49–63.
- Tennessen, C.M., Cimprich, B., 1995. Views to nature: effects on attention. *Journal of Environmental Psychology* 15, 77–85.
- Tyson, M.M., 1998. *The Healing Landscape: Therapeutic Outdoor Environments*. McGraw-Hill, New York, NY.
- Ulrich, R.S., 1979. Visual landscapes and psychological well-being. *Landscape Research* 4, 17–23.
- Ulrich, R.S., 1981. Natural versus urban scenes. Some psychological effects. *Environment and Behavior* 13, 523–556.
- Ulrich, R.S., 1984. View through a window may influence recovery from surgery. *Science* 224 (4647), 420–421.
- Ulrich, R.S., 1999. Effects of gardens on health outcomes: theory and research. In: Cooper-Marcus, C., Barnes, M. (Eds.), *Healing Gardens: Therapeutic Benefits and Design Recommendations*. Wiley, New York, pp. 27–86.
- Ulrich, R.S., 2002. Health benefits of gardens in hospitals. Paper for conference: Plants for People. International Exhibition Floriade. Available from: <[http://www.plantsatwork.org/pdf/HealthSettingsUlrich\\_copy.pdf](http://www.plantsatwork.org/pdf/HealthSettingsUlrich_copy.pdf)> (accessed 29 June 2007).
- Ulrich, R.S., Simons, R.F., Losito, B.D., Fiorito, E., Miles, M.A., Zelson, M., 1991. Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology* 11 (3), 201–230.
- Van den Berg, A.E., Koole, S.L., Van der Wulp, N.Y., 2003. Environmental preference and restoration: (How) are they related? *Journal of Environmental Psychology* 23, 135–146.
- Van den Berg, A.E., Hartig, T., Staats, H., 2007. Preference for nature in urbanized societies: stress, restoration, and the pursuit of sustainability. *Journal of Social Issues* 63 (1), 79–96.
- Wells, N.M., 2000. At home with nature: effects of “greenness” on children's cognitive functioning. *Environment and Behaviour* 32, 775–795.
- Whitehouse, S., Varni, J.W., Seid, M., Cooper-Marcus, C., Ensberg, M.J., Jacobs, J.R., Mehlenbeck, R.S., 2001. Evaluating a children's hospital garden environment: utilization and consumer satisfaction. *Journal of Environmental Psychology* 21, 301–314.
- Williams, A. (Ed.), 1999. *Therapeutic Landscapes: The Dynamic Between Place and Wellness*. University Press of America, Lanham, MD.
- World Health Organization, 1946. Constitution of the World Health Organization. WHO, Geneva.