

HEALTH AND RESTORATIVE BENEFITS OF NATURE AND LANDSCAPES
Dr Andrew Lothian, Scenic Solutions
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NATURE HEALS!

Imagine it if viewing landscapes provided us with healing, restored our souls from tiredness, and lifted our spirits! Well, research over recent decades has established the truth of this – nature heals! This is a really important finding of research over relatively recent years.

Writer and poets, even statesmen, have long believed in the healing power of nature as is evident from the following quotes.

*I wandered lonely as a cloud
For oft, when on my couch I lie
In vacant or in pensive mood,
They flash upon that inward eye
Which is the bliss of solitude;
And then my heart with pleasure fills,
And dances with the daffodils.*
William Wordsworth, 1804 (final verse)

Natural scenery employs the mind without fatigue and yet exercises it; tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system.
Frederick Olmstead, 1865.

It is not so much for its beauty that the forest makes a claim upon men's hearts, as for that subtle something, that quality of air that emanation from old trees, that so wonderfully changes and renews a weary spirit.
Robert Louis Stevenson 1905 *Essays of Travel* Forest Notes.

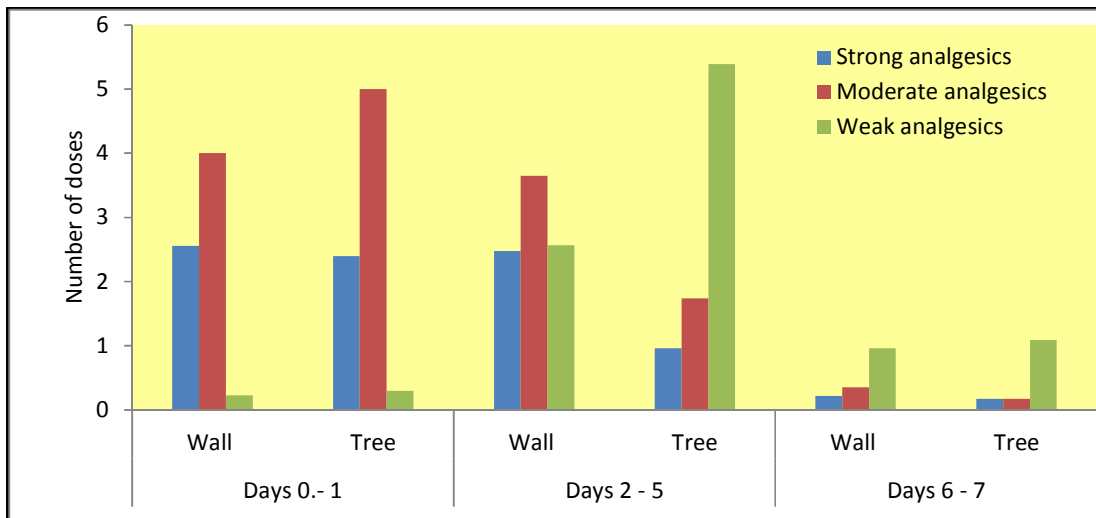
Everybody needs beauty as well as bread, places to play in and pray in where nature may heal and cheer and give strength to the body and soul.
John Muir 1912.

Beauty can enlarge man's imagination and revive his spirit.
President Lyndon Johnson, 1965.

It may seem curious that this phenomenon, the healing power of nature which seems to have been held as self-evident truth for generations, should have had to wait until recent years to be proved. It has been through research of landscape values that this has occurred.

An early study that provided glimpses of this truth was by Roger Ulrich, published in the prestigious journal, *Science*, in 1984. The study compared the recovery of patients in a Pennsylvanian hospital whose rooms faced a blank brick wall with patients who could see trees. The 46 patients had undergone similar gall bladder operations and the records were extracted from records over a ten year period. Those whose beds faced views of trees had shorter stays in hospital: 7.96 days vs 8.70 days, took fewer strong and moderate pain killers and received fewer negative evaluative comments in nurse's notes: 1.13 per patient for those facing trees compared with 3.96 per patient for those facing a wall. The results hinted at a significant influence of viewing nature upon human health.

Figure 1 illustrates the differences over the term of the patients' recovery. The analgesic doses did not vary significantly between the two groups for the first day or the last days but for days 2 - 5 the difference was statistically significant.



Source: Ulrich, 1984

Figure 1 Analgesic doses per patient for wall view and tree view

Ulrich went on to develop his psycho-evolutionary theory (see Chapter 13) in which the positive emotional and physiological effects of experiences with nature have survival benefits. Together with colleagues, he carried out a series of studies to document and quantify the effect of viewing nature on human health.

In this chapter, a non-technical overview is presented of research into the health and restorative effects of viewing nature. The parallels of this with landscape are obvious as much of the interaction with nature is through vision as nature presents landscapes that contrast with urbanscapes.

Figure 2, which builds on models by Abraham et al, 2010 and Tzoulas et al, 2007, provides a framework of cause and effect; the benefits derived from exposure to nature. Han (2003) showed that the restorative influence of environments comprise emotional, physiological and cognitive aspects as well as intended behaviour in the environments.

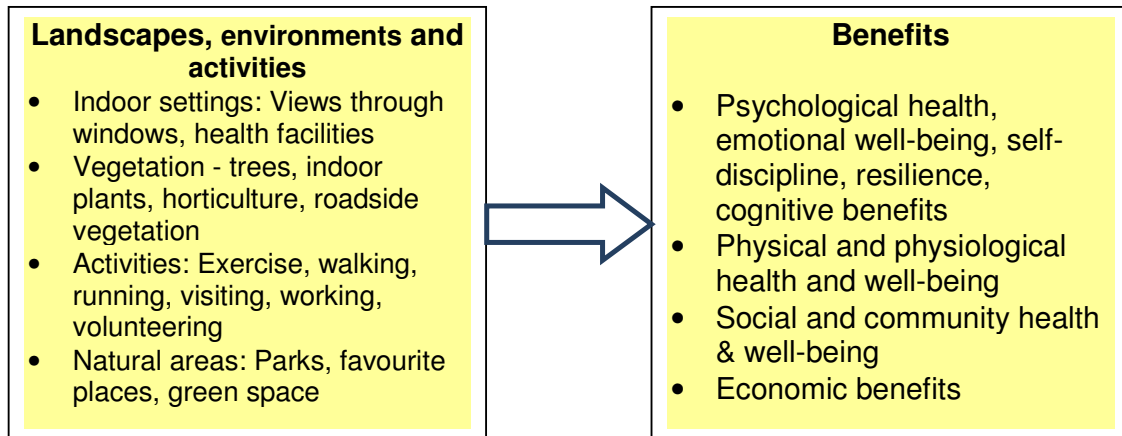


Figure 2 Framework of the health-promoting effect of landscapes

The chapter summarises the two theories that provide explanatory paradigms of the health and restoration benefits of viewing nature, and then presents the findings of research which have examined the application of these theories. It also examines research into several specific areas: the effect of viewing nature on violence, views of surrogates (e.g. posters), views from windows, and views along roads. The chapter ends with a summary and conclusions.

Excluded is research of immersion into the environment such as wilderness hikes (e.g. Kaplan & Kaplan, 1989; Hartig, Mang & Evans, 1991) which provide additional evidence of the restorative effects of nature. Neither does this chapter cover the psychological benefits of indoor plants (Bringslimark, *et al*, 2009, 2011, Han, 2009, Larsen et al, 1998). Three additional areas are not covered as they do not relate solely to viewing nature: social contact, child development, and personal development (sense of purpose), all of which were identified in an official report in The Netherlands into the role of nature and health (Health Council of the Netherlands, 2004). This report also provides a useful critique of the theories and studies on recovery from stress and attention fatigue referred to in this chapter.

EXPLANATIONS OF WHY NATURE HEALS

There have been two main lines of enquiry, complementary but operating from differing theoretical standpoints. Roger Ulrich (1983) proposed a psycho-evolutionary theory (sometimes referred to as a psychophysiological stress reduction framework) in which the positive emotional and physiological effects of experiences with nature have survival benefits. The second explanation is by Stephen and Rachel Kaplan whose Attention Restoration Theory proposes that exposure to nature restores us from the fatigue of prolonged mental work.

Psycho-evolutionary theory

Roger Ulrich argues that contact with nature aids recovery from all forms of stress, not just attention fatigue. Characteristics of the environment ('preferenda') provide an early-warning signal for safety and survival that triggers positive emotional reactions. These ensure attraction to natural environments. Ulrich's preferenda are gross configurational or structural aspects of settings, gross depth properties that require little inference, and general classes of environmental content (1983). He lists the following as the visual properties that influence preferences:

- Complexity – the number of independently perceived elements in a scene, is moderate to high;
- The complexity has structural properties that establish a focal point and other order or patterning is also present;
- There is a moderate to high level of depth that can be perceived unambiguously;
- The ground surface texture tends to be homogeneous and even and is appraised as conducive to movement;
- A deflected vista is present;
- Appraisal threat is negligible or absent;
- Presence of water will enhance preference.

These have been summarized as a level ground surface, considerable spatial openness, the presence of a pattern or structure, curving sightlines and the presence of water (Health Council of the Netherlands, 2004).

In contrast to the Kaplans' cognitive mechanisms, Ulrich argues that the response to nature is based on affect, i.e. emotions, not thought. Ulrich believes that emotional responses to landscapes occur before cognitive information processing - we feel it before we think about it. Emotions lie in the brain's limbic system, which is believed to be one of the earliest developed part of the brain in human evolutionary history, whereas cognition occurs in the neocortex, a much more recently developed part of the brain. Research of facial reactions to emotional triggers indicates that reactions occur far more rapidly than could be cognitively derived. For example, Dimberg, et al (2000) found that subjects exposed to a 30 ms image of a happy, neutral or angry face reacted with the same facial expression which was entirely unconscious.

Attention Restoration Theory

The Kaplans base their Attention Restoration Theory (ART) on the insight of William James, an early psychologist, into *voluntary attention*, the idea that some things require effort to be focused on them in the face of distractions and are susceptible to fatigue –students swotting for exams is a good example. The Kaplans use the term *directed attention* for James's *voluntary attention*. They describe it as having the following properties (1989, 1995), it:

- Requires effort;
- Plays a central role in achieving focus;
- Is under voluntary control (at least some of the time);
- Controls distraction through the use of inhibition.

Typically after working intensively for a period one becomes progressively mentally exhausted and directed attention suffers. Stephen Kaplan (1995) speculates that having to “exert effort to do the important while resisting distraction from the interesting” may be a phenomenon of modern life.

In contrast to directed attention is James's concept of *involuntary attention* which requires no mental effort, such as a walk in the park or other relaxing activity and from which one is unlikely to become mentally fatigued. The Kaplans substituted the term *fascination* for involuntary attention, using the term as explaining the mental attention or focus that one can have for an object. This may be as diverse as the plot of a book, a game of cards or chess, or a view of nature.

They differentiate soft fascination of moderate intensity such as a walk in a park requiring little mental effort, from hard fascination which is very intense and rivets one's attention, such as playing chess or watching a speedway race which require close attention. While soft fascination provides opportunity for reflection that is a restorative experience, hard fascination requires total commitment of attention on the matter at hand.

The Kaplans consider soft fascination to be characteristic of natural settings, are aesthetically pleasing and are restorative environments. Soft fascination contains patterns that hold one's attention effortlessly. The Kaplans' use of the term *fascination* is curious as it does not seem to fully convey their meaning; other words such as *attraction*, *enchanted*, *interest* or in particular, *captivating*, may have been preferable alternatives. Nevertheless, we will stick with their term.

In Kaplanian terms, fascination serves to help recovery from the fatigue of directed attention and additional components to a restorative environment are proposed. These are:

- *Being away* – separation from mental activity and from the everyday environment;
- *Extent* - the diversity and scope of the environment to provide an alternative setting sufficient to remain engaged;
- *Compatibility* between “the environment and one's purpose and inclinations.”
- *Fascination* containing patterns to hold one's attention effortlessly.

In the context of natural landscapes, natural settings fulfill all four requirements of a restorative environment: they provide a compatible opportunity to be away from one's normal environment, in a diverse setting with many objects of fascination.

The Kaplans' view attention fatigue recovery to be a cognitive activity, explainable by the information processing theory in which the brain is synonymous with a computer and, to the limits of its capacity, processes information it receives via its senses through applying logic and strategy.

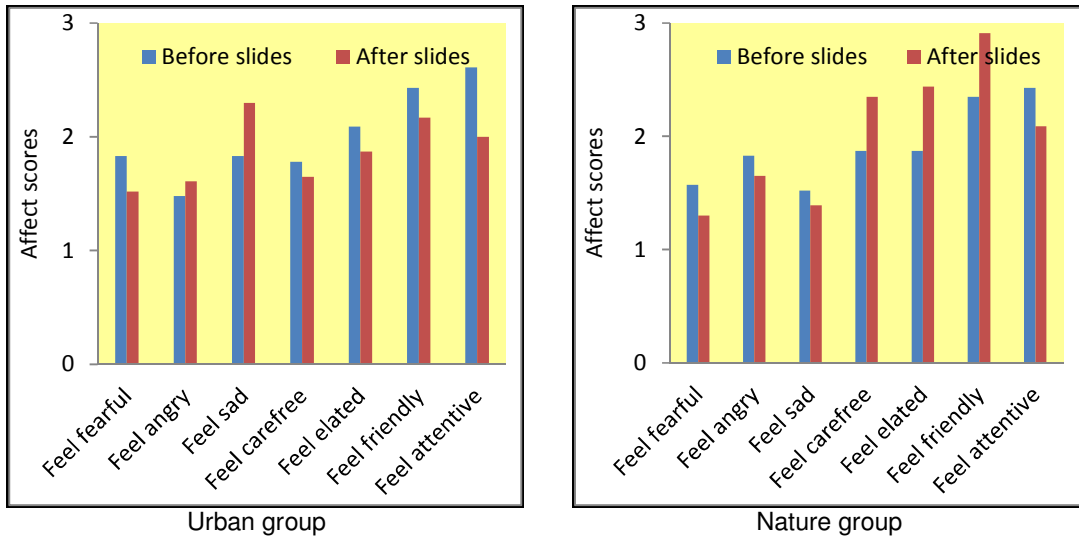
Comparison of theories

The difference between the Ulrich and Kaplan models, apart from the former being based on affect and the latter on cognition, is that Ulrich focuses on the “emotional, mental and physiological components of response to taxing or threatening stimuli” (Hartig, et al, 1991) whereas the Kaplans' interest is in attention-based deficits which result from fatigue associated with everyday activities. Ulrich believes nature promotes recovery from all forms of stress, not just attention fatigue that the Kaplans cover. Both, however, are predicated on “the restorative effects of nature having an innate, evolutionary basis.” (Health Council of the Netherlands, 2004).

In Ulrich's terms, viewing nature produces positive emotions and lessens negative feelings, promotes recovery and restoration from stress, whereas to the Kaplans, stress reduces one's directed attention which is restored by the soft fascination provided by natural settings. Hartig, *et al* (2003) consider the theories are complementary “with regard to the antecedent condition from which the person becomes restored”, specifically stress. Both approaches and the research that has been carried out to verify them provide support for nature providing psychological health and restoration benefits to individuals.

PSYCHO-EVOLUTIONARY THEORY RESEARCH

In his early research, Ulrich (1979) tested participants' feelings before and after viewing slides of urban and natural scenes. The results indicate that individuals who viewed scenes of cities with trees and other vegetation showed significantly reduced feelings of fear and increased positive feelings of affectation and delight, compared with individuals shown scenes of treeless city scenes (Figure 3).

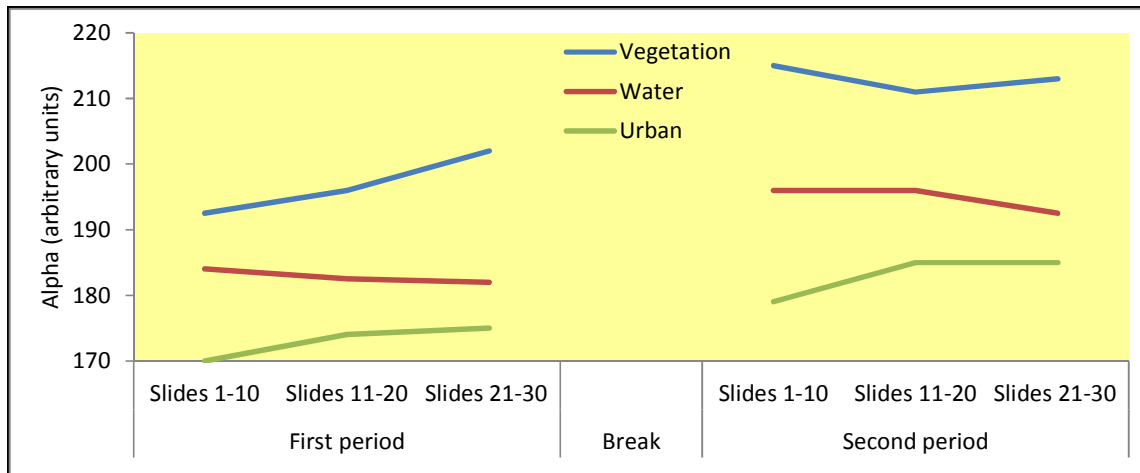


Source: Ulrich 1979

Figure 3 Affect scores before and after slides for urban and nature groups

Negative feelings were lessened and positive feelings became more positive from viewing nature scenes. Ulrich showed that the variation attributable to slide content was highly significant and concluded that the importance of visual landscapes is not confined to aesthetics, but that they also give rise to emotional states, urban scenes having a negative effect and the nature scenes positive.

In a second study, Ulrich (1981) used psycho-physiological measures including heart rates and alpha waves (a gauge of brain electrical activity) to assess the effect of viewing slides which included water, vegetation and urban environments. He found it “extremely interesting” that the alpha wave response varied with each type of landscape. Scenes of vegetation induced relaxation and low arousal while urban scenes provoked anxiety (Figure 4). The results for water lay in between. The significantly higher results for vegetation were cited as one of the most important findings of the study and support “the conclusion that the subjects felt more wakefully relaxed while viewing the vegetation as opposed to urban scenes”.



Source: Ulrich, 1981. Note: High Alpha wave levels = low arousal and a relaxed state and low levels = high arousal and anxiety

Figure 4 Alpha wave scores when viewing scenes

In a second study, Ulrich (1981) used psycho-physiological measures including heart rates and alpha waves (a gauge of brain electrical activity) to assess the effect of viewing slides which included water, vegetation and urban environments. He found it “extremely interesting”

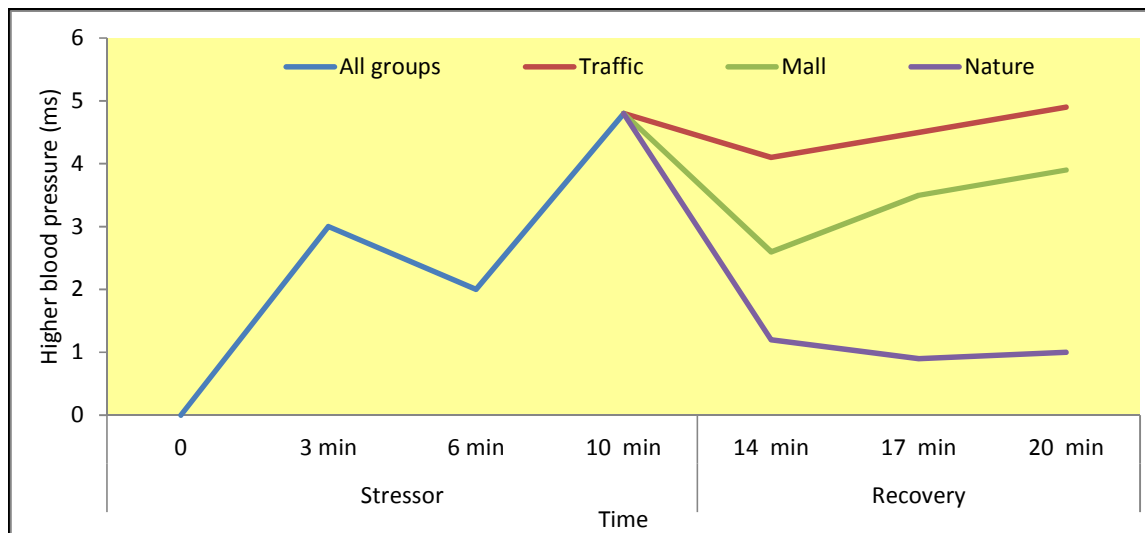
that the alpha wave response varied with each type of landscape. Scenes of vegetation induced relaxation and low arousal while urban scenes provoked anxiety (Figure 4). The results for water lay in between. The significantly higher results for vegetation were cited as one of the most important findings of the study and support “the conclusion that the subjects felt more wakefully relaxed while viewing the vegetation as opposed to urban scenes”.

Ulrich also asked subjects to rate their feelings before and after viewing the slides using the Zuckerman Inventory of Personal Reactions (ZIPERS scale) which measures fear arousal, positive affects, anger/aggression, attentiveness or concentration, and sadness. He found:

- Attentiveness declined but less so for water scenes;
- Sadness increased markedly from viewing urban scenes but increased only slightly for vegetation and was constant for water;
- Fear arousal emotion increased slightly with urban scenes, decreased slightly with vegetation and declined more sharply with water.

Ulrich concluded that “people benefit most from visual contact with nature, as opposed to urban environments lacking nature, when they are in states of high arousal and anxiety.”

Ulrich *et al* (1991) extended physiological measures to include skin conductance, pulse transit time (blood pressure), muscle tension and heart period. Participants were first tested, then viewed a ten-minute stressful video (on workplace accidents), and then viewed a second ten-minute video showing everyday outdoor settings - two natural (vegetation and water) and four urban. They showed that recovery was faster and more complete when exposed to a natural setting rather than an urban setting. Viewing natural scenes resulted in significantly increased positive affect scores compared with either the pedestrian mall or traffic. Figure 5 shows the results for blood pressure and indicates the substantial ameliorative effect that viewing nature has in lowering blood pressure.



Source: Ulrich, *et al*, 1991

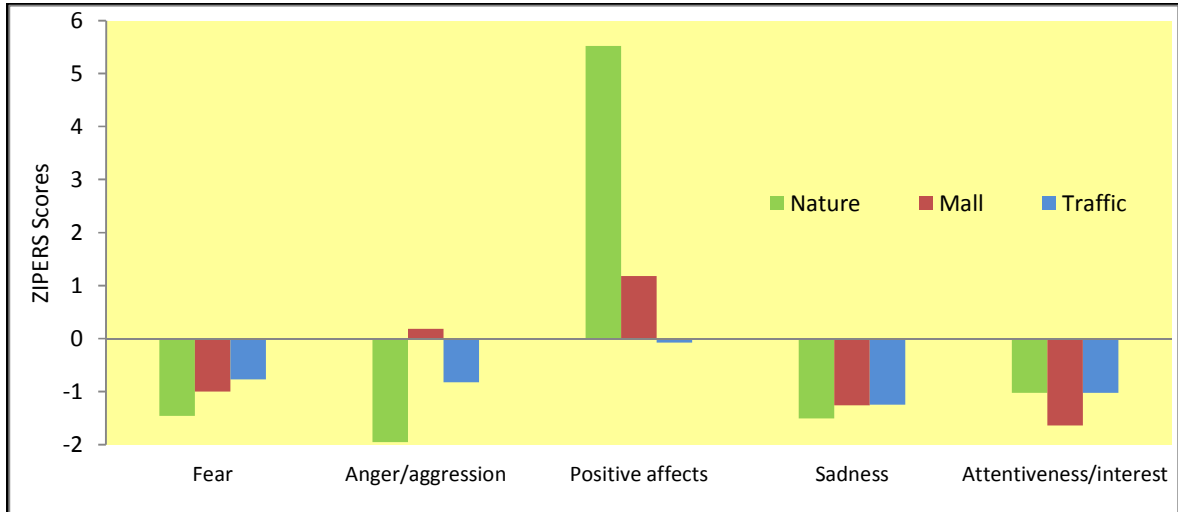
Figure 5 Changes in blood pressure (pulse transit time) during stress and recovery

The findings were consistent, the authors asserted, to Ulrich’s “psycho-evolutionary theory that restorative influences of nature involve a shift towards a more positively-toned emotional state, positive changes in physiological activity levels, and that these changes are accompanied by sustained attention/intake.”

