

HEALTH AND RESTORATIVE BENEFITS OF VIEWING LANDSCAPES
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Quotations about the health and restorative benefits of nature

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.

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.

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

*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 *I wandered lonely as a cloud* (final verse).

1. INTRODUCTION

Spanning many generations these quotes suggest a recurring theme, that of the healing power of nature, an ideal, of being in natural surroundings and of drinking it in and experiencing beneficial restoration and health. Does the ideal exist? Can it be proved? If so, is it significant or barely noticeable? The short answer is that nature does provide psychological healing and restoration.

In a famous study reported in *Science*, Roger Ulrich (1984) compared the recovery of patients in a Pennsylvanian hospital whose rooms faced a blank wall with patients who could see trees. The 46 patients had undergone similar gall bladder operation and the records were extracted from records over a ten year period. Those who viewed trees had shorter stays in hospital: 7.96 days vs 8.70 days, took fewer strong and moderate analgesics 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 hint 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.

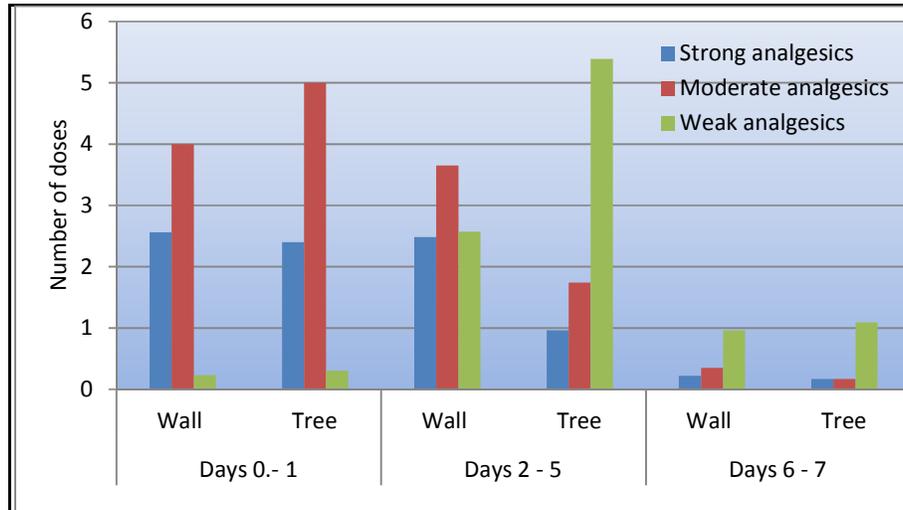


Figure 1 Analgesic doses per patient for wall view and tree view

Ulrich's work, along with that of other early researchers, has stimulated much research over the past several decades into the role of viewing and being amid nature on health and restoration.

In this paper, 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.

The paper 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 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. Finally, a summary and conclusions are presented.

The paper excludes 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 paper cover the psychological benefits of indoor plants (Bringslimark, *et al*, 2009). Four additional areas are not covered as they do not relate solely to viewing nature: exercise in natural environments, 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 here.

There have been two special issues of key journals with extensive papers on restorative environments, *Environment and Behavior* 33:4, 2001, and *Journal of Environmental Psychology*, 23:2, 2003.

2. THEORETICAL APPROACHES

There have been two main lines of enquiry, complementary but operating from differing theoretical standpoints. Stephen and Rachel Kaplan proposed the Attention Restoration Theory in which the restorative exposure to nature helps the individual overcome attention fatigue (1989, 1995). Roger Ulrich 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 (1983).

2.1 Attention Restoration Theory

The Kaplans based 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 – a good example is that of student swotting for exams. The Kaplans used 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*, 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 three additional components to a restorative environment are proposed. These are:

- *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 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.

2.2 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 the oldest part of the brain, whereas cognition occurs in the neocortex, a much more recent part of the brain.

With the development of cognitive psychology in the 1960s, affects were regarded as products of cognition (i.e. post-cognitive). In a widely quoted paper, *Feeling and thinking, preferences need no inferences*, psychologist Robert Zajonc (1980) argued against the prevailing doctrine that affect is post-cognitive and provided experimental evidence that discriminations (like-dislike) can be made in the complete absence of recognition memory. Ulrich (1991) proposed that:

“immediate, unconsciously triggered and initiated emotional responses - not 'controlled' cognitive responses - play a central role in the initial level of responding to nature, and have major influences on attention, subsequent conscious processing, physiological responding and behavior”

Affective theory considers that natural settings and landscapes can produce in their viewers emotional states of well-being that can be detected through psychological and neurophysiological measures. Although it is measured on a like-dislike dichotomy, it has also been shown to be highly correlated with scales such as beautiful - ugly or scenic quality scales (Ulrich, 1986).

2.3 Comparison of theories

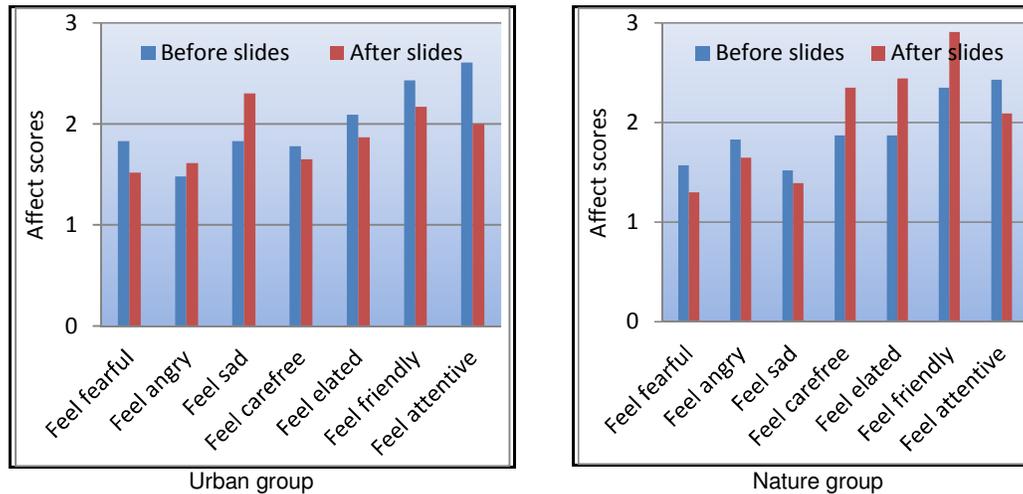
The difference between the Kaplan and Ulrich models, apart from the former being based on cognition and the latter on affect, is that Ulrich focuses on the “emotional, mental and physiological components of response to taxing or threatening stimuli” (Hartig, et al, 1991) whereas the Kaplans' interest 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. Parsons (1991) provides a detailed comparison of the two approaches.

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.

3. PSYCHO-EVOLUTIONARY THEORY RESEARCH

In his earliest 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 affection and delight, compared with individuals shown scenes of treeless city scenes (Figure 2).

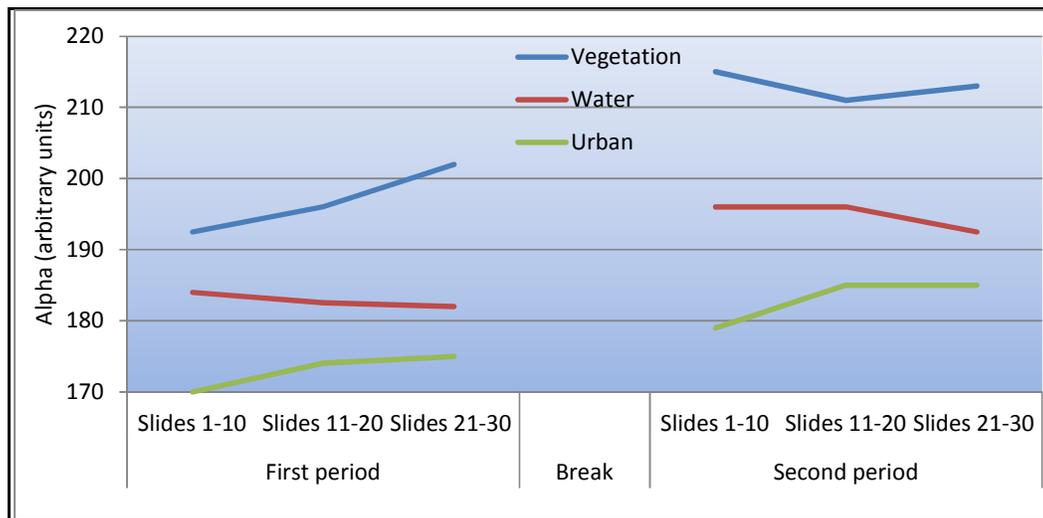


Source: Ulrich 1979

Figure 2 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 3). 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 3 Alpha wave scores when viewing scenes