Results from all four physiological measures showed that the nature scenes reduced stress, indicating their “greater recovery influence”. The study also found that nature scenes resulted

in more rapid recovery from stress, suggesting that even momentary viewings of trees through a window can have benefit.

Using the ZIPERS ratings, they found “much more recuperation” from stress by exposure to natural environments than by the pedestrian mall or traffic contexts. Participants exposed to natural settings had lower scores for anger/ aggression and fear with much higher scores for positive affects (Figure 6).



Source: Ulrich *et al*, 1991. Note: shows ZIPERS score changes from pre- to post-recovery

Figure 6 Influence of environments on affective states

Ulrich et al (1991) believes that the human capacity to have their stress levels reduced in natural settings had important survival advantages and accordingly they can rapidly de-stress in such settings but not in urban or built settings.

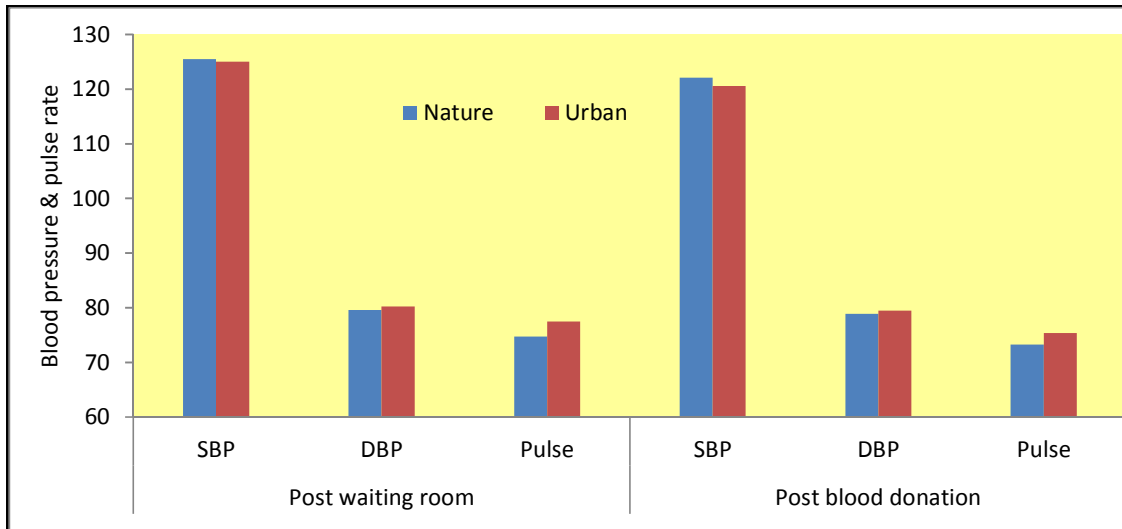
Applying his findings to interior design, particularly of hospitals and other healthcare facilities, Ulrich (1991) argued that “sensory deprivation such as windowless rooms can result in anxiety and depression.” Based on the evolutionary approach, he wrote that “the most effective positive distractions are mainly elements that have been important to humans throughout millions of years of evolution: (1) happy, laughing, or caring faces; (2) animals, and (3) nature elements such as trees, plants and water.”

Ulrich has developed a Theory of Supportive Design to improve the capability of hospitals and other healthcare facilities to enhance health outcomes through more effectively reducing stress for patients, families and visitors as well as for employees. As well as focusing on greater patient control of their situation, including privacy, and facilitating their social support, the third intervention is to provide access to nature via windows, health gardens and posters.

A review in the late 1990s by the John Hopkins Medical School of research on hospital design and health found 85 rigorous studies, 80% of which found positive links between the hospital environment and patient health outcomes, leading them to conclude that “there is suggestive evidence that aspects of the designed environment exerts significant effects on clinical outcomes for patients” (Rubin et al., 1998).

Based on the findings of his previous studies, Ulrich examined the effects of viewing videos of nature or urban scenes in a setting which tends to be stressful, a blood donation center (Ulrich, Simons & Miles, 2003). As part of the normal processing of patients, blood pressure (systolic and diastolic) and pulse of 872 participants were measured. Following the blood donation (phlebotomy), blood pressure and pulse were again measured. During the donation,

the participants viewed a television screen which showed either videos of nature or urban areas, daytime television, or a blank monitor. ZIPERs were also completed by participants prior to and following the blood donation.



Source: Ulrich, Simons & Miles, 2003

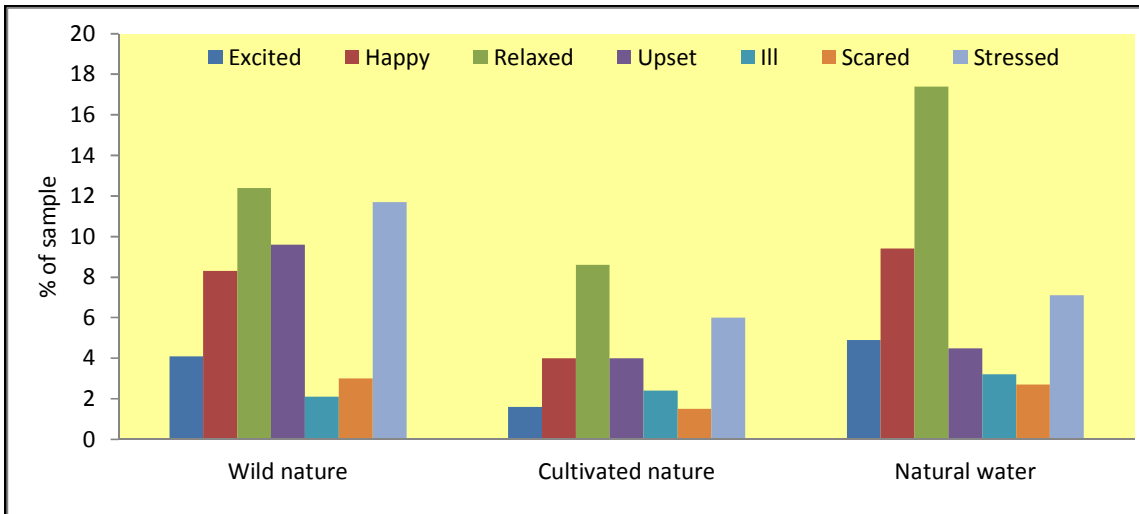
Note: SBP = systolic blood pressure, DBP = diastolic blood pressure

Figure 7 Blood pressure and pulse prior and following blood donations

While the ZIPERs detected no significant difference according to the television content, all reported improved affective states after their donation which is indicative of the stress it causes. The television content had a significant effect on stress: the pulse rate was markedly lower for viewers of nature scenes compared with the urban scenes (Figure 7).

Overall, Ulrich's research findings provide support for his theory that "immediate, unconsciously triggered and initiated emotional responses - not 'controlled' cognitive responses - play a central role in the initial level of responding to nature" (Ulrich, *et al*, 1991). He has written extensively on the design of health facilities (Ulrich, 1997, 1999, 2000, 2001, 2002, 2008, 2009, 2010).

Regan and Horn (2005) examined the links between landscape preferences and the individual mood states of excited, happy, relaxed, upset, ill, stressed or scared. They used three landscape types: wild nature, cultivated nature (i.e. scenes with plants and mowed lawns), and natural water. The study was conducted in Manchester and Hampshire in the UK and included adults and children. It also examined the effect of demographic factors on nature preferences. They found the preferences for wild nature and cultivated nature were associated with a relaxed mood state followed, interestingly, by stressed and upset moods (Figure 8). In contrast, natural water was associated with relaxed and happy moods followed by a stressed mood.

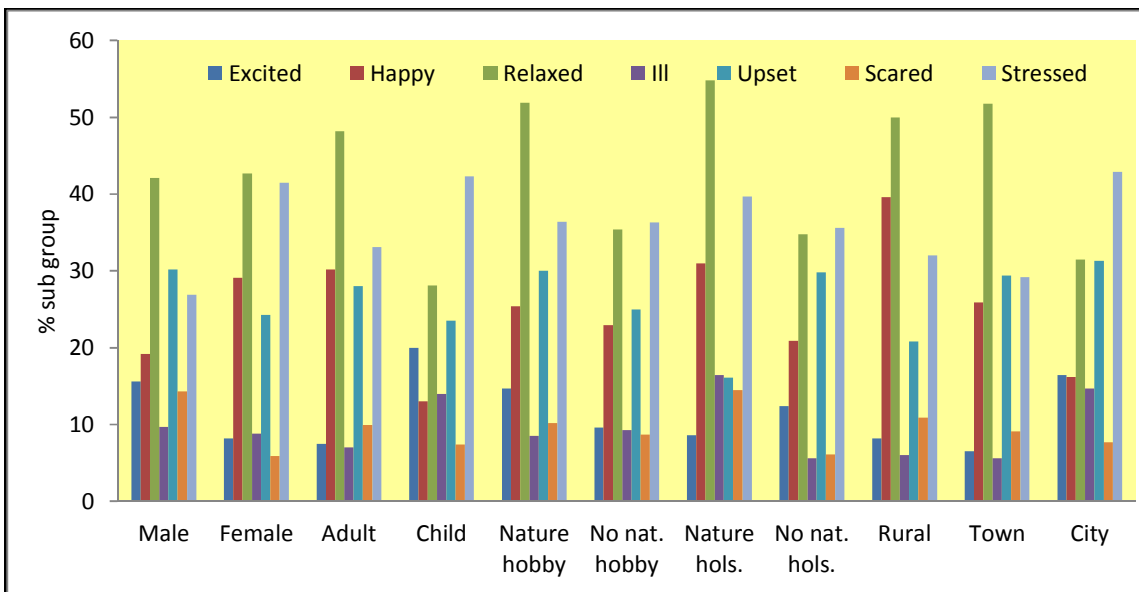


Source: Regan and Horn, 2005

Figure 8 Proportion mentioning each type of nature for each mood state

Combining mood states with demographic variables for those mentioning wild or cultivated nature indicated that the relaxed state was the strongest overall (Figure 9). While both males and females were relaxed, females displayed higher levels of stress although paradoxically they were happier than males. Adults were happier than children and children were more stressed.

Comparing those who had a nature related hobby or who took nature holidays with those not so involved, the former were far more relaxed and happy. Those who took nature holidays, however, were the most scared and among the most stressed. There was a pronounced decline in happiness with urbanization, those in rural areas being the most happy followed by towns and cities.



Source: Regan and Horn, 2005

Figure 9 Relationship of demographic variables with mood states for those mentioning wild or cultivated nature

ATTENTION RESTORATION THEORY RESEARCH

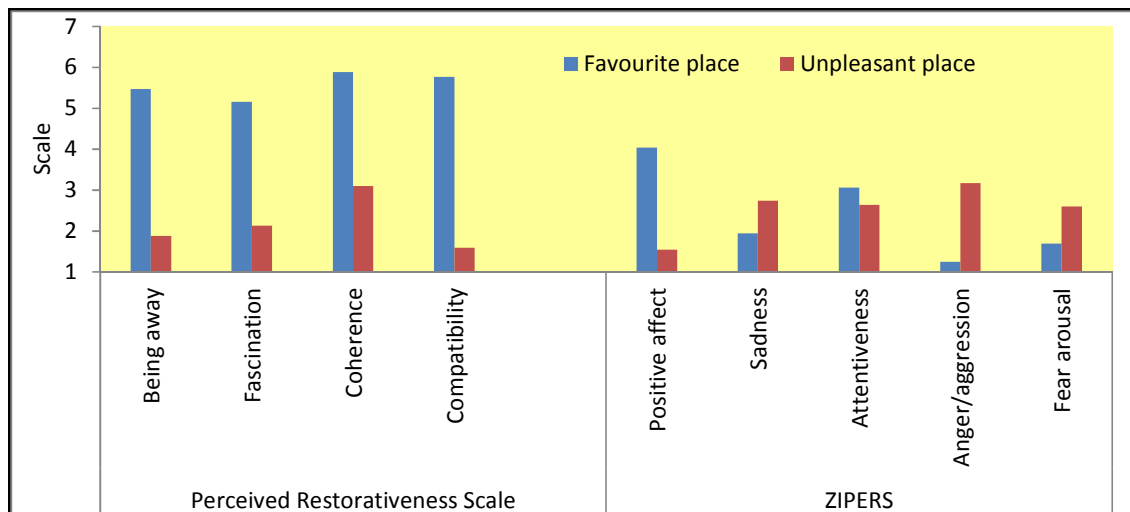
The following research has been conducted into Attention Restoration Theory (ART). These are presented in chronological order. To reiterate, ART comprises four components:

- *Fascination* - serves to help recovery from the fatigue of directed attention;
- *Being away* – separation from mental activity;
- *Extent* - the diversity and scope of the environment to provide an alternative setting sufficient to remain engaged;
- *Compatibility* between “the environment and one’s purpose and inclinations.”

In an early study about restoration, Korpela (1991) asked 17 and 18 year old school students about their favourite places and what experiences and feelings they have there. Their favourite places were in the home (39%), restaurants and downtown (16%), sports facilities and natural settings (10% each). Such places helped them recover from fatigue but also provide them with space to deal with social and internal conflicts. Korpela has followed up this study of favourite places with many further studies.

Korpela and Hartig (1996) asked how individual ratings of favourite and unpleasant places corresponded with ART. Nearly 80 Finnish students were asked to choose and evaluate their own favourite and unpleasant places using the Perceived Restorativeness Scale (PRS) which represents ART factors. The students completed the ZIPERS scale which measures emotional states before undertaking the PRS. Using colour slides, beautiful views were noted by 83% of students (compared with 16.7% of unpleasant places), 73% noted the presence of water (vs 17.9%), and factories and urban places were generally regarded as unpleasant.

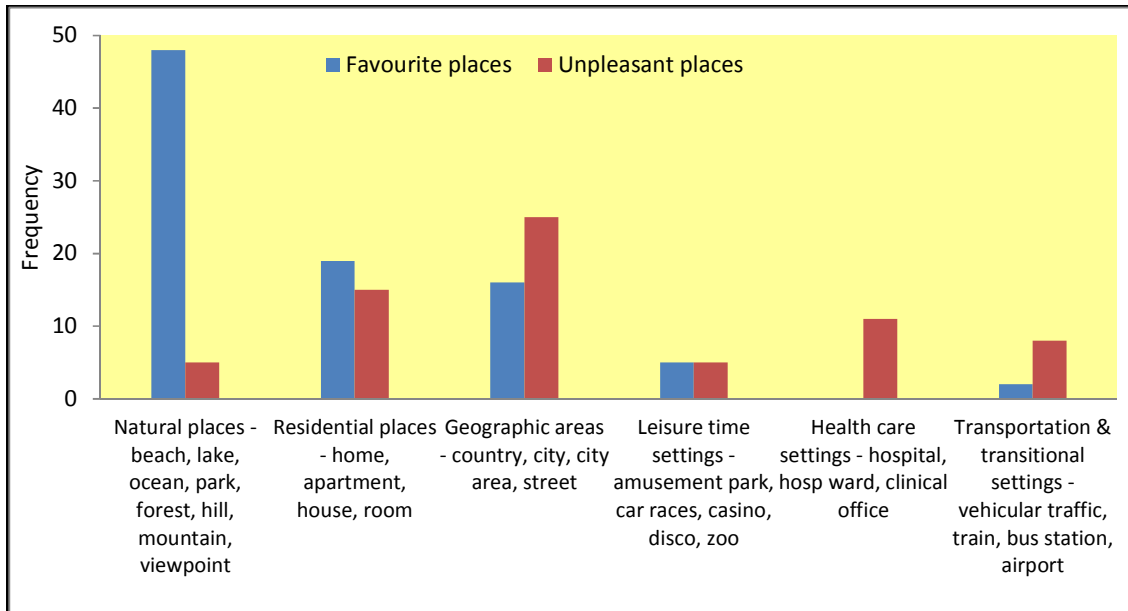
Figure 10 compares the PRS and ZIPERS results for the favourite and unpleasant places. Affirming their role in restorative experience, favourite places were associated with being away, fascination, coherence and compatibility and were mostly places of greenery, water and scenic quality.



Source: Korpela & Hartig, 1996. PRS = Perceived Restorativeness Scale; ZIPERS = Zuckerman Inventory of Personal Reactions

Figure 10 Ratings of favourite & unpleasant places on PRS and ZIPERS scales

Korpela, et al (2001) asked 101 students at Berkeley, California to describe their favourite places and a further 98 students describe their unpleasant places. Half of the favourite places were natural areas - beach, lake, ocean, park, forest, hill, mountain, viewpoint and a further 20% were residential places (Figure 11).

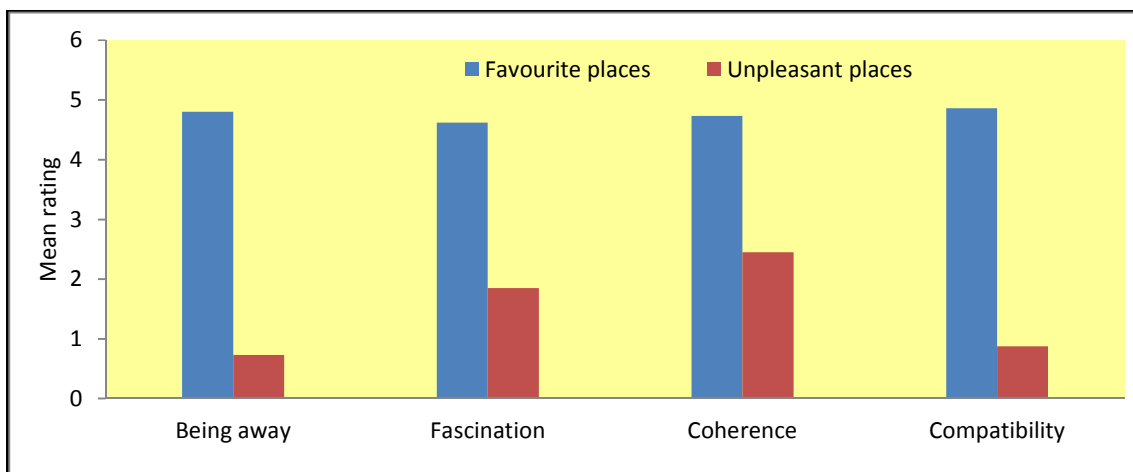


Source: Korpela, *et al*, 2001

Figure 11 Favourite and unpleasant places (top 6 out of 10)

Natural areas were under represented in unpleasant places – less than 5%. Unpleasant places were described as the bad part of town, noisy downtown, or poverty-stricken country, dirty and ugly housing, dirty beaches and trashy parks.

Asked about the experiential qualities of favourite and unpleasant places, the participants spoke of being relaxed, being away from everyday life, forgetting worries, and reflecting on personal matters, all indicative of a link between favourite places and a restorative experience (Figure 12). Places were unpleasant because of an unpleasant people/cultural or social atmosphere, wanting to get out or avoid, or feeling uncomfortable, unsafe, scared or angry. In terms of the four restorative qualities, favourite and unpleasant places differed greatly with favourite places, all rating as high in restorative quality. Unpleasant places registered less than halfway on the scale.

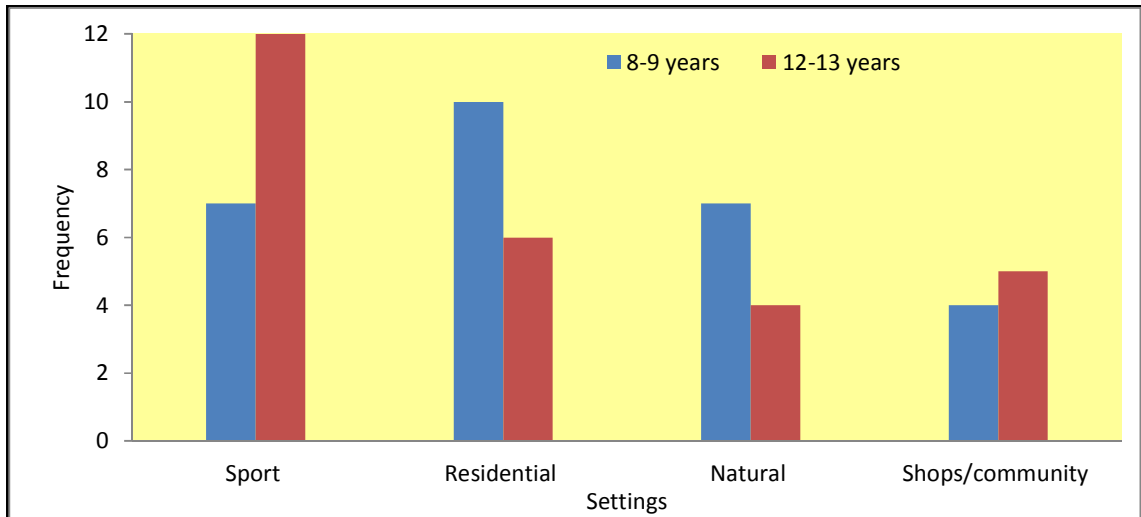


Source: Korpela, *et al*, 2001. Note: Coherence is the same as extent

Figure 12 Favourite and unpleasant places by Attention Restoration Theory components

Korpela, *et al*, (2002) extended research of favourite places to children, surveying 55 children in Finland. Sports settings and residential settings were their favourite places and natural

places did not predominate (Figure 13). Girls more than boys favoured natural areas. As the children grow older they appear to trade home for sports places.



Source: Korpela, *et al*, 2002

Figure 13 Favourite place of children by age group

Over half the children (55%) use favourite places for cognitive restoration, places where they pour out and forget their troubles, and feel free and relaxed. They are also used to recharge after difficult situations such as set-backs and feeling down.

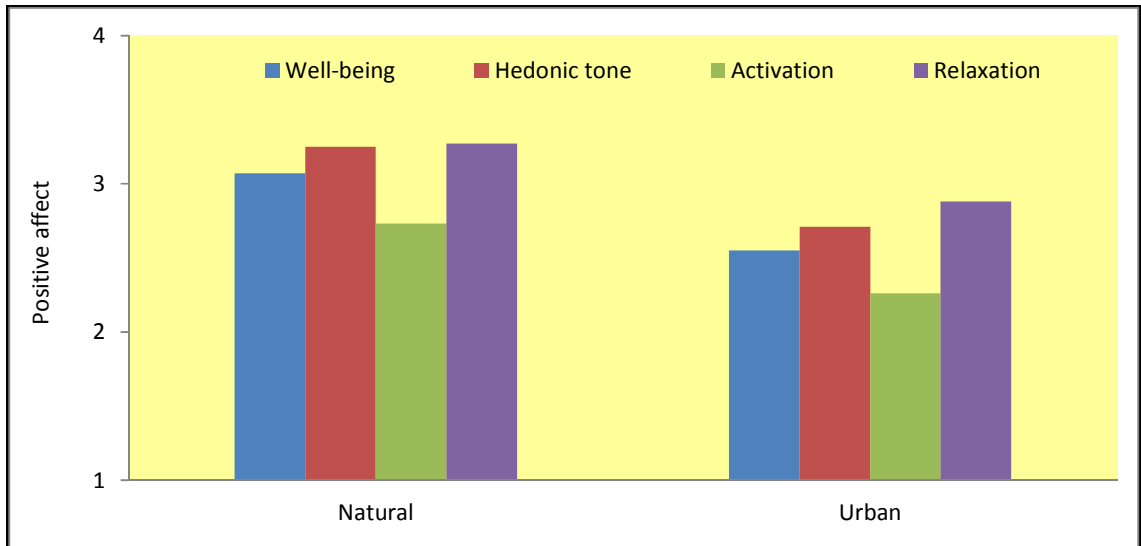
Korpela and Ylén (2007) found that people with health issues were more likely to relax in a natural favourite place and gained greater emotional benefit than people without complaints.