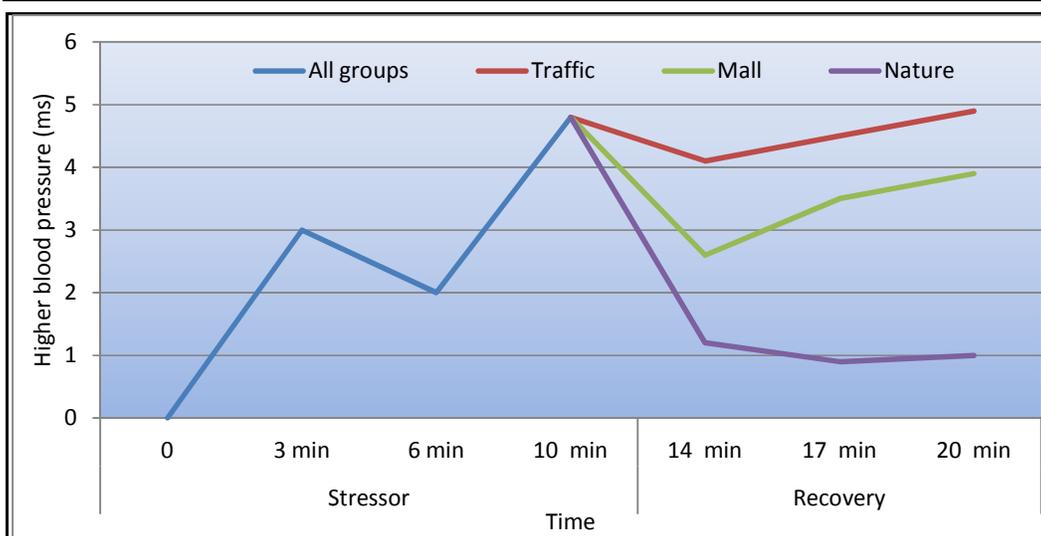
Heart rates were generally higher while viewing either water or vegetation compared with urban scenes - water 71.3 beats/minute, vegetation 71.1, urban 70.2, but the differences were not significant.

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. Viewing natural scenes resulted in significantly increased positive affect scores compared with either the pedestrian mall or traffic. Figure 4 shows the results for blood pressure and indicates the substantial ameliorative effect that viewing nature has in lowering blood pressure.

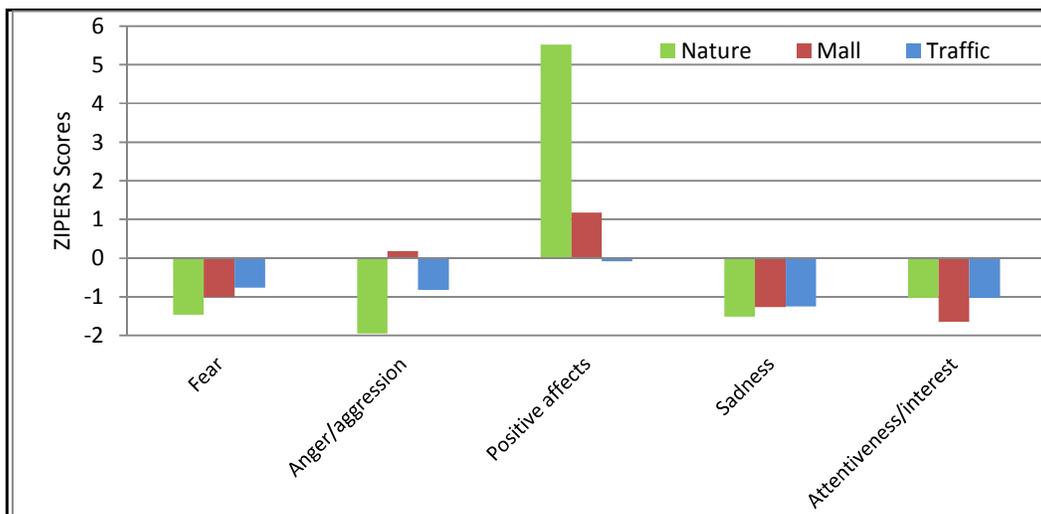


Source: Ulrich, *et al*, 1991

Figure 4 Changes in blood pressure (pulse transit time) during stress and recovery

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 5).



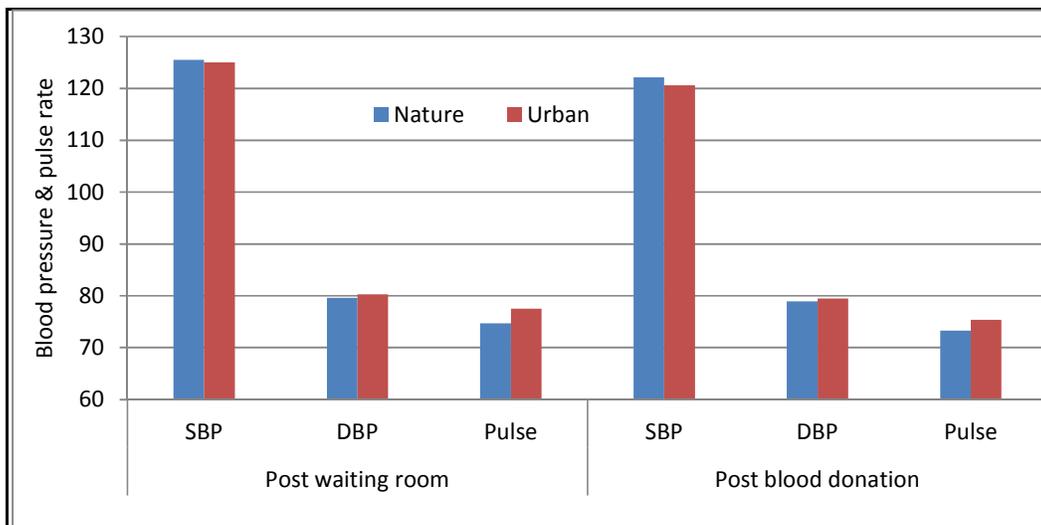
Source: Ulrich *et al*, 1991. Note: shows ZIPERS score changes from pre- to post- recovery

Figure 5 Influence of environments on affective states

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 centre (Ulrich, Simons & Miles, 2003). As part of the normal processing of patients, blood pressure (systolic and diastolic) and pulse of each participant were measured, 872 in all. 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.

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 6). It also found stress was lower when the television was off than when it played daytime television programs.



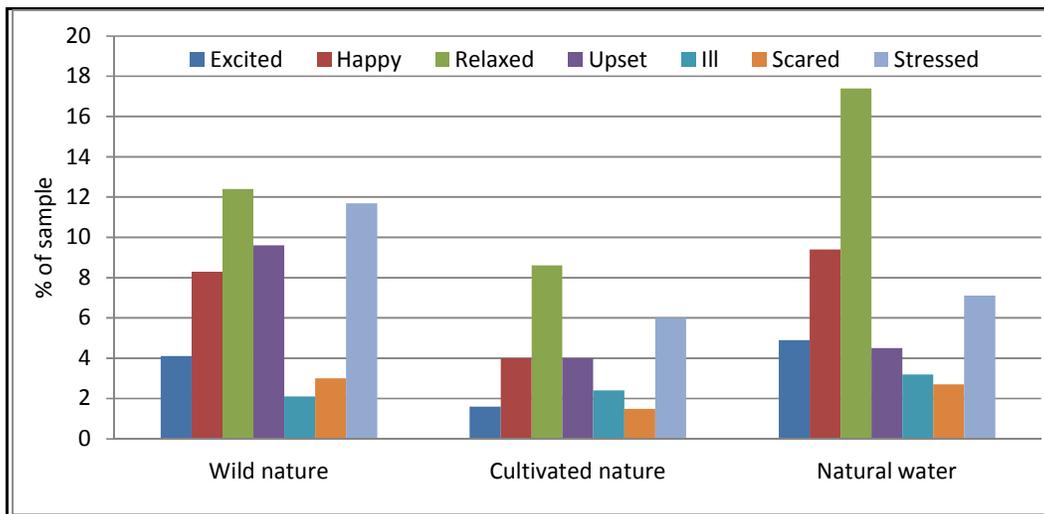
Note: SBP = systolic blood pressure, DBP = diastolic blood pressure