Helsinki and Tampere in Finland are cities with over 25% green space. Korpela *et al* (2008) asked residents in both cities about their restorative experiences in their favourite places. They found each setting (nature areas, urban parks, water spaces, etc) yielded different restorative experiences. The authors suggested using “favourite place prescriptions” as a supplement to “exercise prescriptions” in healthcare.

In a follow-up survey 10 months later of the same respondents, Korpela *et al* (2009) found that two-thirds selected the same main favourite area with urban woodlands and waterside environments the most often selected. They also found greater stability in the repeated use of natural areas compared with urban areas.

Using the same sample as the 2008 and 2009 studies, Korpela *et al* (2010) found that the more worried about money and work a person was, the more stressed they felt and the fewer the visits to favourite restorative places. However when they did visit these places, they gained a higher degree of restorative experience than when they were less stressed.

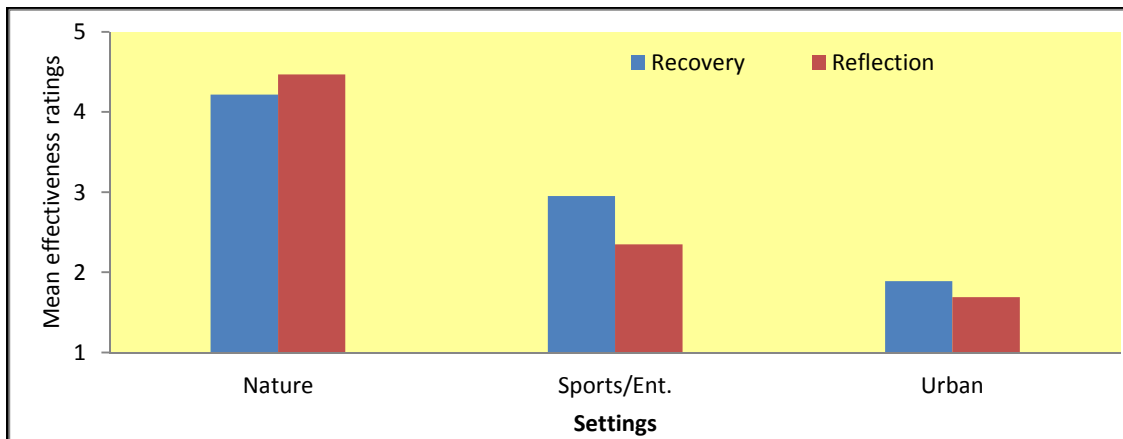
In a study to compare the Kaplan and Ulrich theories, Hartig *et al* (1996) tested the emotional and performance effects on Swedish students using slides of walks through natural and urban environments. Attentionally demanding tasks were undertaken prior to viewing the scenes, the ZIPERS test used to assess emotional states. A physiological measure of stress (cortisol in saliva) was tested before and after viewing the scenes. Oddly, the study found greater sadness after viewing the nature slides, which they attribute to the bittersweet experience of ending a pleasurable activity. The positive affect scores were significantly lower for the urban scenes than the nature scenes (Figure 14).



Source: Hartig, *et al*, 1996

Figure 14 Mood Adjective Check List scores

Two key components of restoration are recovery and reflection. Herzog, *et al* (1997) tested participants in evaluating scenes of three types of settings to assess how well each contributed towards recovery and reflection, and hence mental restoration. The results (Figure 15) found that natural settings had high restorative potential while urban settings had low potential and sporting and entertainment settings were intermediate.

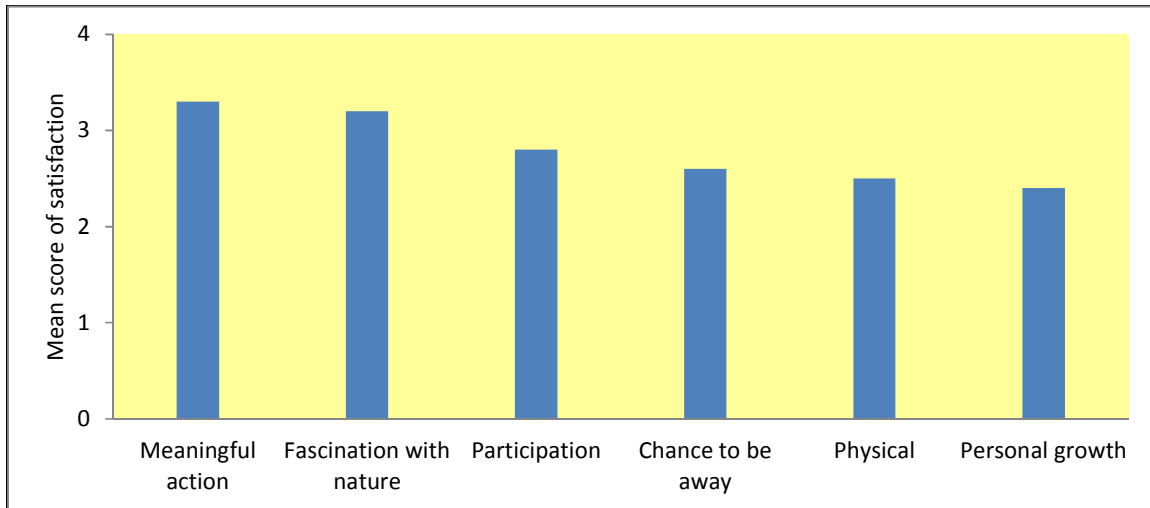


Source: Herzog, *et al*, 1997

Figure 15 Perceived effectiveness rating of settings

If viewing nature provides psychological restoration to the observers, participating in restoring nature must provide such benefits in spades. Miles, *et al* (1998) surveyed volunteers involved with prairie restoration outside of Chicago and measured their satisfaction related to restoration activities, their level of involvement, life satisfaction, and life functioning. The two highest rated sources of satisfaction were meaningful action and fascination with nature (Figure 16). Additional measures of their connection with nature also scored high on a 0 – 4 scale:

- Feeling I can play a role in nature scored 3.1;
- Feeling I belong in nature scored 3.2 – representing the satisfaction gained from feeling part of the natural world.



Source: Miles *et al*, 1998.

Figure 16 Sources of restoration satisfaction

Having some classes do environmental restoration work on field trips while other classes did little or none, Bowler *et al* (1999) found that the students who had participated gained positive environmental attitudes and behaviour and their restorative qualities improved.

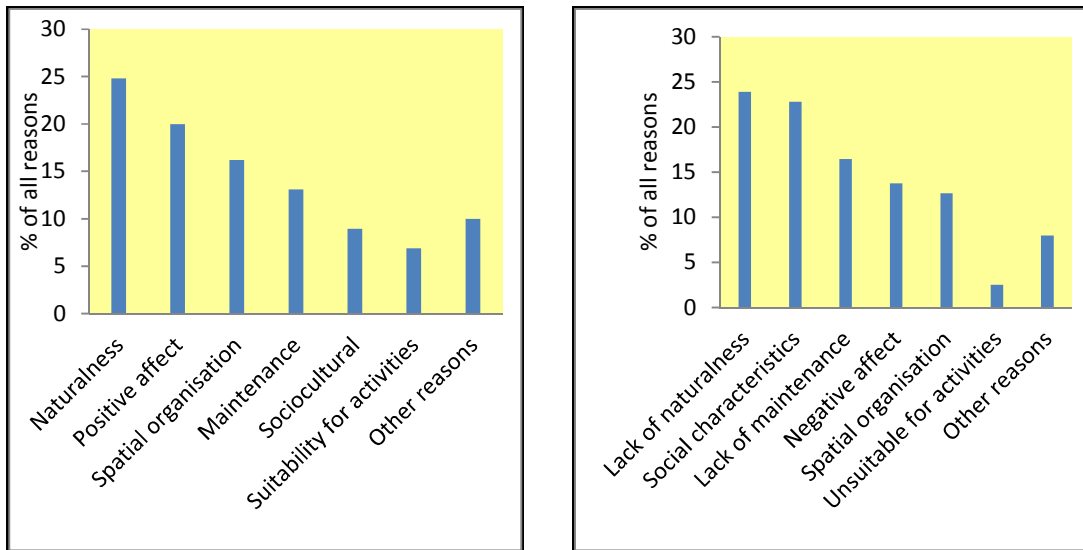
Galindo and Rodriguez (2000) tested students in Seville, Spain with photos of urban Seville and related their general preferences for the 50 scenes with their appraisal of one of the photos on the basis of affective variables – comfortable, excitement, distress, boredom, tranquility, safety. Aesthetic preferences correlated highest with comfortableness and excitement, demonstrating the psychological benefits provided by attractive environments (Table 1).

Table 1 Correlations of aesthetic judgments with aesthetic responses (Pearson's r)

Aesthetic judgment	Comfortableness	Excitement	Distress	Boredom	Tranquility	Safety
General preference	.587	.587	-.337	-.38	.381	.346
Aesthetic attractiveness	.667	.625	-.39	-.43	.432	.372

Source: Galindo and Rodriguez, 2000

The top reasons for their high aesthetic value scores were the existence of vegetation, feeling of tranquility, and openness/wide area and the top reasons for low aesthetic value scores were lack of vegetation, deterioration/neglect/ abandonment, lonely place, traffic/ noise/pollution, and feelings of sadness/ distress. Figure 17 shows the reasons (in categories) for the high and low aesthetic value scores. Naturalness or its lack, were the principal reason. Positive feelings (tranquility, comfortable, pleasant) were among the main reasons for high aesthetic value scores.



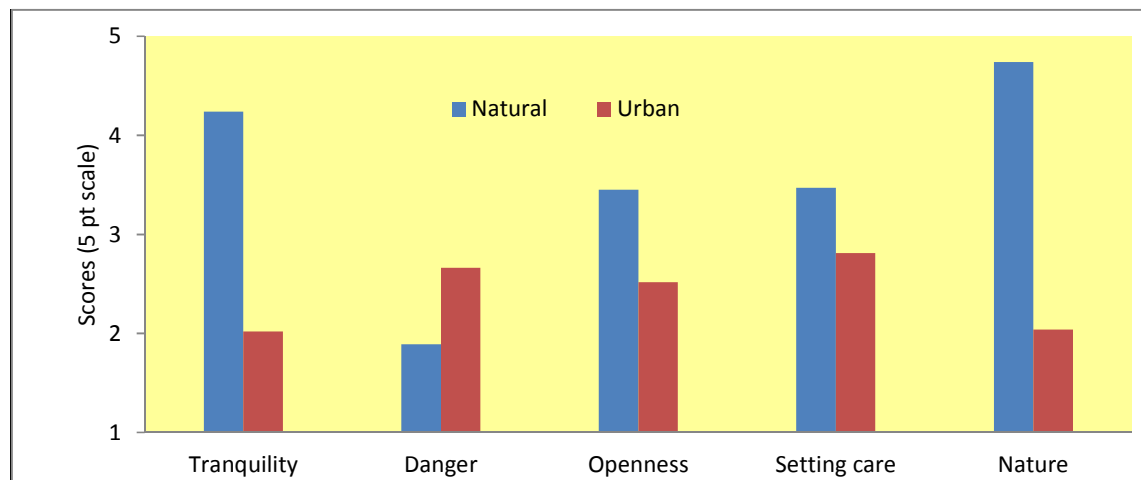
Source: Galindo and Rodriguez, 2000

Figure 17 Reasons for high and low aesthetic value scores

Herzog and Chernick (2000) examined the relationship of tranquility (i.e. the combination of Kaplan's soft fascination with aesthetic pleasure) with perceived danger in urban and natural settings. They also included the degree of care shown in the settings, it being assumed that a scruffy site is more likely to attract dangerous elements. The openness and naturalness of settings were also assessed. The study involved 231 student participants who viewed 48 slides and rated them on a 5 point scale for tranquility - "How much do you think that this setting is a quiet, peaceful place, a good place to get away from the demands of everyday life?" and for danger - "How dangerous is this environment? How likely is it that you could be harmed in this environment?" They were also asked "How well-cared-for does the setting seem to be? Is it in good condition?", "How wide-open is the space in this setting?" and "How much foliage and vegetation is there in this setting?"

Figure 18 shows a clear distinction in the results between the nature and urban settings. The study found:

- Tranquility rated higher in natural than in urban settings, while danger rated higher in urban settings;
- Tranquility and danger were negatively correlated across all settings;
- Openness, setting care, and nature related positively to tranquility and related negatively to danger.



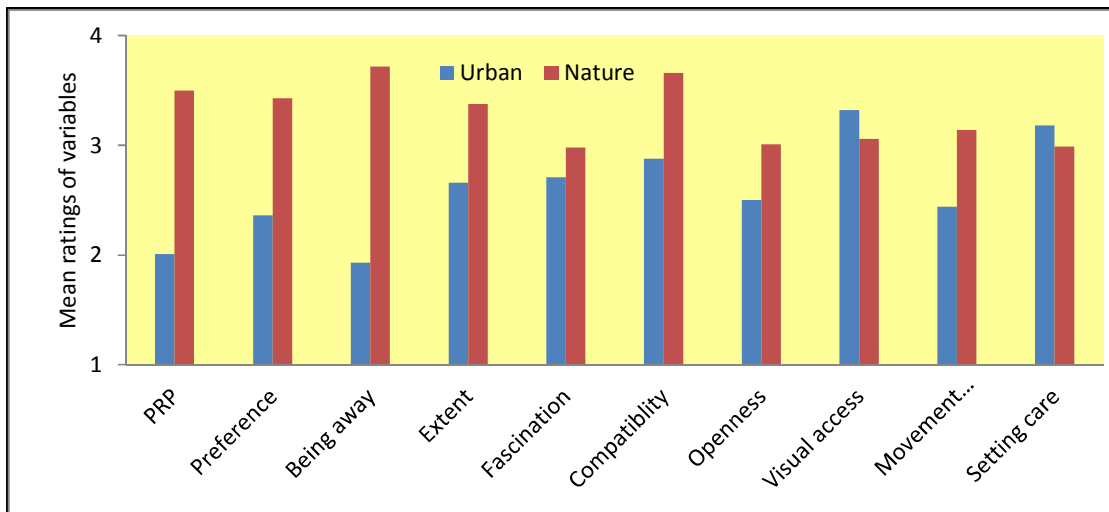
Source: Herzog and Chernick, 2000

Figure 18 Mean ratings of variables for natural and urban sites

The study also found that the degree of care for the natural or urban environment was more important to the perception of danger in urban areas than in natural settings.

Herzog, et al (2002) found that while nature-related activities provided restoration, entertainment and exercise provided greater restoration. They found that having a friend involved affected the restorative effect. Similarly, Staats and Hartig (2004) found that walking alone or with a friend can affect the restorative effect of a walk. While walking in a natural environment provided greater restoration from fatigue than an urban walk, an urban walk with a friend increased preference compared with a walk in a natural environment. This may be due to its greater safety.

In a study which aimed to derive a predictor of perceived restorative potential (PRP) of a setting based on the four restorative components (i.e. being away, extent, fascination and compatibility), Herzog, *et al* (2003) tested students in the Midwest US and their choice of either an urban or a field/forest setting to take a break from an intense and prolonged effort (Figure 19). They also assessed preference for the setting and additional predictor variables (openness, visual access, movement ease, and setting care). Figure 16 shows the mean ratings for all setting categories. Nature rated higher than urban setting in all but two of the variables. The differences were significant for all but the final three. Using regression analysis, they found that the restorative components of being away and compatibility provided positive predictors of perceived restorative potential.



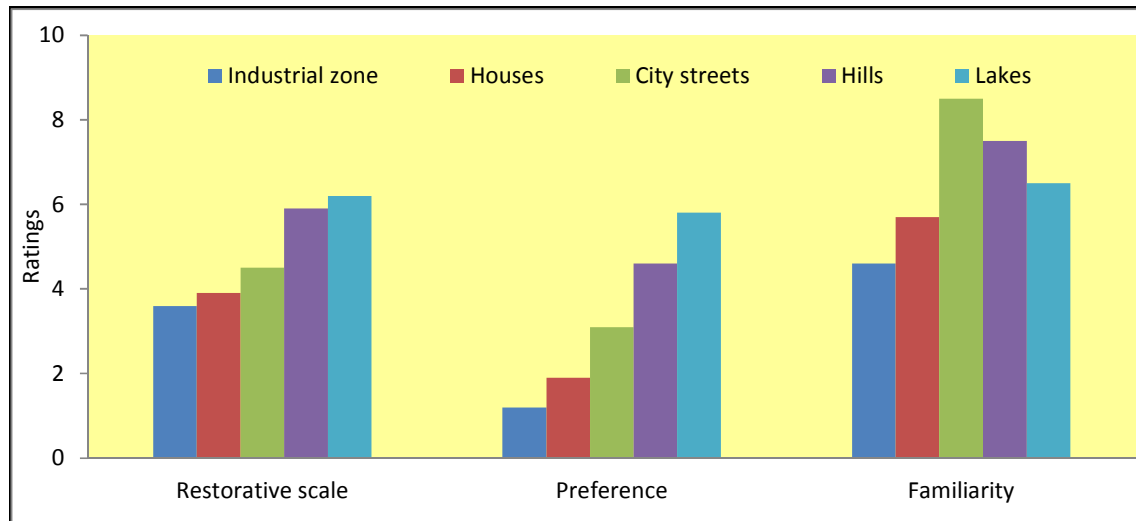
Source: Herzog, *et al*, 2003. Note: 1 – 5 rating (low-high), PRP = Perceived restoration potential

Figure 19 Mean ratings for all rated variables as function of setting

In an unusual analysis, Herzog and Strevey (2008) examined whether there were links between contact with nature and a sense of humour, it being postulated that since nature results in feelings of well-being, that this provides good basis for humour to operate. Identical psychological systems of stress, attention and affect are involved in both. They found that while nature and humour are independent, that they are additive predictors of well-being. Whereas humour appreciation was a good predictor of personal development, contact with nature was the better predictor of effective functioning.

Using Italian students in Padua and scenes of industry, housing, city streets, hills and lakes, Purcell *et al* (2001) assessed the extent by which their restorative effects correlated with preference and familiarity (Figure 20). They found that while the order of restoration and

preference was the same and correlated closely (0.81), familiarity followed a different pattern. Familiarity correlated poorly with both restorativeness (0.31) and preference (0.32). They found that the highest restoration and preference was for scenes of hills and lakes, much more so than for the urban scenes. The mean restoration for nature scenes was 6.05 compared with 4 for urban scenes (150% more), and the mean preference for nature scenes was 5.2 compared with 2.07 for urban scenes (252% more).

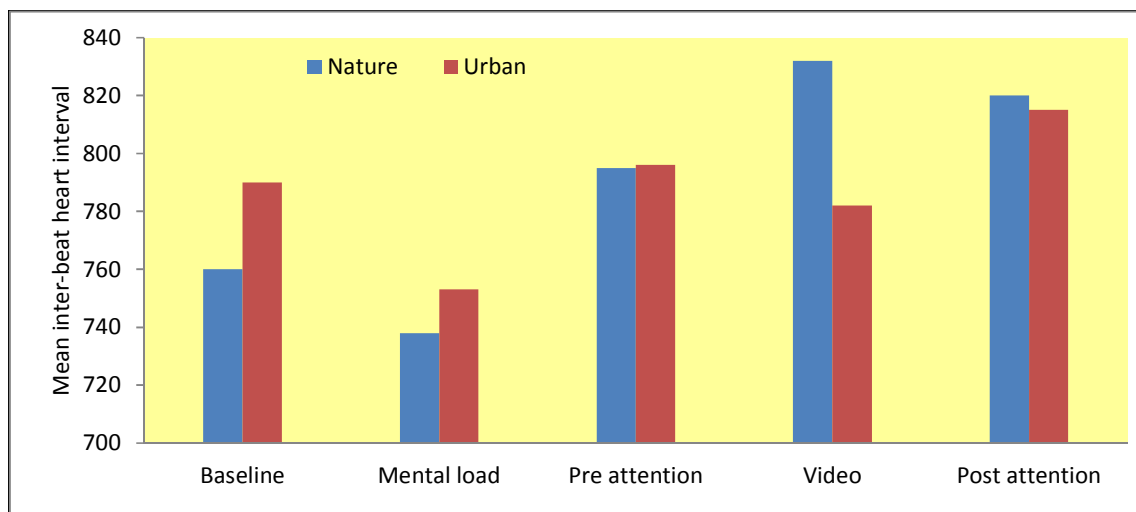


Source: Purcell, *et al*, 2001

Figure 20 Assessment of restoration, preference and familiarity for varying scenes

To assess the physiological effect that viewing videos of nature and urban environments, Laumann, *et al* (2003) tested the heart beat interval of a group of 28 female students in Bergen, Norway. Their heart beat interval was tested prior to and during a mentally tiring exercise involving proof reading, during an attention-orienting task involving valid and invalid cued targets, during viewing a video either of nature or an urban environment, and finally following the video while again doing the attention-orienting task.

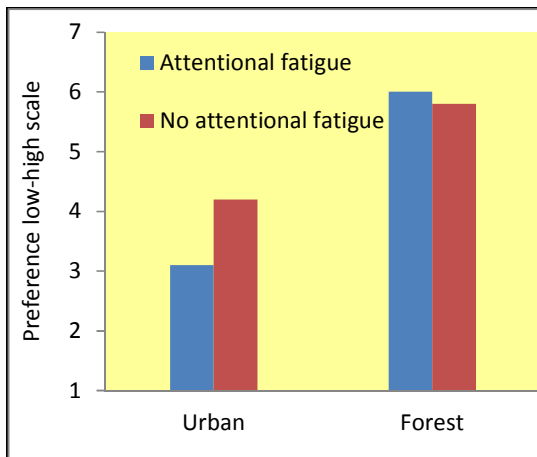
The findings were that those who viewed the nature video had significantly lower heart rate than those who watched an urban video (Figure 21). Following the video, the urban group was still faster on valid vs invalid cued trials but the nature group exhibited no difference. The authors stated that the “findings suggest that the nature video had a relaxing effect on autonomic functions”.



Source: Laumann, *et al*, 2003. Note: Longer IBI = lower heart rate

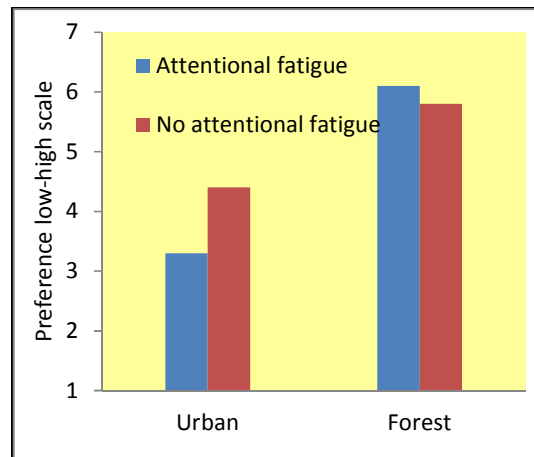
Figure 21 Cardiac inter-beat interval (IBI) in nature and urban groups

Staats *et al* (2003) asked 101 students in Leiden, Holland, to view slides and imagine themselves walking through the centre of Rotterdam or through a forest when they felt either fully refreshed or attentionally fatigued. The results indicated a stronger preference for the natural environment than the urban environment, and the difference was greater when the participants imagined themselves to be attentionally fatigued (Figure 22). Interestingly, while the preference was greater for the natural environment when attentionally fatigued, it was greater for the urban environment when feeling refreshed. Walking in a natural environment engendered more positive attitude than in an urban environment, particularly when feeling attentionally fatigued (Figure 23).