Figure 6 Blood pressure and pulse prior and following blood donations

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).

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 7). In contrast, natural water was associated with relaxed and happy moods followed by a stressed mood.

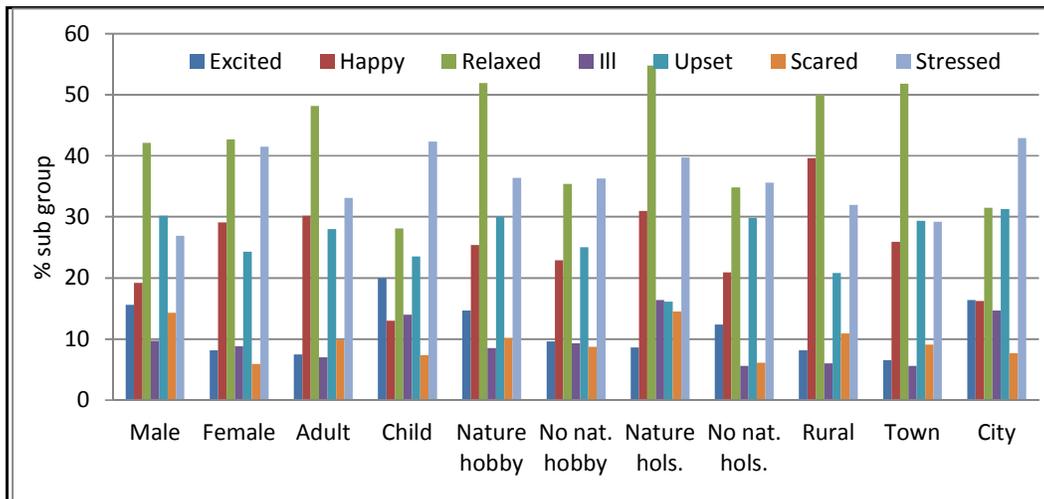


Source: Regan and Horn, 2005

Figure 7 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 8). 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 8 Relationship of demographic variables with mood states for those mentioning wild or cultivated nature

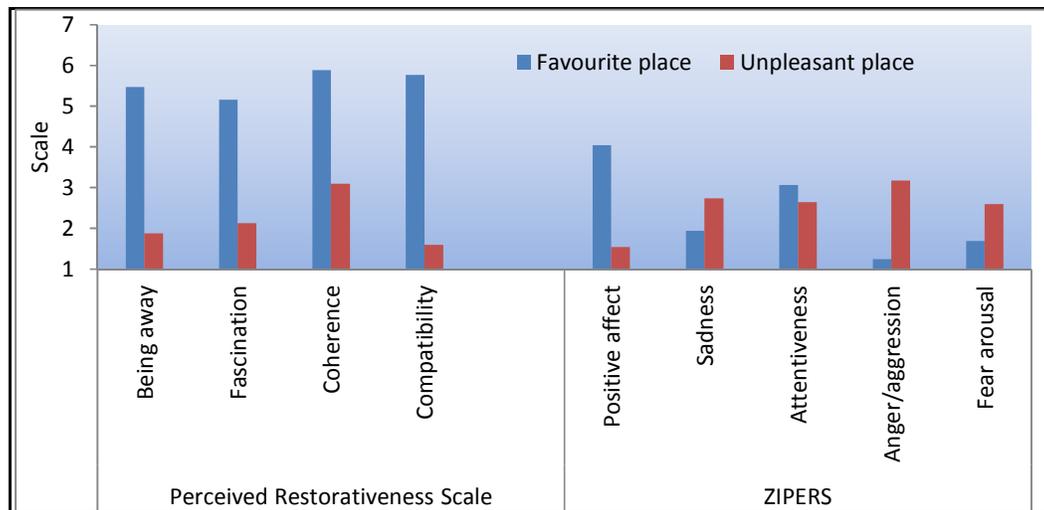
4. ATTENTION RESTORATION THEORY RESEARCH

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.”