Source: Staats, *et al*, 2003

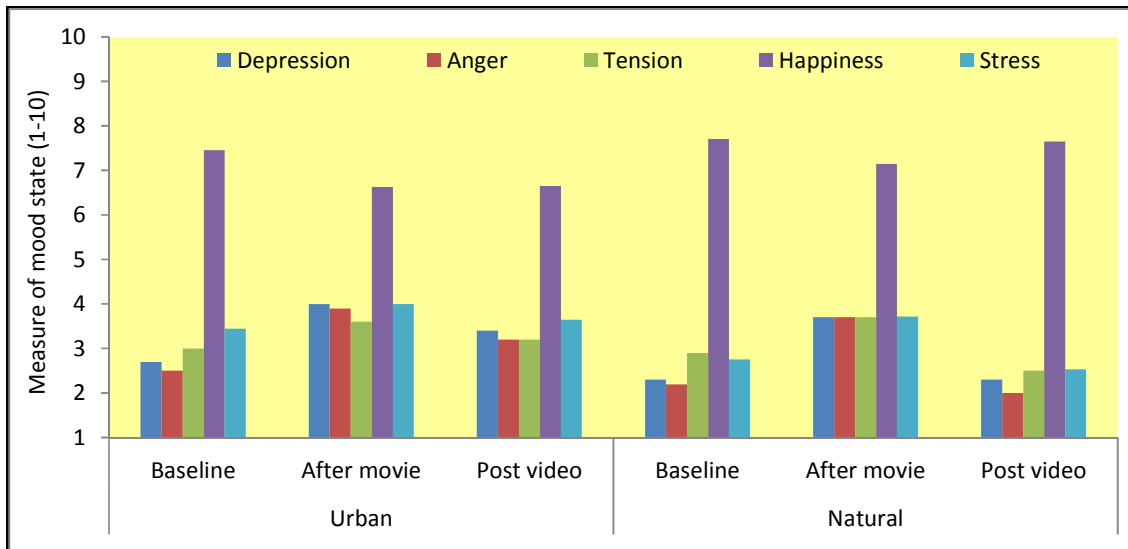
Figure 22 Preference for environment given attentional fatigue or no attentional fatigue



Source: Staats, *et al*, 2003

Figure 23 Attitude for walking in environment given attentional fatigue or no attentional fatigue

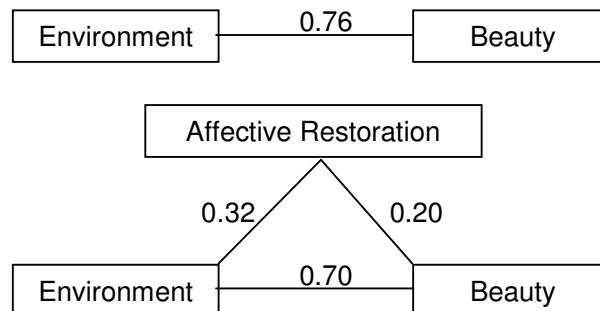
Van den Berg *et al* (2003) showed Dutch participants clips from a frightening movie (animal killings) followed by videos of natural and urban (Utrecht) environments, measuring mood states prior to and after the movie and after the video. They also rated the environments for beauty and naturalness. Those who viewed videos of natural environments showed greater restoration on all five affective measures whereas those who viewed the built environments experienced lesser affective restoration (Figure 24). Use of the horror movie also showed that restoration occurs from anxiety-based stress.



Source: Van den Berg *et al*, 2003. Note Happiness and Stress originally 1 - 100 scale, converted here to 1 - 10 scale.

Figure 24 Mood states as a function of environment type and timing of measurement

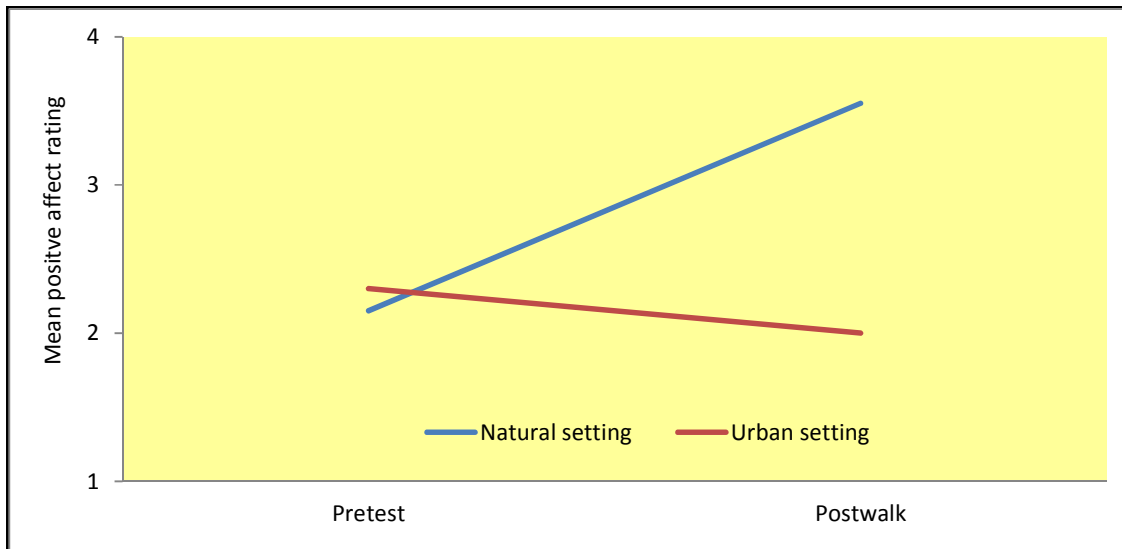
Using regression analysis, the study also showed a strong relationship between environment and beauty (Figure 25 – upper part). Natural environments rated 6.75, considerably higher than 3.26 for built environments. In the lower part of Figure 25 those who viewed the natural environments scored higher on the affective restoration factor than the participants who viewed built environments. There was also a positive relationship between affective restoration and beauty, even when the environmental influence was held constant.



Source: Van den Berg *et al*, 2003. Note: Coefficients are standardized β

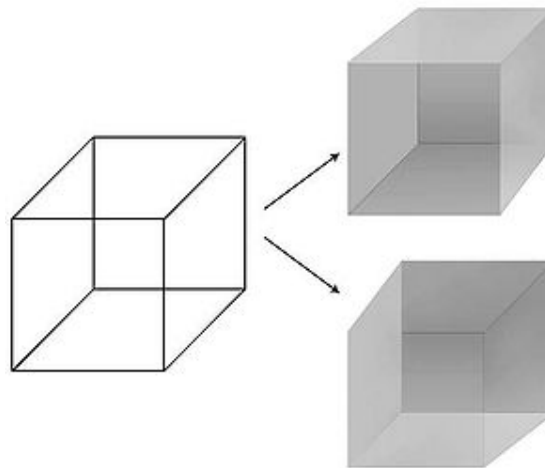
Figure 25 Unmediated model (upper) and mediated model (lower) of the effect of environment on beauty

Using students at Irvine, California, Hartig, *et al* (2003) compared stress recovery and restoration from directed attention in natural and urban settings using physiological and psychological tests involving demanding tasks and driving to a nature site. The self-administered measure of overall happiness before and after the walk in natural and urban environments found an increase from the natural setting and a decrease from the urban setting (Figure 26). Other tests showed that anger decreased in the nature reserve by the end of walk, but increased in the urban environment.



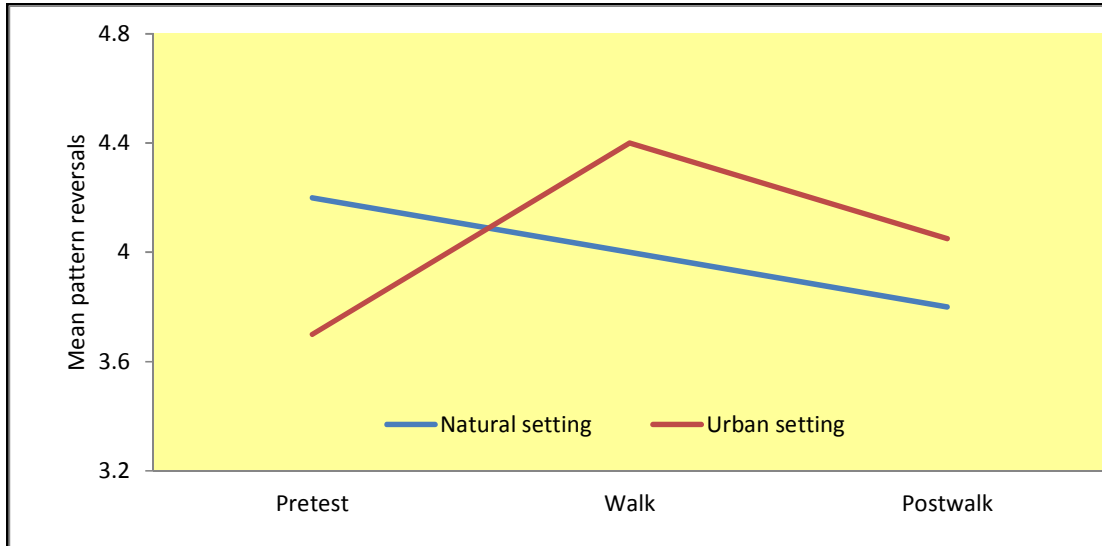
Source: Hartig, *et al*, 2003. Scores 1 – 5 range; no task option. Higher scores more positive affect.
Figure 26 Change in self-reported positive affect as function of environment and task condition

The Necker Cube Pattern Control Task (NCPCT) was used as a measure of attention. The test involves looking at a line drawing of a cube which can be perceived as from the front or from the back but not the two together (Figure 27). The number of reversals in over 30 seconds is a measure of attentional fatigue, the fewer the better. Figure 28 shows a downward trend for the nature setting while the reverse occurred in the urban setting, “opening a performance gap that persisted through the postwalk NCPCT administration.”



Source: Wikipedia

Figure 27 Necker Cube

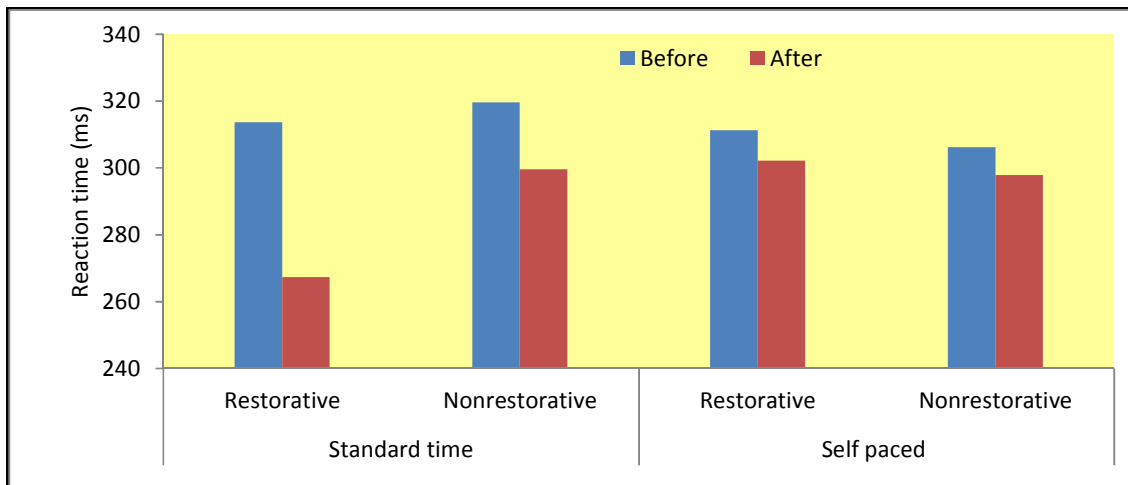


Source: Hartig, *et al*, 2003. Scores 0 – 11. Values represent pattern reversals that occurred despite effort to maintain a focus on one pattern. Downward trend indicates fewer reversals and hence improved performance.

Figure 28 Change in performance on NCPCT as function of environment condition

Overall, these tests found the natural setting yielded positive physiological effects (lower blood pressure), positive affect (happiness), and better attentional performance while for the urban setting the opposite applied.

In Padova, Italy, Berto (2005) used photographs of nature and urban scenes to represent restorative and nonrestorative environments and tested them before and after a fatiguing attention test. Only the participants exposed to restorative environments regained their attentional capacity to a sufficient degree to perform well on the post-test (Figure 29).



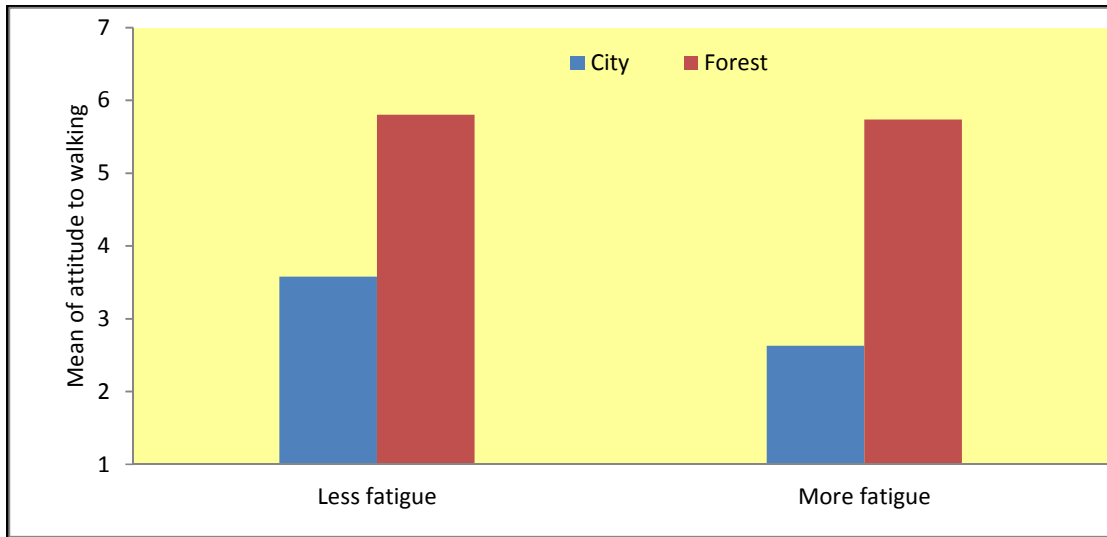
Source: Berto, 2005. Note: Reaction times were one of four measures used in the tests

Figure 29 Reaction times before and after viewing nature and urban scenes

Hartig *et al* (1996) developed a measure of restorative experiences, the Perceived Restorativeness Scale (PRS) comprising 16 items through a series of four studies conducted in the US, Sweden and Finland and through using on-site, video and photos to present the restorative environment. The scale measured the effectiveness of the four aspects of Kaplan's Attention Restoration Theory: being away, fascination, extent and compatibility.

Working on the assumption that gaining restorativeness from natural environments might also lead to ecologically friendly behaviour, Hartig et al (2001) tested the degree of restoration that students gained from a familiar freshwater wetland and compared this with the ecological behaviour. They found that 23% of the variance in behaviour could be explained by the fascination component of Kaplan's ART.

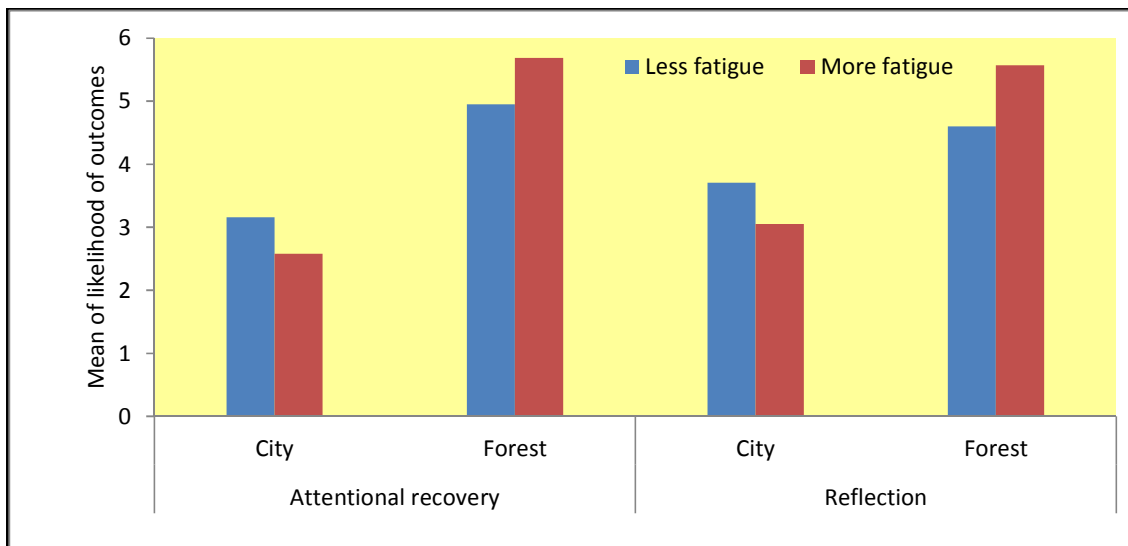
Hartig and Staats (2006) tested the extent to which a walk in a forest or a walk in a city would provide restoration from attentional fatigue and allow for reflection. Using over 100 students in Stockholm, they tested them before and after fatiguing lectures. The students reported more positive attitude towards walking in forest than city (Figure 30).



Source: Hartig & Staats, 2006

Figure 30 Attitude towards walking in given environment as function of attentional fatigue

Recovery from attentional fatigue was more likely to occur in a forest than city and this was particularly true for those with more fatigue where a walk in the city hampered recovery whereas a walk in the forest enhanced recovery (Figure 31). The same pattern occurred for reflection where greater reflection occurred in the forest than the city, and for those with more fatigue, the forest enhanced reflection while the city reduced reflection.



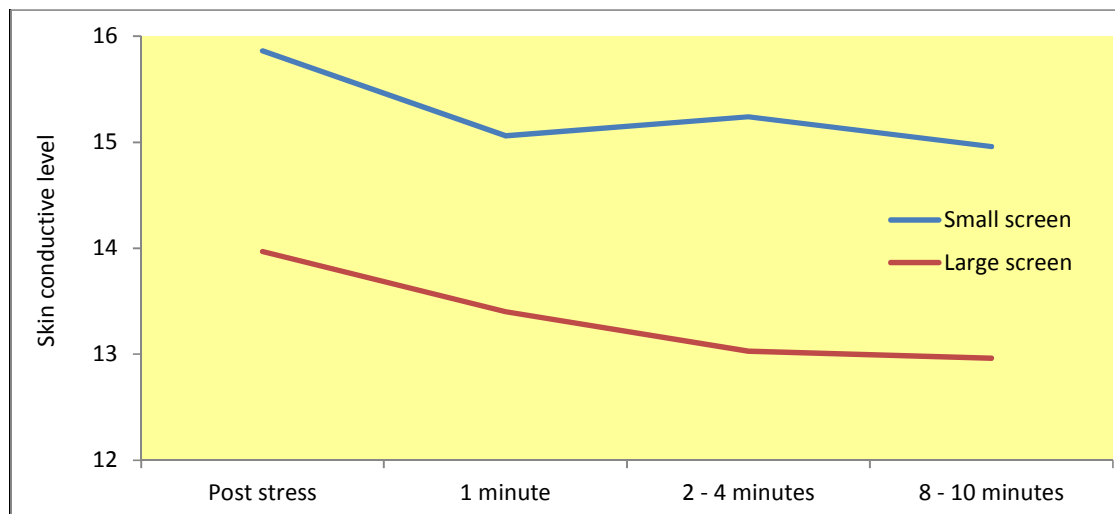
Source: Hartig & Staats, 2006

Figure 31 Judged likelihood of attentional recovery and reflection of walking in given environment as function of attentional fatigue

Positive experiences in natural environments may promote ecological behaviour was the finding from a study in Norway by Hartig et al (2007) which surveyed over 1400 adults regarding their use of the natural environment for personal restoration and relating this to their ecological behaviour.

In a series of three experiments involving exposure of some participants to restorative environments, Berto (2005) found that only those so exposed improved their performance in a sustained attention test, a result which accords with Kaplan's Attention Restoration Theory.

De Kort et al (2006) examined the influence of immersion in the virtual environment in relation to restoration where immersion was achieved through varying the screen size for images. They measured changes in the skin conductance level and the heart's inter-beat interval as well as the participant's self-reported affects. Eighty Dutch students participated in the study which involved a 16 minute stress-inducing task of doing mental arithmetic in a noisy location followed by a 10 minute nature film. Half the group viewed the film on a small screen, 0.25 sq. m. in area, the other half viewed it on a large screen 1.59 sq. m. in area. Immersion was measured after viewing the film by a questionnaire in which they scored questions such as: 'the displayed environment seemed natural', 'I had a sense of being in the scenes displayed', and 'I felt I was visiting the places in the displayed environment'. The physiological measures showed a clear effect of the larger screen in terms of lowering stress and thus improving restoration (Figure 32). They therefore concluded that "immersion enhances restorative potential of a mediated natural environment."



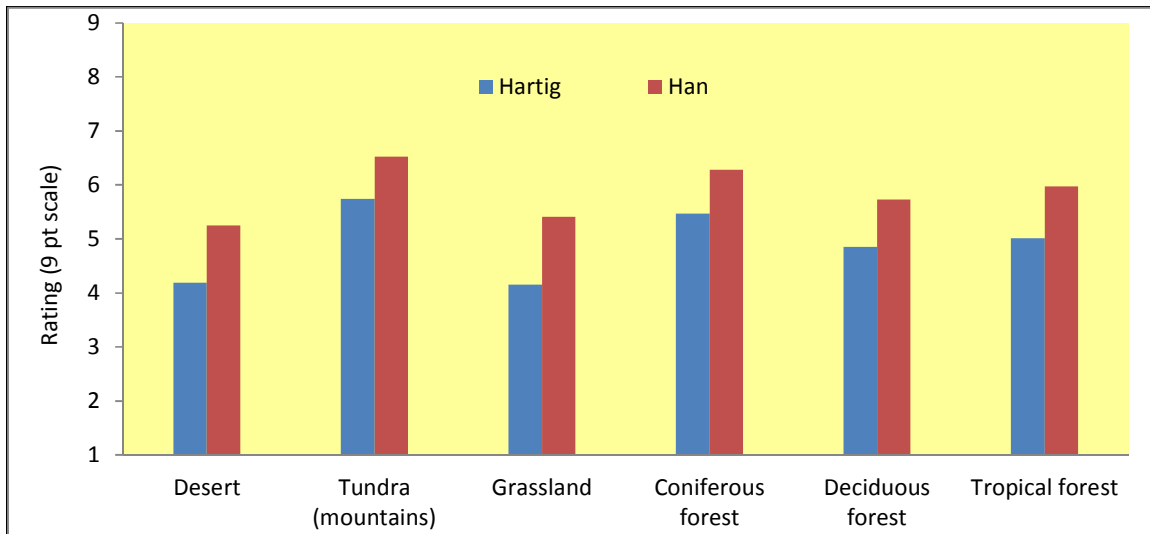
Source: de Kort et al, 2006

Figure 32 Skin conductive level during nature film

Han (2007) used two scales of restorativeness:

1. Short-version revised perceived restorativeness scale (SRPPS) of Hartig et al (1997) covering three dimensions: being away, fascination, and compatibility based on Kaplan's Attention Restoration Theory. The scale contained 12 questions including: I would like to get to know this place better, I have a sense that I belong here.
2. Short-version revised restoration scale (SRRS) of Han (2003) covering four dimensions: emotion, physiology, cognition and behavior based on the theories of both Kaplan and Ulrich. The scale contained 8 questions including: if I was in the scene, I would be breathing faster and my hands would be sweating, I would like to visit here more often.

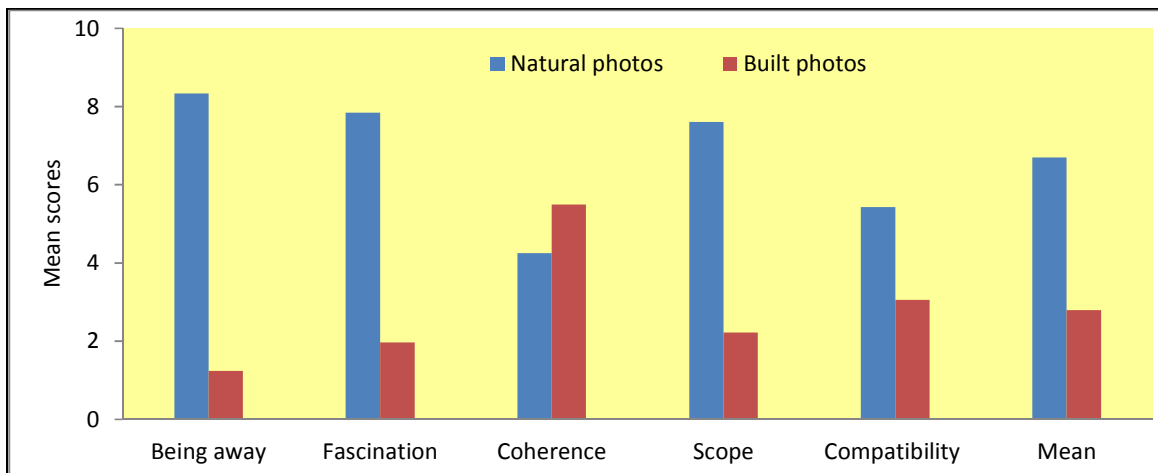
Both surveys were scored by around 90 participants viewing 48 scenes of the six different world biomes. The study found that the tundra scenes followed by coniferous forests offered the highest restorativeness (Figure 33). However (as noted in Chapter 13) the scenes selected of tundra were of snow-capped mountains, not the vast flat snow plains of Arctic latitudes. Grassland and deserts offered the lowest restorativeness.



Source: Han, (2007)

Figure 33 Restorativeness for six terrestrial biomes as measured by two scales

Berto *et al*, 2008 used Eye Position Detector System apparatus to measure saccades (quick eye movements) and fixations of the eye viewing scenes of nature and urban environments representing low and high fascination respectively. Differences in eye movements suggest that less effort is required to view nature than urban scenes which is consistent with Kaplan's soft fascination. In preparing the experiment, Berto had participants assess 100 photographs on the Perceived Restorativeness Scale which covers the ART factors (Figure 34). In the *being away*, *fascination* and *scope* factors, the natural scenes scored much higher than the scenes of the built environment.

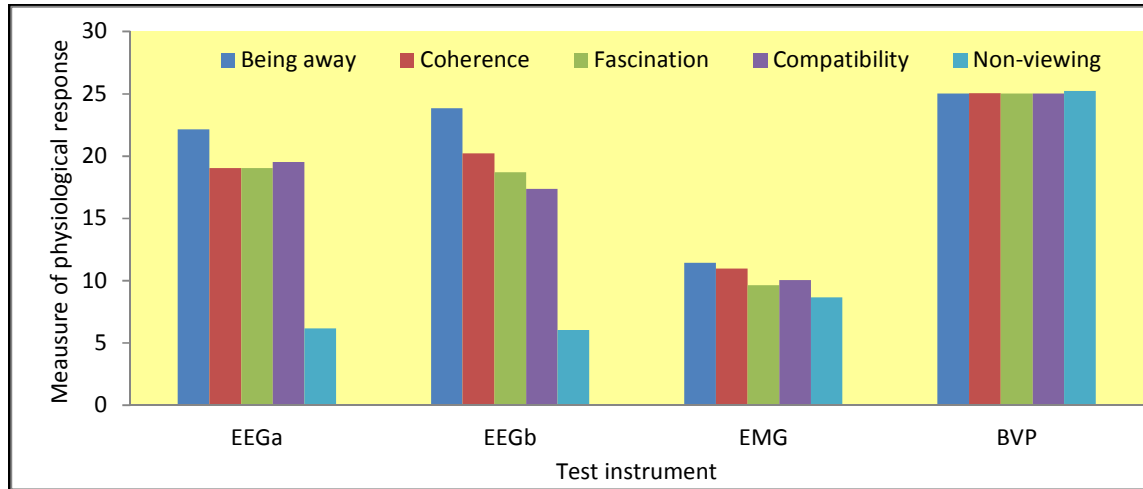


Source: Berto, et al, 2008

Figure 34 Mean scores of restorative factors

Chang *et al* (2008) tested the physiological responses of 110 participants in Taiwan while viewing twelve scenes that represented the restorative components of being away, extent or

coherence, fascination and compatibility. The psychological response was measured with Perceived Restorativeness Scale and physiological responses using electromyography (EMG), electroencephalography (EEG), and blood volume pulse (BVP) measurements. All four physiological measures found improved condition over the non-viewing control condition with EEGa & b and EMG increasing and BVP decreasing. The findings demonstrated a congruency between the psychological response scores and the physiological responses (Figure 35).

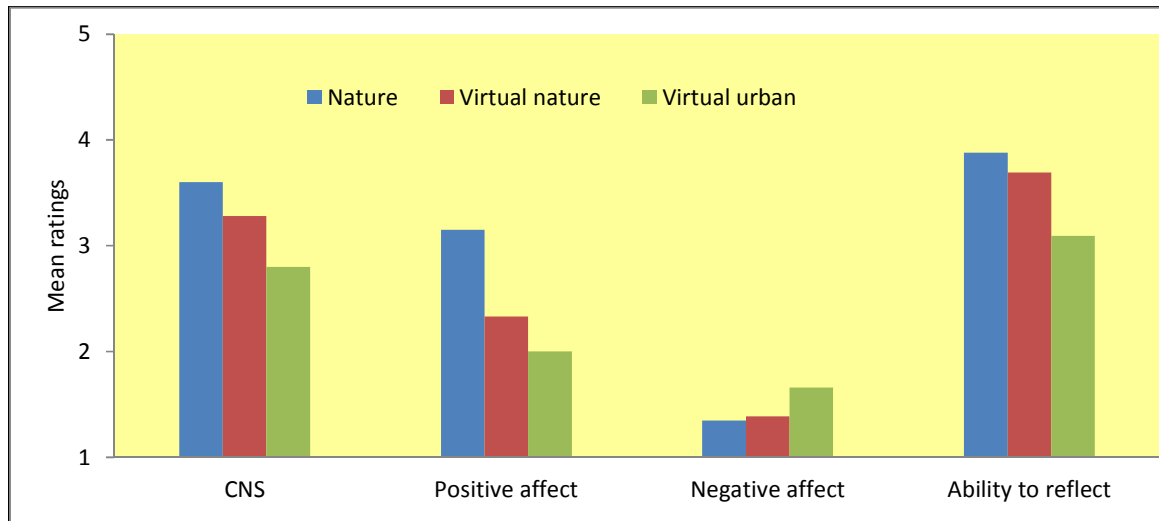


Source: Chang, *et al*, 2008.

Note: EEGa and b measure alpha waves of the left and right sides of the brain

Figure 35 Mean value of respondents' physiological responses

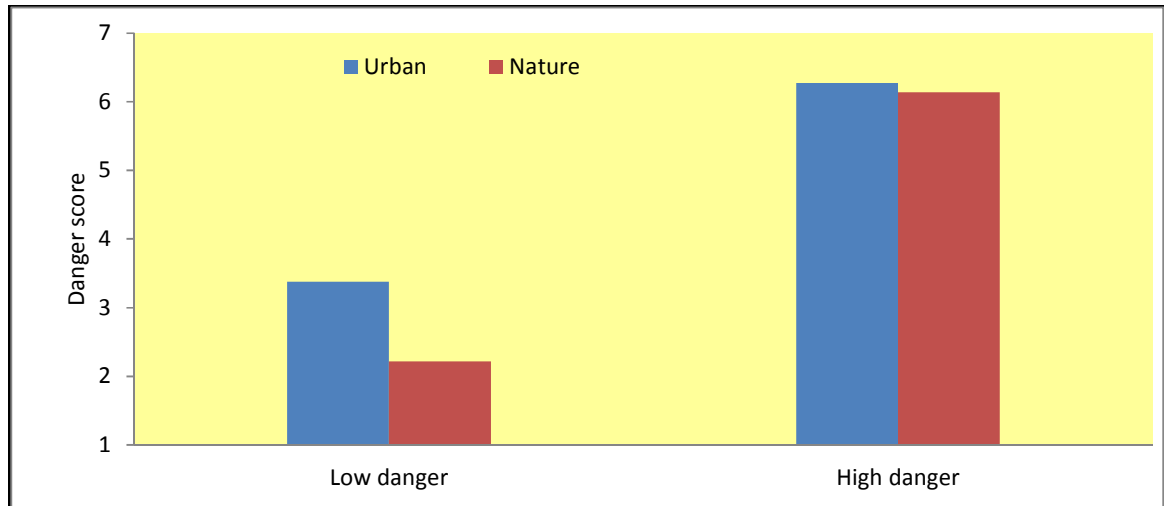
Hypothesising that connectedness with nature would have positive affect, Mayer *et al* (2009) had students in an Ohio university walk among, and view videos of, urban and natural settings. Using measures of the experiential sense of connectedness to nature as well as measures of affect and reflection, they found the exposure to real nature via a walk provided substantially more psychological benefits than virtual nature (via videos). Participants were significantly more aware of their immediate environment than were the participants in the virtual-nature condition (Figure 36). Compared with urban videos, nature videos improved the overall positive affect 17% while exposure to real nature improved it by 37% (including connectedness with nature, positive affect, and ability to reflect).



Source: Mayer, *et al*, 2009. Note: CNS = by Connectedness to Nature Scale

Figure 36 Mood states for three conditions

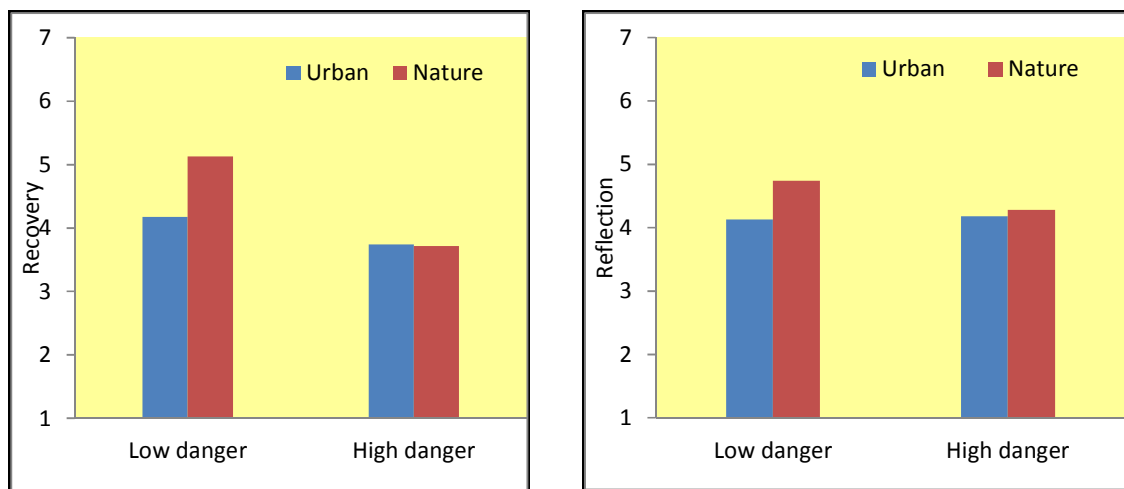
Herzog and Rector (2009) were interested in the degree of danger that is perceived in walking in places that are potentially restorative, including a nature trail and a busy urban street. Students read two scenarios involving two levels of perceived danger – a feeling of danger, and being followed by a stranger. They tested the effect on recovery from fatigue, freedom for reflection and preference. Urban settings were regarded as more dangerous when no obvious danger existed but in the presence of high danger, both settings were regarded as dangerous (Figure 37).



Source: Herzog & Rector, 2009

Figure 37 Perceived danger for urban and nature settings

For recovery and reflection, the two settings differed significantly in conditions of low danger but were virtually identical in high danger (Figure 38). The nature setting assists recovery and reflection more than the urban setting when no obvious danger is present but in conditions of high danger loses its appeal and is reduced to the same level as the urban setting. Thus the perceived presence of danger reduces the restorative benefits of nature compared with the urban setting, and in conditions of high danger, eliminates it altogether. A walk in the woods is only restorative if people feel safe.

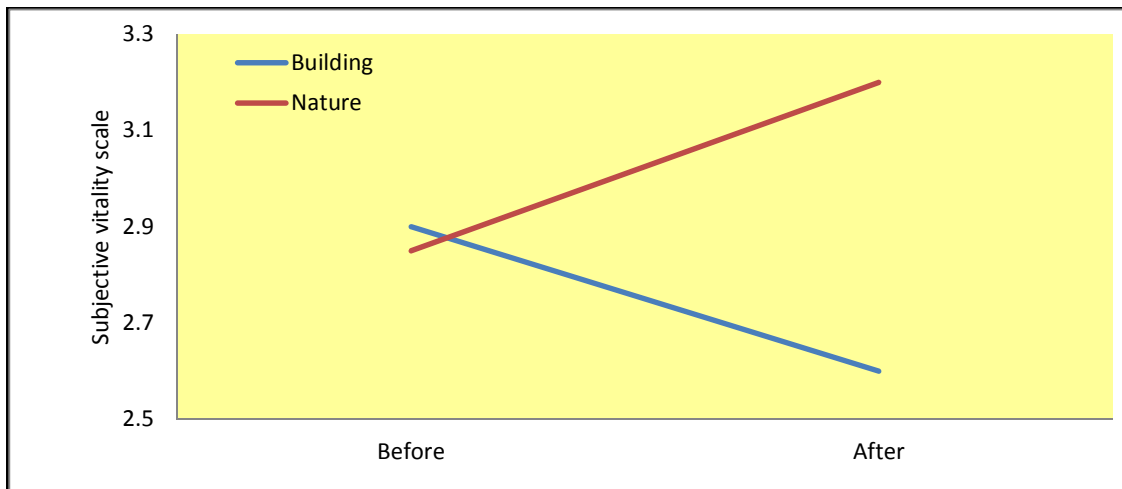


Source: Herzog & Rector, 2009

Figure 38 Recovery and reflection in urban and nature settings when faced by danger

Ryan, *et al* (2010) extended the concept of restoration to include vitality. Whereas he considers restoration means positive but low-energy states such as relaxation, his concept of

subjective vitality involves positive but high-energy states such as are gained by an energetic bike ride or run. He had participants from Rochester, New York, imagine themselves in different settings depicted on slides which they looked at for an extended time (2 minutes each). Using a Subjective Vitality Scale he measured their state of vitality before and after viewing the scenes. There were four scenes each of nature or of building. A recorded script accompanied each slide to help them be immersed in it. The study found similar results for males and females and an increase in vitality for those viewing nature scenes and a decrease for those viewing building scenes (Figure 39).



Source: Ryan, *et al*, 2010

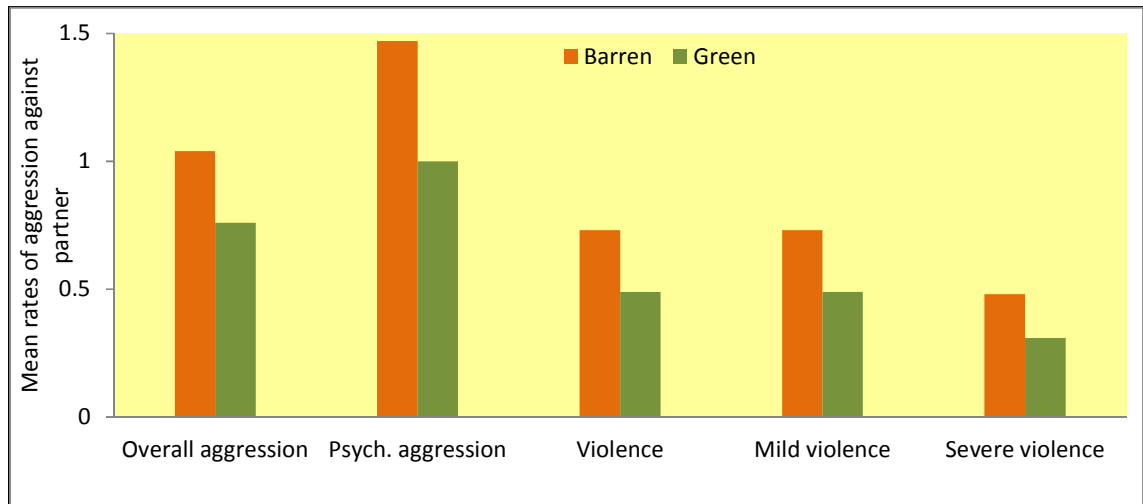
Figure 39 Interacting effects of nature or building slides on vitality over time

ADDITIONAL RESEARCH OF THE HEALTH ASPECTS OF NATURE

Nature and violence

Kuo and Sullivan (2001a) carried out a very closely controlled experiment among residents in multi-story public housing apartments in Chicago to ascertain whether nature (in the form of trees and grass) outside some of the apartments reduced propensity to anger and violence. Most of the residents were single African-American women in their 30s with several children. They had no control over which apartment they lived in or over the planting of trees and gardens in their surrounds.

The study found that those living with nature outside their apartments had significantly lower levels of aggression and violence than those who lived without trees and grass outside (Figure 40). This applied to both mild and severe violence although it was not consistent for the more violent forms of aggression. In addition, the study found that residents living with green in their vicinity used a smaller range of types of conflicts (e.g. stomping out of room, threatening to hit or kick something, pushing, biting) than those amidst barren conditions. Clearly, the study showed that living amongst nature resulted in less anti-social behavior than in the absence of nature.



Source: Kuo and Sullivan, 2001

Figure 40 Comparison of aggression against partner over past year in green vs barren conditions

Anti-social behavior extends to the neighbourhood in the form of crime. It has been conventional wisdom that thick vegetation and trees promote crime but Kuo and Sullivan (2001b) found the opposite to be true. In a poor public housing neighbourhood of Chicago they found that the greener a buildings surrounds, the fewer the total crimes (i.e. property crime and violent crime). Buildings with high levels of vegetation had 52% fewer total crimes, 48% fewer property crimes and 56% fewer violent crimes than buildings with low levels of vegetation.

An earlier survey by Talbot and Kaplan, R. (1984) of mainly Afro-American residents in low – moderate income in Detroit found that while they liked well-maintained areas, they associated natural densely wooded areas with physical danger. However, they did place a high value on the opportunities to enjoy the outdoors (Table 2).

Table 2 Importance of nature experience

Perceived value	Number
Low (not extremely important)	18
Moderate (not extremely important but part of daily life)	4
High (very important, frequent involvement)	29
Daily life (very important, part of daily life)	45

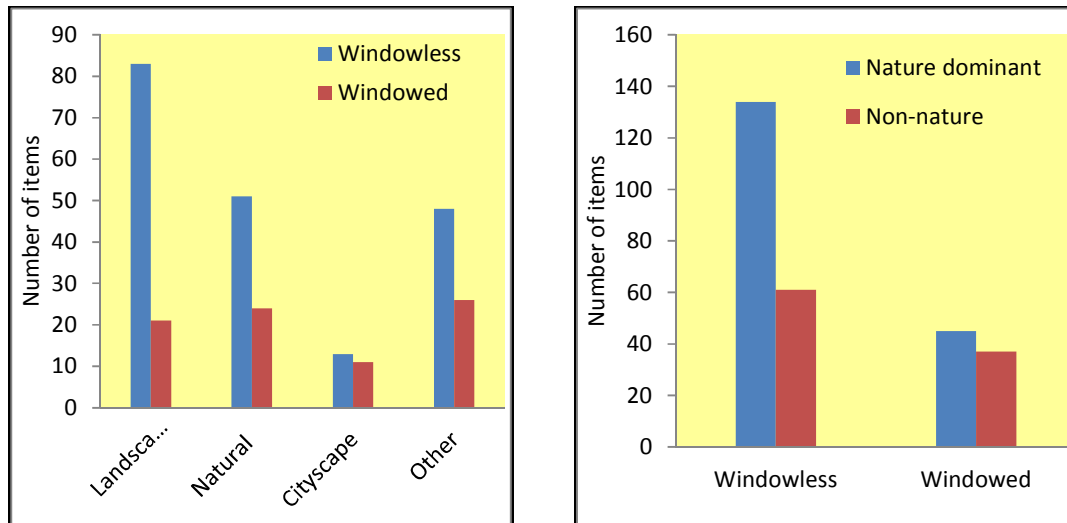
Source: Talbot and Kaplan, R., 1984

An assessment of the influence of nature on children's self-discipline in high rise apartments in Chicago (Taylor, et al, 2002) found that the more natural the view from the girl's home was, her self-discipline improved by about 20%, however for boys no relationship was detected.

Office Posters

Office posters of nature scenes provide a surrogate of the nature view, and while the experience may lack the presence of the actual view, generally the scene will be of a higher quality landscape than is likely to be visible from the office window.

Heerwagen and Orians (1986) examined the décor in 75 campus offices at the University of Washington in Seattle. Half the offices (37) had windows and the remaining 38 were windowless. The study found that the windowless offices had more than twice the number of posters and items on the wall as the windowed offices, 195 items compared with 82. Moreover, the windowless offices had four times as many scenes of landscapes than windowed offices (Figure 41a). Landscapes outnumbered cityscape posters in windowless offices six-fold whereas in windowed offices they were only twice as many. Combining the landscape and posters of other natural objects (e.g. flowers, animals), windowless offices had three times more nature materials than did the windowed offices, and they used more than twice as many nature items as non-nature items (e.g. abstract paintings, collages, crafts) (Figure 41b).

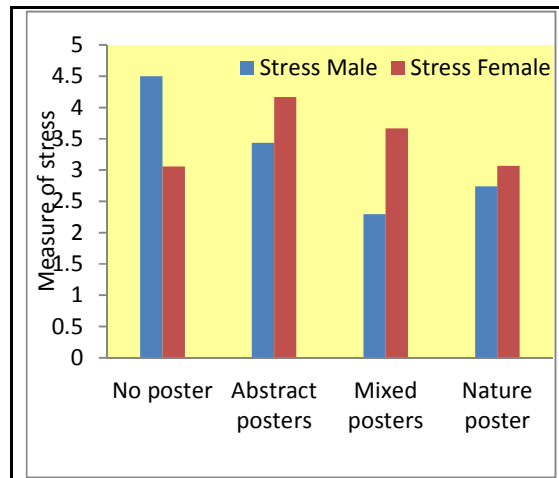
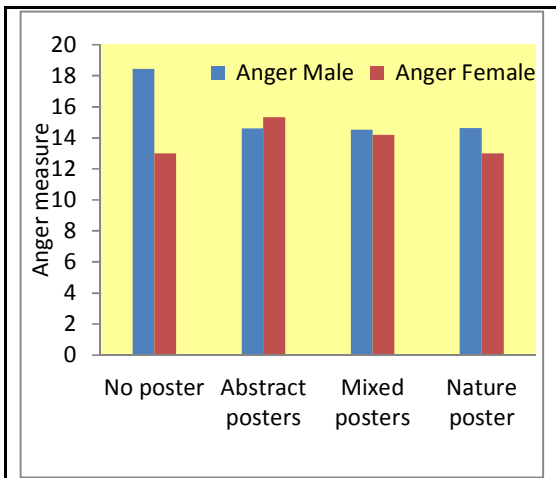


Source: Heerwagen & Orians, 1986

Figure 41a and 41b Comparison of décor in windowless and windowed offices

Kweon, *et al* (2008) asked students at Texas A&M University to undertake some frustrating computer exercises in four different office environments, one with no posters, one with abstract posters, one with nature posters and one with both abstract & nature posters. Male and female students, 210 in all, participated. The study made no mention of the posters which simply decorated the offices. The computer tasks required high attention and were very difficult, providing negative feedbacks and with loud beep adding to the annoyance. The participants used tests to measure their anger from the test and the stress involved.

The results found the highest levels of state anger and stress for males was with offices without posters, whereas for females it was offices with all abstract posters (Table 3, Figure 42). Mixed art posters (abstract and nature) produced the lowest levels of anger and stress for males whereas the lowest levels for females were offices with all nature posters. Stress- and anger-reducing effects of posters tended to be greatest when nature content was present in the posters.



Source: Kweon, *et al*, 2008

Figure 42 Anger and stress associated with office posters

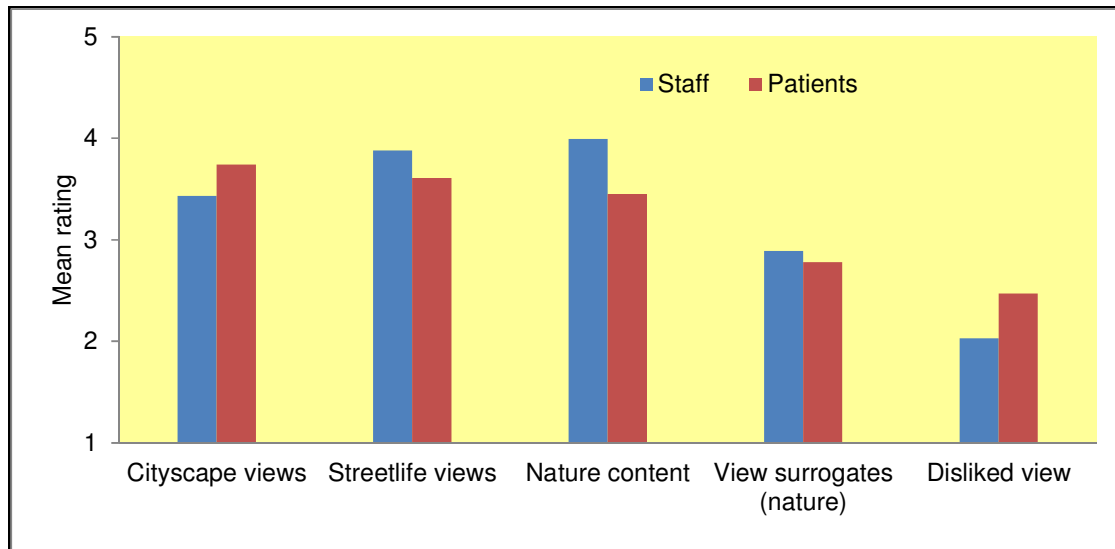
Table 3 Stress and anger associated with office posters

Office conditions	Anger			Stress		
	Male	Female	Total	Male	Female	Total
No poster	18.45	13.00	16.03	4.50	3.06	4.02
Abstract posters	14.61	15.33	14.97	3.44	4.17	3.79
Mixed posters	14.51	14.19	14.35	2.30	3.67	2.92
Nature poster	14.63	13.00	13.94	2.74	3.07	3.03

Source: Kweon, *et al*, 2008

Views from windows

Complementing Ulrich's 1984 study of views from hospital windows (see Figure 1), Verderber (1986) surveyed patients and staff at six hospitals in Chicago with windows and windowless rooms. Using 56 colour photos of rooms ranging from "highly windowed" to windowless, he surveyed their preferences. Among staff, nature content of windowed rooms was the most preferred (Figure 43). Among patients, preferences of nature views were slightly lower than views of the busy city and streetlife. Interestingly, where there were no windows, nature surrogates, which included plants, pictures and calendars, provided some satisfaction but "artificial 'views' were nearly always less preferred than real views.



Source: Verderber, 1986

Figure 43 Influence of view on preference ratings, Chicago hospitals

Kaplan, et al, 1988 conducted a survey of office workers, 55 without a view and 60 with a view of natural elements. Survey forms provided to all with Likert scale question covering perceived job stressors, restorative opportunities, life satisfaction, physical health and job settings. Workers without a view averaged 3.02 ailments over the previous 6 months whereas those with a view averaged 2.45, a statistically significant difference and a 19% improvement. Those with a view claimed greater job satisfaction.

Kaplan, et al, 1988 conducted a survey of 615 office workers, mainly women, to examine whether plants and nature can help people cope with daily hassles. The survey questionnaire included whether they could see outside and what they saw and whether it was restorative. Satisfaction related strongly with whether they could see out a window but viewing streets, buildings and car parks contributed nothing to restorativeness whereas a view of nature strongly affected satisfaction and restoration. Satisfaction rated 2.22 for those without a view of nature compared with 2.91 with a minimal nature view (31% improvement compared with those without a view) and 3.40 for a view of two natural elements (53% improvement) and 3.58 for three natural elements (61% improvement).

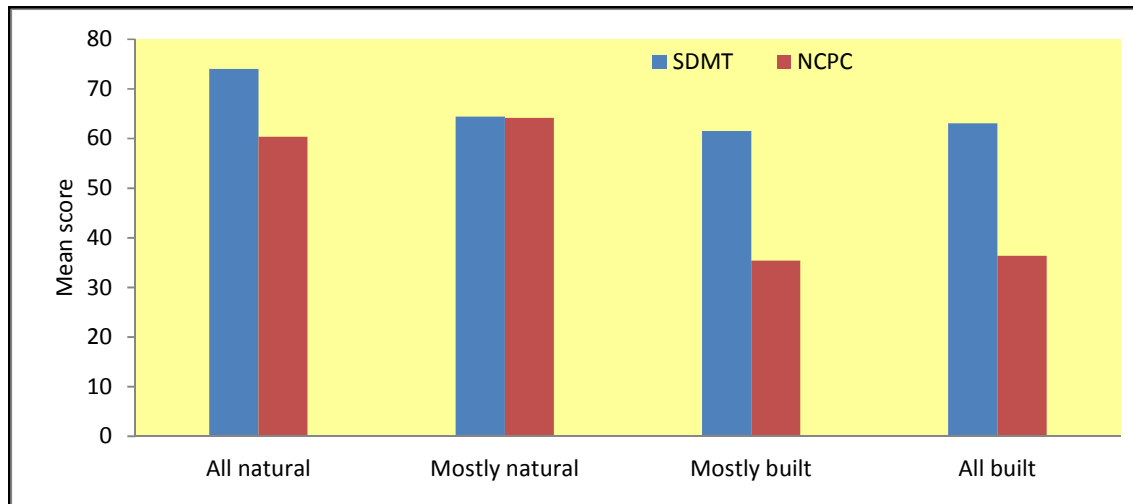
A study examined the extent to which views that university students had from their dormitory windows affected their capacity for directed attention (i.e. study). Tennessen and Cimprich (1995) tested the students in their rooms with a battery of seven tests of their direct attention capacity as measured by speed, accuracy, and ability to sustain activity in the presence of distracting stimuli. Two of these tests were:

- Symbol Digit Modalities Test (SDMT) a standardized test of directed attention in a complex task;
- Necker Cube Pattern Control (NCPC) test measures directly ability to inhibit competing stimuli, i.e. the capacity to direct attention.

The view from the student's windows was photographed and assessed separately on a four point scale from all natural, mostly natural, mostly built, to all built.

Natural views from their windows enhanced the student's capacity for directed attention compared with those with less natural views (Figure 44). The results also support the link in the Attention Restoration Theory between the natural environment, fatigue derived from

directed attention, and restoration of attention Even a modest exposure to natural environment such as a window view may benefit the capacity for directed attention.



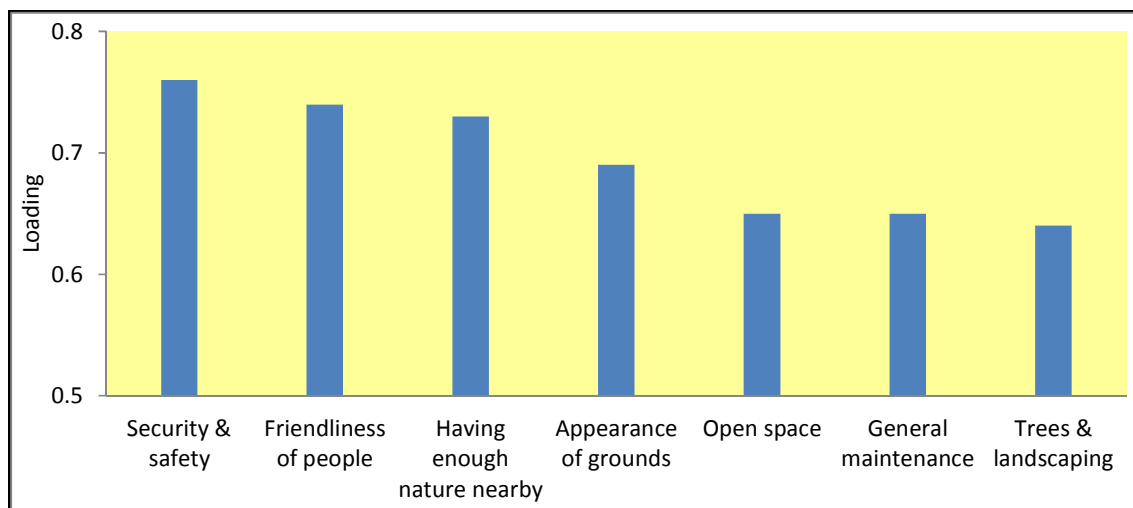
Source: Tennessen & Cimprich, 1995.

Note: Original NCPC data is negative % numbers e.g. -60.3%.

SDMT = Symbol Digit Modalities Test, NCPC = Necker Cube Pattern Control

Figure 44 Scores of measures to assess capacity for directed attention

Rachel Kaplan (2001) noted that windows provide numerous opportunities for restoration through brief glances to the outside world. She surveyed 188 residents in low-rise apartments in Ann Arbor, Michigan with views out to parks, streams, woods and landscaped grounds. Using a photo album of typical views from the apartments, she had the residents rate the scenes. She also asked about their nature-related activities in the vicinity, demands on their life, and their satisfaction with their apartment community. Figure 45 indicates the degree of satisfaction in the apartments and shows the importance of nature, open space and trees.



Source: R. Kaplan, 2001. Note: Uses loadings from factor analysis

Figure 45 Satisfaction measures of apartments

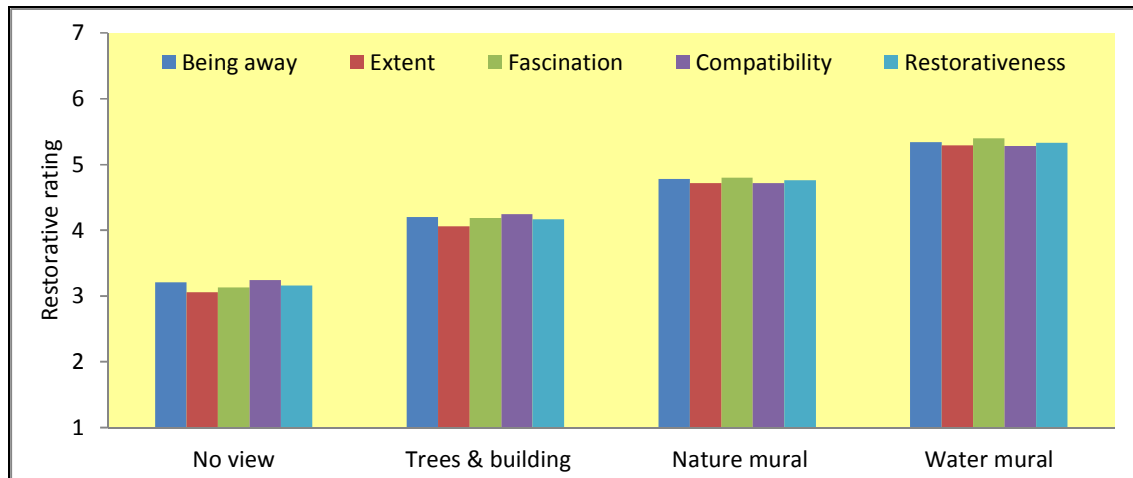
From this analysis, Kaplan concluded that the results "Provided considerable support for the premise that having natural elements or settings in the view from the window contributes

substantially to residents' satisfaction with their neighbourhood and with diverse aspects of their sense of well-being."

Views of nature or exposure to nature have been found to have positive effects:

- Prisoners with a view to fields and farms in the vicinity had much lower use of medical services than those without such a view (Moore, 1981).
- Office workers without a view of nature had greater number of ailments over 6 months than workers with a view of nature, the latter also claiming greater job satisfaction (Kaplan, et al, 1988).
- Office workers reported that views of nature contributed to their satisfaction and restoration compared with those who viewed street, buildings and car parks which reported no such benefit (Kaplan, et al, 1988).
- Elderly residents considered access to nature near their homes to be very important, according to a study by Talbot and Kaplan (1991). Residents with a view over natural settings or who lived near such settings were more satisfied with life than those without these.
- Workers with natural elements in the view had greater job satisfaction, less frustrated and more patient, more challenged and enthusiastic about their jobs (Kaplan, R., 1993)
- Students in dormitories with views to vegetation had better academic performance and mental functioning (Tennessen and Cimprich, 1995).
- Comparing the restorative effectiveness of school libraries and playgrounds, Bagot (2004) found the latter to provide far higher restoration potential.
- Sop Shin (2007) found that workers who had a view of nearby forests had better job satisfaction and lower stress. Individual factors such as gender, age and job category had no influence.
- Classrooms with views of trees and shrubs improve student performance and behaviour in terms of test scores, graduation rates, continuing on to college and less criminal behaviour (Matsuoka, 2010).
- Children with Attention-Deficit Hyperactivity Disorder had lower symptom severity if they spent time in natural settings (Faber, Taylor and Kuo, 2011).

Felsten (2009) compared the efficacy of windows and large wall murals of trees, rolling hills, coasts and waterfalls with no views in providing an environment for a study break for tertiary students. Settings lacking views rated low-moderate, settings with mundane leafless trees and structures rated moderate, nature murals rated moderate – high, and murals with water rated high in restorative potential (Figure 46).

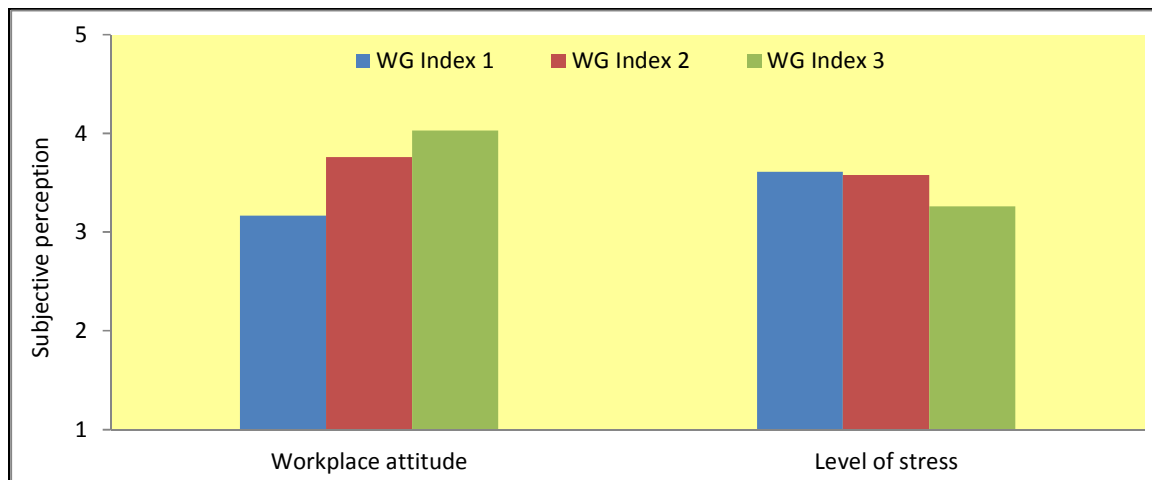


Source: Felsten, 2009

Figure 46 Restorative capabilities of differing views

To assess the health benefits of a view to natural surroundings from a hospital bed, Raanaas et al (2012) tested patients in a rehabilitation centre for coronary and pulmonary patients. They found that lack of a view negatively affected women's recovery while for men it negatively affected their mental health. Patients with a view often chose to stay in their bedroom when they wanted to be alone than those with a blocked view.

Lottrup et al (2013) found that as physical access to the outdoors and views outside increased, workplace attitudes improved and the level of individual's stress decreased (Figure 47). They suggest that the "workplace outdoor environment is an asset for employees' wellbeing and level of stress".



Source: Lottrup et al, 2013.

WG-Index 1 No view of a green outdoor environment. No physical access to any outdoor environment

WG-Index 2 View of a green outdoor environment. No physical access to an outdoor environment dominated by greenery

WG-Index 3 Physical access to an outdoor environment dominated by greenery

Figure 47 Relationship between access/view of outdoors and attitude/stress

View along the road

Using a battery of physiological tests covering blood pressure and electrodermal activity (EMG), Parsons, et al (1998) tested 160 drivers with four video-taped simulated drives before

and after mildly stressful events. They hypothesized that those driving along the nature-dominated routes would be less stressed than those driving along artificially dominated routes and that they would also recover more quickly from the stress, and be better “immunized” against further stress. The study found both hypotheses valid pointing the way for “a sympathetic-specific mechanism that underlies the effect of nature on stress recovery and immunization.”

Whether drivers along main roads would find their frustrations eased by the presence of roadside vegetation was tested by Cackowski & Nasar (2003) who used videotapes of three highways, a built-up highway, a garden highway and a scenic parkway. Viewed by participants and given frustrating tasks to perform, they showed greater tolerance to frustration after exposure to roads with more vegetation. They concluded that parkway design and roadside vegetation has restorative effects in reducing frustration.

Health and green space

Over the past decade a number of studies have established a relationship between people’s health and the amount of greenspace such as parks and gardens in their vicinity.

In an early study, Ulrich and Addoms (1981) assessed the psychological and recreation benefits of an urban park and found it provided substantial psychological benefits to residents even though they made little or no direct use of the park. The findings implied that mere awareness of the park’s presence is beneficial.

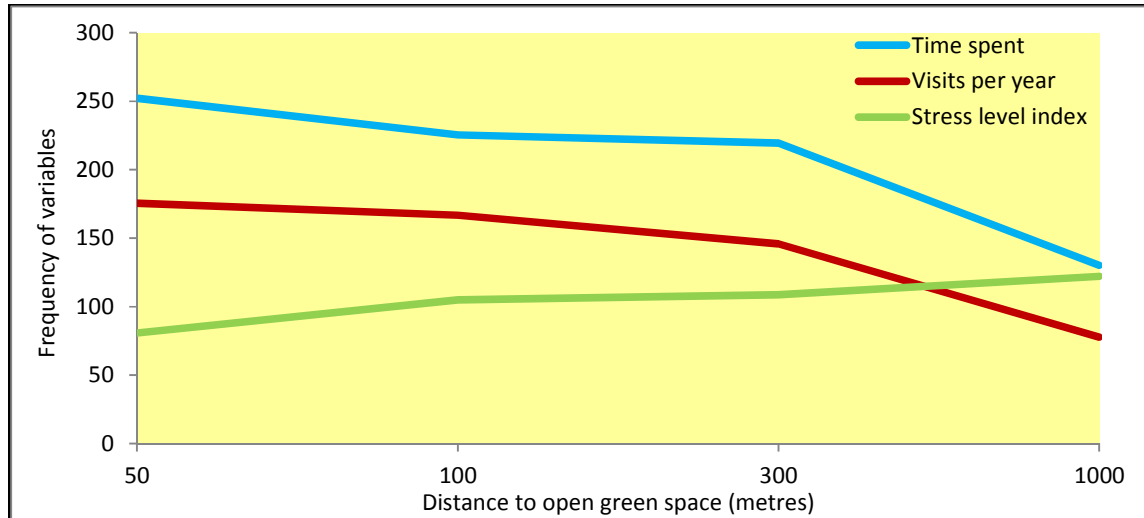
In an experiment with runners, Bodin and Hartig (2003) found the runners preferred the park over the urban streets and perceived it as more psychologically restorative. Pretty, *et al* (2005) found that exercise conducted in view of pleasant rural and urban scenes produced lower blood pressure and increased self-esteem and improved mood while the opposite resulted from unpleasant rural and urban scenes. In a study in Zurich, Hug *et al* (2009) found that outdoor exercise settings were rated as more restorative than indoor settings resulting in more frequent exercise. Any walking improves one’s outlook but walking in a park reduces concerns about time pressures to a greater extent than walking on streets according to research by Johansson *et al* (2011). Exercise and being outdoors during free-time was the most effective activity for recovery from work stress, and the time spent in interacting with nature was second in importance; these were the results from a survey of employees in five organisations by Korpela and Kinnunen (2010).

Contrary, however, to other studies, an early study by Hull and Michael (1995) found that recreating outdoors near nature in an urban park produced no more personal restoration than recreating indoors, away from nature.

Having clinically depressed people spend several months in a therapeutic horticulture program reduced their depression severity and improved their attentional capacity, effects which persisted well after they left the program (Gonzalez *et al*, 2009).

Grahn & Stigsdotter (2003) examined the health and use of open green spaces by 953 people living in nine large urban areas in Sweden. Questionnaires were mailed to residents of all ages (including children) and, apart from personal data, they asked how often and for how long did they visit open green spaces in their town. It asked them their health status covering stress-related illnesses: fatigue, headache, ache in the back of the head, backache, irritation and a feeling of being chased, harassed and stressed, plus their incidence of the common cold.

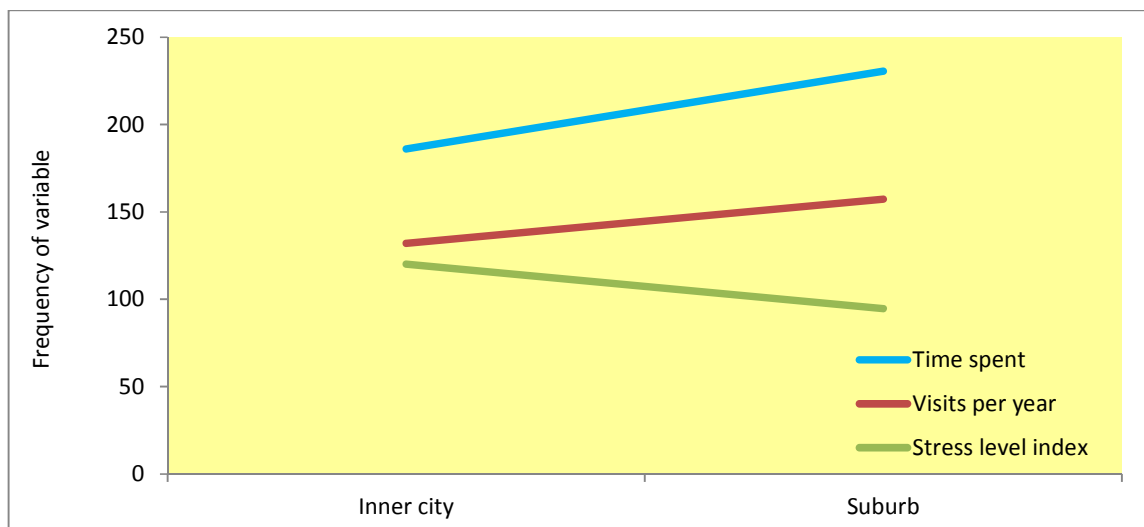
In answer to the question, “What would you recommend a close friend to do if he or she felt stressed and worried?” the dominant answer was to take a walk in the forest. Figure 44 shows that with greater distance, visits to open green space drop off and as this occurs, stress levels increase by more than 50% at the greatest distance (1 km) compared with nearby (50 m).



Source: Grahn & Stigsdotter, 2003

Figure 44 Relationships between stress levels and distance to open green space

The authors noted that around 70% of respondents would like to visit open green spaces more often than they do. Those who admitted this felt stressed. Overall they reported that “that the more often a person visits urban open green spaces, the less often he or she will report stress-related illnesses.” This occurred across all ages, gender, and socio-economic levels. Figure 45 shows that higher stress levels in the inner city appear related to less use of open green space.

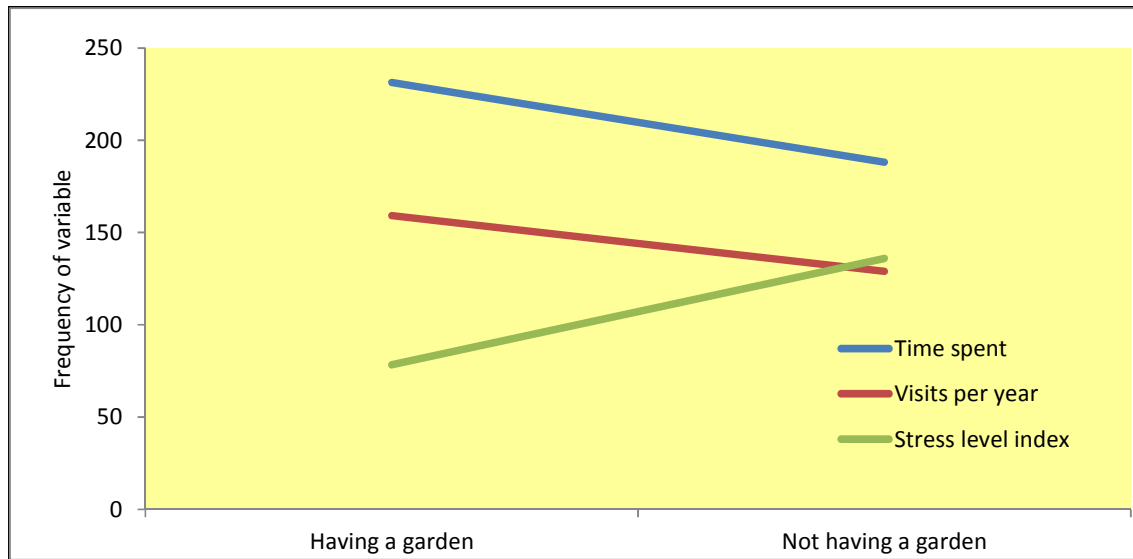


Source: Grahn & Stigsdotter, 2003

Figure 45 Relationships between stress levels and use of open green space in the inner city and suburbs

While it might be expected that those who did not have a garden would compensate by greater use of open green space, the reverse was in fact true, they used it less and their

stress levels were accordingly greater than those with a garden (Figure 46). Those with a garden also made greater use of open green space.



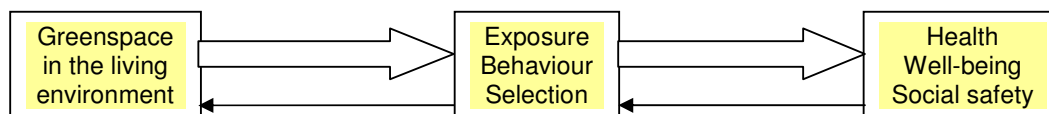
Source: Grahn & Stigsdotter, 2003

Figure 46 Relationship of having/not having a garden and stress levels/open space use

The authors suggest from their findings that more green areas should be provided near apartment housing, ensuring their accessibility, to alleviate stress and improve the health of town-dwellers.

Would the benefits of contact with nature extend to elderly people in an age person's home? To test this, Ottosson & Grahn (2005) had 15 elderly people rest in a garden or an indoor setting for an hour and then tested their concentration. They found that those who had sat outside had greater powers of concentration.

In a paper entitled *Vitamin G: effects of green space on health, well-being, and social safety*, where Vitamin G stands of the amount of greenspace near people, Groenewegen *et al* (2006) outlined a program of macro country-wide study in Holland, together with an intermediate scale study and micro scale study looking at allotment gardens. They proposed a simple model of the relationship between people and greenspace (Figure 47).



Source: Groenewegen et al, 2006

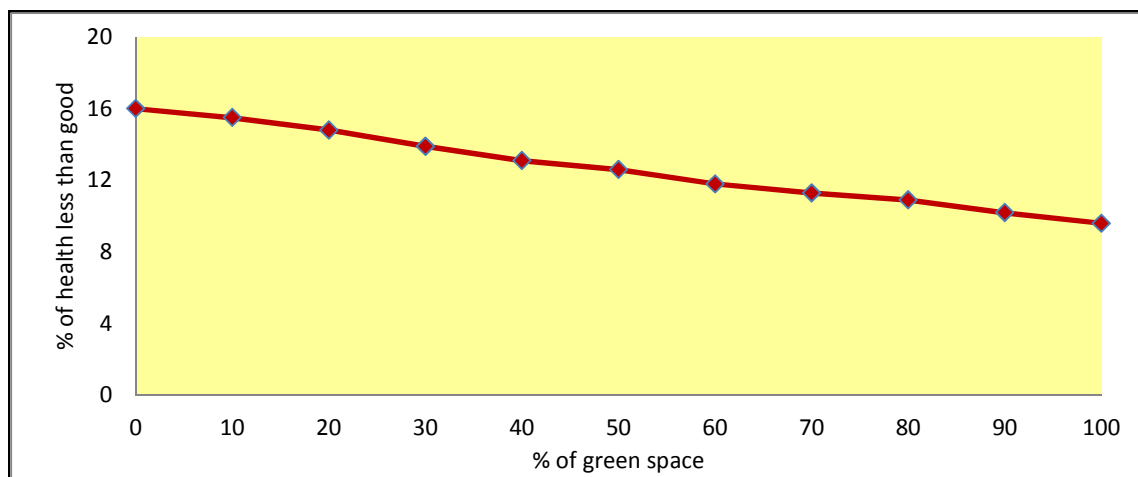
Figure 47 Model of relationships between green space and health, well-being and social safety

The intermediate study, reported by de Vries et al (2003), used self-reported health data of over 10,000 Dutch people and combined this with land use data on the amount of greenspace in their living environment up to 3 km. from the analysis, they drew the following findings:

- With greater greenspace, people's health, including mental health, was better. The effect was substantial, 10% more greenspace lowers symptoms by the equivalent of 5 years lower age.

- While evolutionary psychologists argue that particular types of trees are best, their results do not support this, in fact all types of green were found to be effective. The difference between a “red (brick) and green environment” is the key rather than differences within green.
- Greenspace is particularly important for those at home more, “housewives”, elderly, and children.
- It is the amount of greenspace within the living environment that is relevant rather than its distance.

The country-wide study covering all of Holland (Maas *et al*, 2006) used extensive data sets of people’s health and of green spaces that are available. This enabled the team to compare health with the greenness of an individual’s vicinity. Using self-rated scale of health for 250,000 people, they measured the agricultural, forest, nature and urban green spaces within a 1 km and 3 km radius. They found that the amount of green space correlated positively with an individual’s perceived general health. Those living with green space nearby are healthier than those without green space. Where 90% of the surrounding environment is green, only 10% of people felt unhealthy whereas in areas with only 10% greenness, 15.5% of residents felt unhealthy (Figure 48).

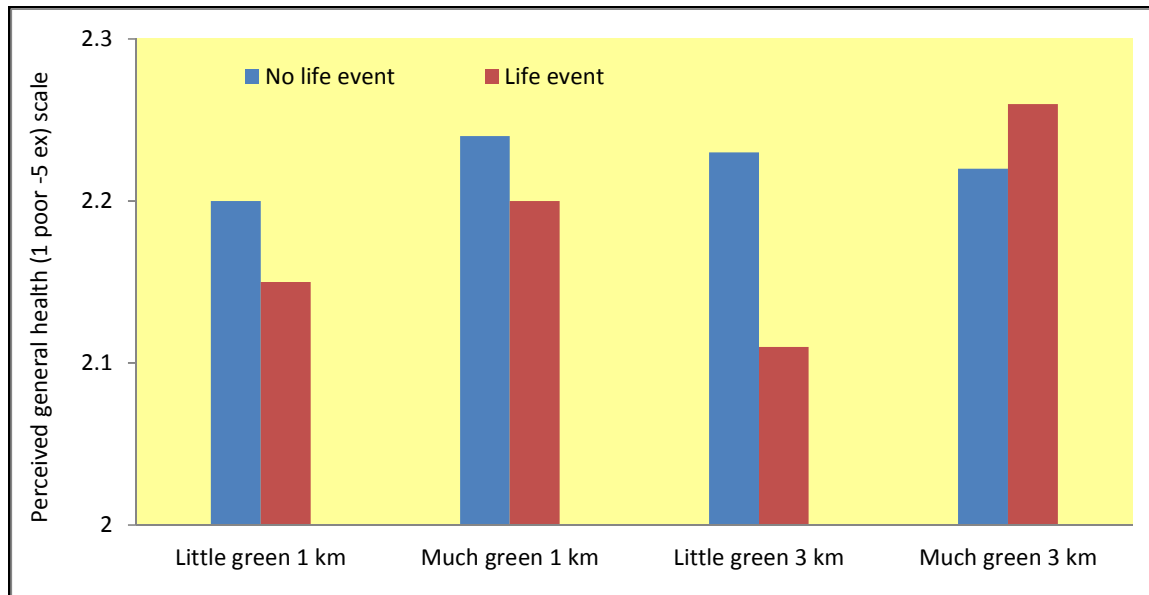


Source: Maas *et al*, 2006

Figure 48 Relation between health and green space (radius 3 km)

Maas, *et al*, found that people in rural areas felt healthier than those in urban areas, but interestingly, the amount of green space may have an independent effect on health at all levels of urbanity. In densely urban areas, proximity to green space is very important. Maas, *et al*, claimed that the “health differences in residents of urban and rural areas are to a large degree explained by the amount of green space.”

Following up the Maas study in Holland, Van den Berg *et al* (2010) examined the influence of green space on the number of health complaints, perceived mental health, and general health. As well it assessed the influence of green space in ameliorating the effects of stressful life events – events such as divorce, family death, financial and legal problems or serious illnesses or injuries over the previous 3 months. The study controlled for age, gender, income, education level and urbanity. It found that respondents with a high amount of green space in a 3 km radius were less affected by a stressful life event than those without much green space (Figure 49). A similar but lesser effect was found for mental health. Interestingly the effect was found only for green space at a distance of 3 km rather than 1 km, possibly because the areas were larger. General health improved by 2% following a life event for those with green space within 2 km, and improved by 7% for green space within 3 km.



Source: Van den Berg, et al, 2010. Note: Scale reversed from source.

Figure 49 Perceived general health as a function of stressful life events in previous three months and green space in 1 km and 3 km radius

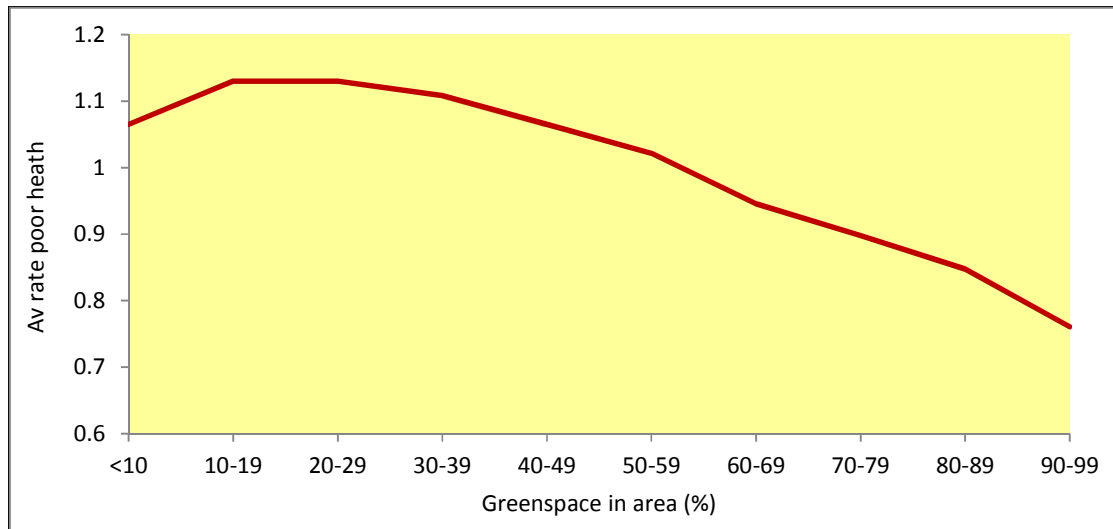
Following an extensive review of studies of the health benefits of contact with nature, Maller et al (2006) concluded that “nature plays a vital role in human health and well-being, and that parks and nature reserves play a significant role by providing access to nature for individuals.” They advocate a “socio-ecological approach to public health” to maximise the benefits.

Mitchell and Popham (2007) examined the relationship between green space and “not good health” covering all residents of England. Using the 32,482 statistical areas they calculated the percentage of greenspace in each and then related this to the answers in a question in the 2001 Census, whether the person’s health had been “good”, “fairly good” or “not good”, over the previous 12 months. They used the “not good” responses and as well as greenspace, related it to the levels of employment deprivation, education skills and training deprivation, barriers to housing and service, crime and income deprivation in each of the statistical areas.

For all areas, the regression equation they derived was as follows:

$$Y (\text{rate of poor health}) = -0.02 \text{ greenspace} - 0.03 \text{ urbanity} + 0.24 \text{ income deprivation} + 0.5 \text{ employment deprivation} + 0.17 \text{ education \& training deprivation} + 0.006 \text{ housing barriers} + 0.07 \text{ crime} (R^2 = 0.84, n = 32,482).$$

The model indicates that only greenspace and urbanity are positive factors while of the remainder, employment deprivation and income deprivation are the major factors. The model places greenspace in context as a minor but positive factor. Based on the algorithm they derived a graph relating poor health with the amount of greenspace (Figure 50). It is clear that large proportions of greenspace have a positive effect on health.



Source: Mitchell and Popham (2007)

Figure 50 Relationship between health and greenspace

Mitchell and Popham (2008) then took their research further by examining the relationship between green space and mortality in England. Using data covering 40 million people of below retirement age, it looked at mortality from all causes (366,348 deaths) as well as specific mortalities (circulatory disease, lung cancer and intentional self-harm) for 5 years, 2001-2005, and compared the mortality with green space exposure measured in 2001. This covered areas as small as 10 square metres and covered parks, open spaces and agricultural land, but excluded domestic gardens. The study also included area-based income deprivation levels.

After controlling for confounding factors and income deprivation levels, the study found mortality rates reduced as green space increased. Compared with the group with the least green space (i.e. green space 1):

- Green space 2 mortality increased by 1.6%
- Green space 3 mortality decreased 1.8%
- Green space 4 mortality decreased by 5%
- Green space 5 (most) mortality decreased by 5.5%

The authors estimated that the highest exposure to green space saved 1328 lives annually. The study found the mortality from circulatory diseases similarly decreased with exposure to green space but that no relationships were detected for deaths from lung cancer or suicide.

A study by Nordh et al (2009) that compared the restorative effect of parks with their detailed attributes found that the variables most predictive of restoration were the percentage of ground surface covered by grass, the amount of trees and bushes visible from the given viewing point, and apparent park size. They suggested the results be used to guide park design.

The authors further refined their method (Nordh et al, 2011) and found that the amount of grass, trees and other people had the most influence on their choices of parks, these being more important than flowers and water features.

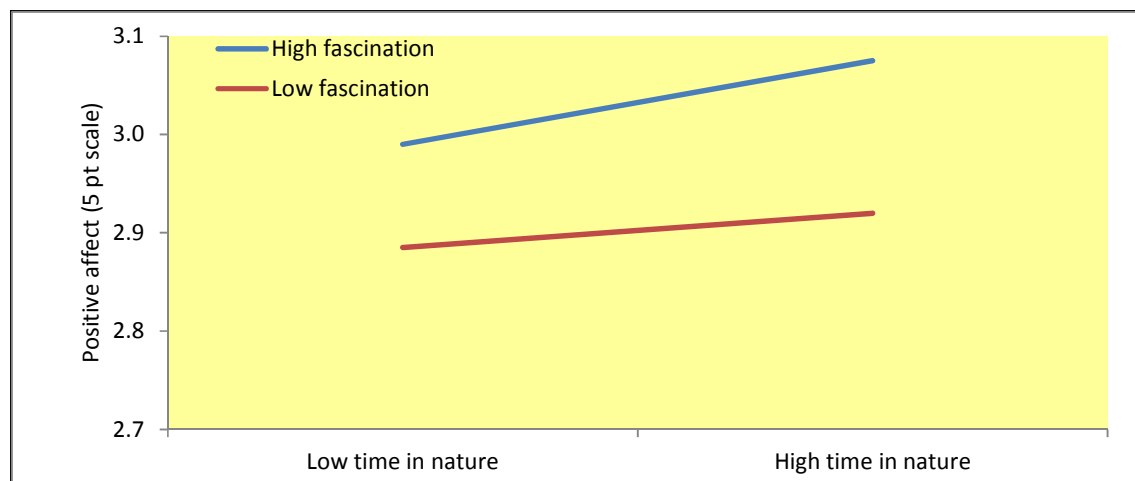
In urban areas, parks were preferred for restoration from fatigue, according to research by Staats et al (2010). Urban areas can provide "other mundane but attractive restorative situations".

Contrary to expectations from previous studies, an assessment by Richardson et al (2012) of 49 cities in the US found no association in the link between the greenness of the city and the rates of mortality from heart disease, diabetes, lung cancer, motor vehicle fatalities and other causes. Indeed the study found that mortality actually increased with greater greenness, a feature they attributed to the greater sprawl of the city and higher car dependency.

Alvarsson *et al* (2010) found that recovery from stress while being exposed to natural sounds was faster than exposure loud traffic noise.

Paquet *et al* (2013) in a study in Adelaide, South Australia measured the relationship between cardiometabolic health and availability of public open space (POS). They found the “number and proportion of POS were not found to be statistically significantly related to cardiometabolic health; however, greenness, size, and type (active) of available POS were inversely related to cardiometabolic risk.” Physical activity was important in the association. The results suggest that it is the characteristics of public open space rather than their number that is important and that improving their quality rather than their accessibility would be more beneficial.

In a New Zealand study, Sato and Tamplin (2013) examined the extent to which one of Kaplan’s components, fascination, related to positive affect. Using a diary method over 13 days, subjects recorded how long they spent in green spaces and the interesting/fascinating things observed and tested their daily positive and negative affect. Fascination enhanced the relationship between nature and higher positive affect for both men and women (Figure 51) and for women, the more time they spent in nature, the less negative they felt. The authors believed that the quality of time spent in nature observing and paying attention to the natural surroundings is as important as the quantity of time.



Source: Sato & Tamplin, 2013

Figure 51 Relationship between time in nature and daily PA as a function of fascination

Lachowycz & Jones (2013) proposed a theoretical framework to better understand the relationships between green space and health, involving five components:

- Exposure - access to greenspace;
- Potential moderating factors -demographic, living context, greenspace characteristics, climate;
- Mechanism of moderation – opportunity to use, personal drivers and motivation to use, ease of use;
- Potential mediators – improved perceptions of living environment, aesthetic pleasure and relaxation from viewing greenspace, use of greenspace;

- Outcomes – physical health benefits and psychological health benefits.

They discussed the available evidence and identified areas requiring further research.

In a paper titled “Linking landscape and health: The recurring theme”, Catherine Thompson (2011) shows that the idea of health benefits from landscape is not new but was in fact recognised in Persian, Greek and Roman times through their establishment of parks and gardens specifically for their health benefits. This was followed by the monasteries of the Middle Ages which established gardens for production but also for the health of their friars. The 18th and 19th century English landscape gardens continued this tradition and were followed by the urban parks movement in large cities such as London, Berlin, Paris and New York where parks were regarded as the city’s lungs.

She noted that the 2007 report of the Royal Commission on Environmental Pollution concluded that “access to good quality green space provides an effective, population-wide strategy for the promotion of good health, wellbeing and quality of life . . . We are convinced that the evidence is sufficiently strong to warrant amending planning guidance to recognise the health benefits of green space”.

Thompson concluded: “Throughout history and across cultures, people have considered access to some form of ‘nature’ as a fundamental human need and attractive, green and well-watered landscapes as an essential constituent of the ideal, paradisaical, healthy environment. Writers from the earliest times have recognised that the landscape not only provides for our nutritional needs, it also supports us at every level in our wellbeing.” A Scottish professor of psychiatry, William Parry-Jones, acknowledged (1990) that while the “causation, exacerbation and perpetuation of certain mental disorders can be influenced by environmental factors”, however in psychiatry, the environment covers the family, home workplace and wider cultural setting. The natural environment has received minimal attention in psychiatry.

SYNTHESIS

Preference for nature scenes over urban scenes

Table 4 lists the 21 studies that compared the preferences for nature and urban scenes and indicates the percentage increase of preference for the nature scene over the urban scene. The basis of each study varied and included measures of affect, vitality and restoration, and the use of photos, posters, views from windows, and walks. They include physiological measures such as heart beat and pulse, brain alpha waves, and taking analgesics, all of which can provide direct evidence of the calming effect of nature. The overall mean is 168% (SD 61%) which means that the preference for nature is nearly double that for urban scenes.

Table 4 Preference for nature scenes over urban scenes

Authors	%	Aspect assessed
Ulrich 1979	134%	Positive affect
Ulrich 1981	115%	Reduced anxiety
Ulrich, 1984	258%	Strong analgesics
	210%	Moderate analgesics
Heerwagen & Orians, 1986	180%	Natural object posters
	335%	Landscape posters
Verdeber, 1986	94%	Patients
	109%	Staff

Ulrich, <i>et al</i> , 1991	151%	Physiological recovery
Tenessen & Cimprich, 1995	132%	Student window views
Hartig, <i>et al</i> , 1996	119%	Mood states, nature of urban scenes
Herzog, <i>et al</i> , 1997	223%	Restoration
	265%	Reflection
Purcell <i>et al</i> , 2001	252%	Preference nature of urban scenes
Ulrich, <i>et al</i> , 2003	125%	Lower pulse rate watching nature videos when giving blood
Hartig, <i>et al</i> , 2003	190%	Affect changed in natural setting
Herzog, <i>et al</i> , 2003	126%	Restorative properties
Laumann, <i>et al</i> , 2003	106%	Heart beat
Staats, <i>et al</i> , 2003	194%	Preference for forest given attentional fatigue
	185%	Preference for walking in forest given attentional fatigue
Ulrich, <i>et al</i> , 2003	103%	Lower pulse rate watching nature videos when giving blood
Van den Berg, <i>et al</i> , 2003	138%	Restoration following horror movie
Hartig & Staats, 2006	218%	Walk in forest preferred over city
	220%	Attentional recovery in forest of city
	183%	Reflection in forest of city
Berto, <i>et al</i> , 2008	240%	Natural photos > built photos
Mayer, <i>et al</i> , 2009	137%	Real nature of urban video
	117%	Virtual nature of urban video
Ryan, 2010	124%	Vitality change
Loddrup, <i>et al</i> , 2013	127%	Workplace attitude re green access
Van den Berg, <i>et al</i> , 2010	102%	Improved perceived general health, 1 km green, life event
	107%	Improved perceived general health, 3 km green, life event
Mean	168%	

Restorative power of nature

Applying Attention Restoration Theory, several studies measured the restorative effect of urban and nature scenes using the four components: being away, fascination, extent or coherence, and compatibility. Restoration in natural environments from “being away” is over three times that of urban environments, followed by “compatibility” (i.e. of the environment with one’s purposes) and fascination at over twice the urban environment (Table 5).

Table 5 Restorative power of nature - Percentage increase over urban scenes

			Being away	Fascination	Extent/coherence	Compatibility	Restorative-ness
Korpela & Hartig	1996	PRS	291%	242%	190%	363%	
Korpela <i>et al</i>	2001	FU	658%	250%	193%	559%	
Purcell <i>et al</i>	2001						151%
Herzog <i>et al</i>	2003		193%	110%	127%	127%	
Berto <i>et al</i>	2008	%	672%	398%	77%	178%	
Chang <i>et al</i>	2008	EEG	377%	309%	321%	302%	
Chang <i>et al</i>	2008	EMG	132%	111%	126%	116%	
Felsten	2009	land	149%	153%	154%	146%	151%
Felsten	2009	water	166%	173%	173%	163%	169%
		Mean	330%	218%	170%	244%	157%

Note: PRS = Perceived Restorativeness Scale; FU = Favourite sites % of unpleasant sites; EEG = electroencephalography, EMG = electromyography. Korpela *et al* studies compared favourite & unpleasant places. Felsten compared no view with views of murals of land and water.

Other findings

Views from windows over trees or nature benefited patients, visitors and staff in hospitals, students in dormitories and classrooms, residents in apartments, and office workers. Elderly people's concentration improved after sitting in a garden.

A study by Kaplan et al (1988) found ailments over 6 months were 19% lower for workers with a view than for those without a view. It also found that personal satisfaction increased as much as 61% for those who viewed three natural elements.

Even large pictures, posters and murals of nature scenes were of benefit. Posters of nature lowered levels of violence, anger and stress in office and hospital settings.

Exercise, walking and running in natural surroundings was more pleasurable and beneficial for restoration than in an urban setting.

Roadside vegetation made the drivers more tolerant and less frustrated and less stressful than along roads without trees.

Living near accessible green space yielded significantly improved human health and lowered stress levels particularly for the housebound. Levels of poor health were reduced along with rates of morbidity. Green space is particularly vital for cities with largely apartment living where there are few private gardens. The adverse effect of stressful life events such as a death in the family or separation are ameliorated by the presence of green space in the area.

Health Council of the Netherlands Report findings

In 2004 the Health Council of the Netherlands published an extensive review of the literature on nature and health from which they issued the following conclusions:

There is strong evidence that nature has a positive effect on recovery from stress and attention fatigue. Exposure to nature evidently has a positive impact on such factors as mood, concentration, self-discipline and physiological stress. This applies both to experimental and quasi-experimental research, performed under laboratory and field conditions with healthy adults and, in some cases, with children.

It is notable that beneficial effects occur even in connection with brief exposure to a view of nature. We know little, however, about what impact the duration of the exposure has on recovery from stress and attention fatigue and about the knock-on effect of that impact on the prevention of illness and on well-being in the long term. It is not inconceivable that a permanent view may lessen the stress-relieving effect.

Little is known about the influence of different types of nature. Subjects were always exposed to nature either via a view of one type of predominantly urban nature (whether simulated or real) or by walking or playing in urban nature. Only in a few studies did the researchers look into the influence of wild nature.

(It) is plausible that there could be a genetic component (i.e. evolutionary influence). This does not, however, rule out the possibility that all manner of individual and cultural factors may play a moderating role. Research indicates, for example, that people tend to seek out nature when they feel stressed or tired because they presume nature to have a restorative effect. It is not known whether people who do not believe nature to have restorative powers – or are perhaps even afraid of nature – can also recover as a result of contact with nature.

CONCLUSIONS

The past several decades has seen much research into the healing and restorative effects of viewing nature. Approximately 120 studies were reviewed, the universal conclusion from which is that exposure to nature through viewing and experiencing it provides substantial emotional and physiological benefits. The preference for nature scenes is nearly twice that of urban scenes, while the restorative benefits of nature are at least three times as much as viewing urban scenes. Exposure to green space in cities is vitally important, improving health and even reducing morbidity.

The research findings should be applied in the design of hospitals, offices, schools and homes to ensure views and access to greenery, to the design of cities to better integrate green spaces into their fabric and ensure their access by residents. No one should be without nearby open green space. The research shows the importance of introducing greenery into cities with street trees, back yards with trees and greenery and green parks and gardens with extensive trees and grass. With increasing higher density living in cities, the research shows how essential it is that people have windows to view greenery, not blank walls. This calls for care in designing living spaces at a micro level, ensuring views together with proximity and access to greenspace.

The research also encourages us as individuals to make greater use of nature, by visiting green spaces more often, by ensuring our houses look out at greenery in our private space, by taking children to parks and gardens and natural areas so that they become accustomed to them, by ensuring that the elderly are still able to enjoy a view over gardens with flowers and trees. All of these will promote better health for the individual and may even prolong our lives!

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APPENDIX 1 RESEARCH TABLES IN CHRONOLOGICAL ORDER

Ulrich, 1979

Affect scores before and after slides for urban and nature groups

	Urban Group Before slides	After slides	Nature Group Before slides	After slides
Feel fearful	1.83	1.52	1.57	1.3
Feel angry	1.48	1.61	1.83	1.65
Feel sad	1.83	2.3	1.52	1.39
Feel carefree	1.78	1.65	1.87	2.35
Feel elated	2.09	1.87	1.87	2.44
Feel friendly	2.43	2.17	2.35	2.91
Feel attentive	2.61	2	2.43	2.09

Ulrich, 1981

Alpha wave scores when viewing scenes

	First period Slides 1- 10	Slides 11-20	Break Slides 21-30	Second period Slides 1-10 20	Slides 11- 20	Slides 21- 30
Vegetation	192.5	196	202	215	211	213
Water	184	182.5	182	196	196	192.5
Urban	170	174	175	179	185	185

Ulrich, 1984

Analgesic doses per patient for wall view and tree view

	Days 0.- 1		Days 2 - 5		Days 6 - 7	
	Wall	Tree	Wall	Tree	Wall	Tree
Strong analgesics	2.56	2.4	2.48	0.96	0.22	0.17
Moderate analgesics	4	5	3.65	1.74	0.35	0.17
Weak analgesics	0.23	0.3	2.57	5.39	0.96	1.09

Talbot & Kaplan, 1984

Importance of nature experience

Perceived value	Number
Low (not extremely important)	18
Moderate (not extremely important but part of daily life)	4
High (very important, frequent involvement)	29
Daily life (very important, part of daily life)	45

Verderber, S., 1986

Influence of view on preference ratings, Chicago hospitals

	Staff	Patients	p
Cityscape views	3.43	3.74	< 0.001
Streetlife views	3.88	3.61	< 0.01
Nature content	3.99	3.45	< 0.001
View surrogates (nature)	2.89	2.78	< 0.001
Disliked view	2.03	2.47	< 0.001
Windowless (arch)	1.94	2.02	

Windowless (psych)	1.58	2	< 0.001
Preferred views	4.08	3.96	
View surrogates	3.6	3.37	< 0.05

Heerwagen, J.H. and G.H. Orians, 1986

Comparison of décor in windowless and windowed offices

	Windowless	Windowed	total
Landscape	83	21	104
Natural	51	24	75
Cityscape	13	11	24
Other	48	26	74
	195	82	277

P = 0.05

	Windowless	Windowed	total
Surrogate views	96	32	128
Non-views	99	50	149
	195	82	277

Surrogate views = ls + cityscape.

Not significant

	Windowless	Windowed	total
Nature dominant	134	45	189
Non-nature	61	37	98
	195	82	277

P = 0.025, one-tailed test

Ulrich, et al, 1991

Changes in blood pressure (pulse transit time) during stress and recovery

	Stressor				Recovery		
	0	3 min	6 min	10 min	14 min	17 min	20 min
All groups	0	3	2	4.8			
Traffic				4.8	4.1	4.5	4.9
Mall				4.8	2.6	3.5	3.9
Nature				4.8	1.2	0.9	1

Ulrich, et al, 1991

Influence of environments on affective states

	Nature	Mall	Traffic
Fear	-1.46	-1	-0.77
Anger/aggression	-1.95	0.18	-0.82
Positive affects	5.52	1.18	-0.08
Sadness	-1.51	-1.26	-1.25
Attentiveness/interest	-1.02	-1.64	-1.02

Tennessen & Cimprich, 1995

Scores of measures to assess capacity for directed attention

	All natural	Mostly natural	Mostly built	All built
SDMT	74	64.4	61.5	63.08
NCPC	60.35	64.18	35.38	36.35

Note: NCPC originally negative % numbers

Hartig, T., A. Bök, J. Garvill, T. Olsson, & T. Gärling, 1996

Mood Adjective Check List scores

	Natural	Urban
Well-being	3.07	2.55
Hedonic tone	3.25	2.71
Activation	2.73	2.26
Relaxation	3.27	2.88

Korpela & Hartig, 1996

Ratings of favourite & unpleasant places on PRS and ZIPERS scales

		Favourite place	Unpleasant place
PRS	Being away	5.47	1.88
	Fascination	5.16	2.13
	Coherence	5.89	3.1
	Compatibility	5.77	1.59
ZIPERS	Positive affect	4.04	1.54
	Sadness	1.94	2.74
	Attentiveness	3.06	2.64
	Anger/aggression	1.25	3.17
	Fear arousal	1.69	2.6

Differences are significant

Herzog et al, 1997

Perceived effectiveness rating of settings

Setting	Goal Set	
	Recovery	Reflection
Nature	4.22	4.47
Sports/Ent.	2.95	2.35
Urban	1.89	1.69

Nature/sports $p < 0.001$, Sports/urban $p < 0.001$ **Miles, I., W.C. Sullivan and F.E. Kuo, 1998**

Sources of restoration satisfaction

Source of satisfaction	Mean	p
Meaningful action	3.3	0.03
Fascination with nature	3.2	<0.0001
Participation	2.8	0.0008
Chance to be away	2.6	0.06
Physical	2.5	0.005
Personal growth	2.4	

P is between each source of satisfaction and next highest rated source

Herzog and Chernick, 2000

Mean rating of variables

	Setting	
	Natural	Urban
Tranquility	4.24	2.02
Danger	1.89	2.66
Openness	3.45	2.52
Setting care	3.47	2.81

Nature 4.74 2.04

Galindo Galindo, M.P & J.A.C. Rodriguez, 2000

Reasons for high aesthetic value scores

Positive reasons		Negative reasons	
Reason category	%	Reason category	%
Naturalness	24.82	Lack of naturalness	23.87
Positive affect	20	Social characteristics	22.79
Spatial organisation	16.21	Lack of maintenance	16.45
Maintenance	13.1	Negative affect	13.75
Sociocultural	8.96	Spatial organisation	12.65
Suitability for activities	6.9	Unsuitable for activities	2.53
Other reasons	10	Other reasons	7.96

Kuo, F., & W.C. Sullivan, 2001

Comparison of aggression against partner over past year in green vs barren conditions

	Barren	Green	p
Overall aggression	1.04	0.76	<0.05
Psychological aggression	1.47	1	0.01
Violence	0.73	0.49	<0.01
Mild violence	0.73	0.49	0.001
Severe violence	0.48	0.31	<0.05

Kaplan, R., 2001

Satisfaction measures of apartments

	Loading
Security & safety	0.76
Friendliness of people	0.74
Having enough nature nearby	0.73
Appearance of grounds	0.69
Open space	0.65
General maintenance	0.65
Trees & landscaping	0.64

Purcell, T., E. Peron, R. Berto, 2001

Restorative scale, preference and familiarity per scene type

	Restorative scale	Preference	Familiarity
Industrial zone	3.6	1.2	4.6
Houses	3.9	1.9	5.7
City streets	4.5	3.1	8.5
Hills	5.9	4.6	7.5
Lakes	6.2	5.8	6.5

Korpela, K.M., T. Hartig, F.G. Kaiser & U. Fuhrer, 2001

Favourite and unpleasant places (top 6 out of 10)	Favourite places	Unpleasant places
Natural places - beach, lake, ocean, park, forest, hill, mountain, viewpoint	48	5
Residential places - home, apartment, house, room	19	15
Geographic areas - country, city, city area, street	16	25
Leisure time settings - amusement park, car races, casino, disco, zoo	5	5

Health care settings - hospital, hosp ward, clinical office	0	11
Transportation & transitional settings - vehicular traffic, train, bus station, airport	2	8
Retail settings - shopping area, mall, grocery store, market	2	6
Food service settings - restaurant, bar, diner	2	4
Community & government service settings - post office, library	1	2
Other	2	7
Total	101	98

Favourite and unpleasant places by Attention Restoration Theory components

	Favourite places	Unpleasant places
Being away	4.8	0.73
Fascination	4.62	1.85
Coherence	4.73	2.45
Compatibility	4.86	0.87

Korpela, K, M. Kyttä & T. Hartig, 2002

Favourite places for children

	Sport	Residential	Natural	Shops/community
8-9 years	7	10	7	4
12-13 years	12	6	4	5
Girl	8	8	8	5
Boy	11	8	3	4

Hartig et al, 2003

Change in self-reported positive affect as function of environment and task condition

	Pretest	Postwalk
Natural, Task	2.2	2.6
Natural, No Task	2.15	3.55
Urban, Task	2.4	2.1
Urban, No Task	2.3	2

$p < 0.001$

Change in performance on NCPCT as function of environment condition

	Pretest	Walk	Postwalk
Natural, Task	4.4	3.9	3.95
Natural, No Task	4.2	4	3.8
Urban, Task	3.85	4.75	4.65
Urban, No Task	3.7	4.4	4.05

$p < 0.001$

Herzog, et al, 2003

Mean ratings for all rated variables as function of setting

	Urban	Nature	p
PRP	2.01	3.5	<0.001
Preference	2.36	3.43	<0.001
Being away	1.93	3.72	<0.001
Extent	2.66	3.38	<0.001
Fascination	2.71	2.98	0.048
Compatibility	2.88	3.66	<0.001
Openness	2.5	3.01	0.019
Visual access	3.32	3.06	0.187
Movement	2.44	3.14	0.085

ease			
Setting care	3.18	2.99	0.214

Laumann, K., T. Gärling, & K. Morten Stormark, 2003

Cardiac inter-beat interval (IBI) in nature and urban groups

Mean inter-beat interval (IBI), Longer IBI = slower heart rate

	Nature	Urban
Baseline	760	790
Mental load	738	753
Pre attention	795	796
Video	832	782
Post attention	820	815

Staats, H., A. Kieviet, T. Hartig, 2003

Preference for environment given attentional fatigue or no attentional fatigue

	Urban	Forest
Attentional fatigue	3.1	6
No attentional fatigue	4.2	5.8

$p < 0.001$

Attitude for walking in environment given attentional fatigue or no attentional fatigue

	Urban	Forest
Attentional fatigue	3.3	6.1
No attentional fatigue	4.4	5.8

$p < 0.001$

Ulrich, Simons, Miles, 2003

Effect of television on stress among blood donors

	Post waiting room			Post blood donation		
	SBP	DBP	Pulse	SBP	DBP	Pulse
Nature	125.5	79.6	74.7	122.1	78.9	73.3
Urban	125	80.3	77.5	120.6	79.5	75.4

Van den Berg, A, S.L. Koole, N.Y. van der Wulp, 2003

Mood states as a function of environment type and timing of measurement

	Urban			Natural		
	Baseline	After movie	Post video	Baseline	After movie	Post video
Depression	2.7	4	3.4	2.3	3.7	2.3
Anger	2.5	3.9	3.2	2.2	3.7	2
Tension	3	3.6	3.2	2.9	3.7	2.5
Happiness	7.45	6.63	6.65	7.71	7.14	7.65
Stress	3.45	4	3.64	2.75	3.72	2.53

Note Happiness and Stress originally 1 - 100 scale. Divided by 10 here.

Grahn & Stigsdotter, 2003

Distance to open green space

	50m	100m	300m	1000m
Visits per year	175.36	166.76	145.81	77.68
Time spent	252.03	225.32	219.34	130.29
Stress level index	80.79	104.9	108.58	122.03

Comparison of inner city and suburb use of open green space

	Inner city	Suburb
Time spent	186.14	230.57
Visits per year	131.99	157.29
Stress level index	120.08	94.6

Comparison of use of open space of those with a garden and those without a garden

	Having a garden	Not having a garden
Time spent	231.31	188.16
Visits per year	159.13	128.97
Stress level index	78.31	135.97

Berto, 2005

Reaction times before and after viewing nature and urban scenes

		Standard time		Self paced	
		Restorative	Nonrestorative	Restorative	Nonrestorative
Reaction time (ms)	Before	313.71	319.59	311.27	306.21
	After	267.38	299.61	302.22	297.91

Regan, C.L. and S.A. Horn, 2005

Proportion mentioning each type of nature for each mood state

	Excited	Happy	Relaxed	Ill	Upset	Scared	Stressed
Wild nature	4.1	8.3	12.4	2.1	9.6	3	11.7
Cultivated nature	1.6	4	8.6	2.4	4	1.5	6
Natural water	4.9	9.4	17.4	3.2	4.5	2.7	7.1
Green nature	5.5	12.4	20.7	4.5	13.3	4.4	17.7
Any nature	9.8	18	33.8	7.2	16.7	5.6	21.9

Relationship of demographic variables with mood states for those mentioning wild or cultivated nature

	Excited	Happy	Relaxed	Ill	Upset	Scared	Stressed
Male	15.6	19.2	42.1	9.7	30.2	14.3	26.9
Female	8.2	29.1	42.7	8.8	24.3	5.9	41.5
Adult	7.5	30.2	48.2	7	28	9.9	33.1
Child	20	13	28.1	14	23.5	7.4	42.3
Nature hobby	14.7	25.4	51.9	8.5	30	10.2	36.4
No nature hobby	9.6	22.9	35.4	9.3	25	8.7	36.3
Nature hols.	8.6	31	54.8	16.4	16.1	14.5	39.7
No nat. hols.	12.4	20.9	34.8	5.6	29.8	6.1	35.6
Rural	8.2	39.6	50	6	20.8	10.9	32
Town	6.5	25.9	51.8	5.6	29.4	9.1	29.2
City	16.4	16.2	31.5	14.7	31.3	7.7	42.9

de Kort, Y.A.W., A.L. Meijnders, A.A.G. Sponselee, W.A. Ijsselsteijn, 2006

Skin conductive level during nature film

	Small screen	Large screen
Post stress	15.86	13.97
1 minute	15.06	13.4
2 - 4 minutes	15.24	13.03

8 - 10 minutes 14.96 12.96

Hartig & Staats, 2006

Attitude towards walking in given environment as function of attentional fatigue

	City	Forest
Less fatigue	3.58	5.8
More fatigue	2.63	5.74

Judged likelihood of attentional recovery and reflection of walking in given environment as function of attentional fatigue

Means	Attentional recovery			Reflection		
	City	Forest	p	City	Forest	p
Less fatigue	3.16	4.6	0.005	3.71	4.6	<0.001
More fatigue	2.58	5.57	0.005	3.05	5.57	0.001

Maas, J., R.A. Verheij, P.P. Groenewegen, S de Vries & P. Spreeuwenberg, 2006

Influence of green space on perceived health

% green space	% health less than good
0	16
10	15.5
20	14.8
30	13.9
40	13.1
50	12.6
60	11.8
70	11.3
80	10.9
90	10.2
100	9.6

Han, 2007

Restorativeness scales

Biome	Scales	
	Hartig	Han
Desert	4.192	5.249
Tundra (mountains)	5.739	6.526
Grassland	4.154	5.411
Coniferous forest	5.466	6.283
Deciduous forest	4.857	5.729
Tropical forest	5.011	5.973

Mitchell & Popham, 2007

Average rate of not good health and greenspace

% Greenspace	Av rate poor health
<10	1.07
10-19	1.13
20-29	1.13
30-39	1.11
40-49	1.07
50-59	1.02
60-69	0.95
70-79	0.90

80-89	0.85
90-99	0.76

Chang, C-Y, W.E. Hammitt, P-K Chen, L Machnik and W-C Su, 2008.

Mean value of respondents' physiological responses

	Being away	Coherence	Fascination	Compatibility	Non-viewing	P
EEGa	22.14	19.04	19.05	19.53	6.18	<0.001
EEGb	23.86	20.21	18.72	17.36	6.03	<0.001
EMG	11.45	10.96	9.63	10.03	8.67	<0.001
BVP	25.02	25.04	25.01	25.02	25.22	<0.001

Kweon B-S., R.S. Ulrich, V. D. Walker and L. G. Tassinary, 2008

Stress and anger associated with office posters

Office conditions	State Anger			Stress		
	Male	Female	Total	Male	Female	Total
No poster	18.45	13	16.03	4.5	3.06	4.02
Abstract posters	14.61	15.33	14.97	3.44	4.17	3.79
Mixed posters	14.51	14.19	14.35	2.3	3.67	2.92
Nature poster	14.63	13	13.94	2.74	3.07	3.03

Felsten, G., 2009.

Restorative capability of differing views

	Being away	Extent	Fascination	Compatibility	Restorativeness	p
No view of nature	3.21	3.06	3.13	3.24	3.16	<0.001
Window view of trees & building	4.2	4.06	4.19	4.25	4.17	<0.001
View of nature mural	4.78	4.72	4.8	4.72	4.76	<0.001
View of water mural	5.34	5.29	5.4	5.28	5.33	<0.001
p	<0.001	<0.001	<0.001	<0.001		

Herzog, T. & A.E. Rector, 2009.

Perceived danger in urban and natural settings

Perceived danger	Urban	Nature	p
Low danger	3.38	2.22	<0.001
High danger	6.27	6.14	
p	< 0.001		<0.001

Recovery, reflection & preference in urban and natural settings when faced by danger

Recovery	Urban	Nature	p
Low danger	4.18	5.13	<0.001
High danger	3.74	3.72	
p	< 0.001		<0.001
Reflection			
Low danger	4.13	4.74	0.022
High danger	4.18	4.28	
p	<0.005		0.076?
Preference			

Low danger	3.17	5.6	<0.001
High danger	1.54	1.47	
P <0.001			

Mayer, F.S., C. M. Frantz, E. Bruehlman-Senecal, K. Dolliver, 2009

Mood states for three conditions

	Nature	Virtual nature	Virtual urban
CNS	3.6	3.28	2.8
Positive affect	3.15	2.33	2
Negative affect	1.35	1.39	1.66
Ability to reflect	3.88	3.69	3.09

CNS = Connectedness to Nature Scale

Ryan, 2010

Interacting effects of nature or building slides on vitality over time

	Before	After
Building	2.9	2.6
Nature	2.85	3.2

p < 0.01

Van den Berg, et al, 2010

Perceived general health (Original data 1=Excellent, 5 = poor. Scale has been reversed here)

	Little green 1 km	Much green 1 km	Little green 3 km	Much green 3 km
No life event	2.2	2.24	2.23	2.22
Life event	2.15	2.2	2.11	2.26

Lottrup, et al, 2013

Workplace attitude and access to workplace greenery

All	Workplace attitude	Level of stress
WG Index 1	3.17	3.61
WG Index 2	3.76	3.58
WG Index 3	4.03	3.26

Sato & Tamlin, 2013

Fascination vs time in nature

	Low time in nature	High time in nature
High fascination	2.99	3.075
Low fascination	2.885	2.92