Korpela and Hartig (1996) asked how individual ratings of favourite and unpleasant places corresponded with ART. Finnish students (78) 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 9 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.

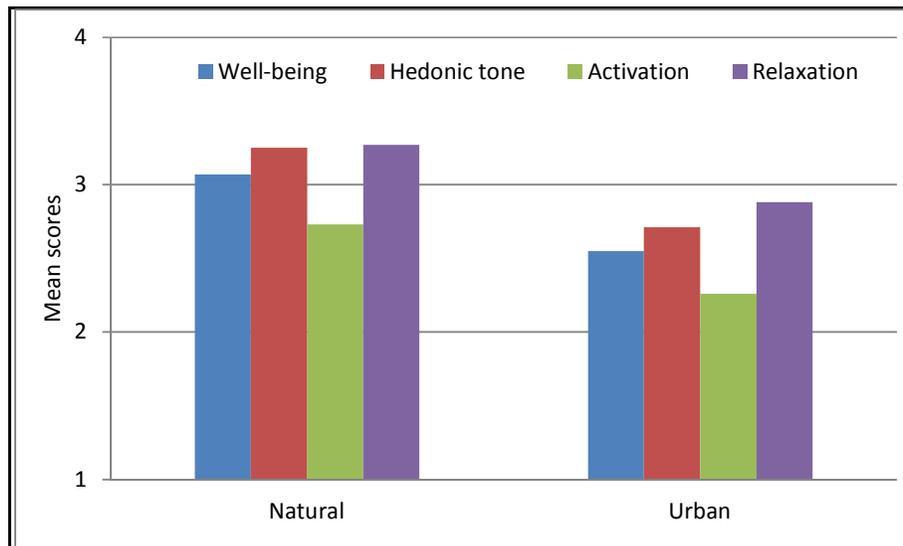


Source: Korpela & Hartig, 1996. PRS = Perceived Restorativeness Scale; ZIPERS = Zuckerman Inventory of Personal Reactions

Figure 9 Ratings of favourite & unpleasant places on PRS and ZIPERS scales

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

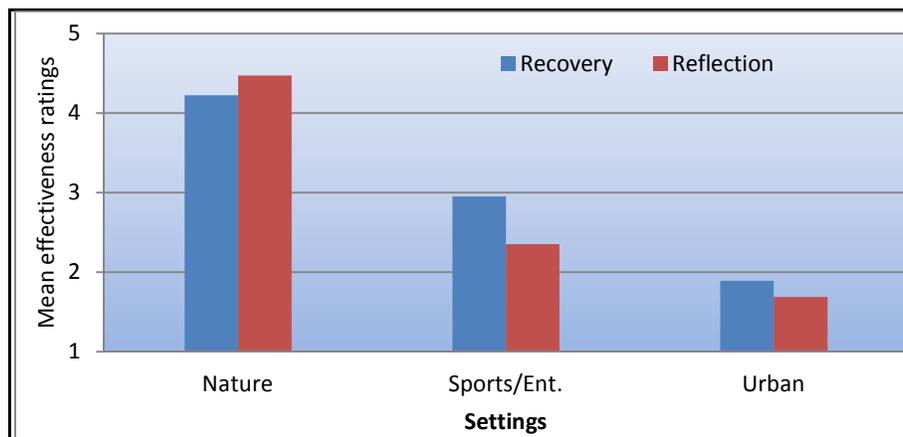
attribute to the bittersweet experience of ending a pleasurable activity. The positive affect scores were significantly lower for the urban scenes than the nature scenes (Figure 10).



Source: Hartig, *et al*, 1996

Figure 10 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 11) found that natural settings had high restorative potential while urban settings had low potential and sporting and entertainment settings were intermediate.



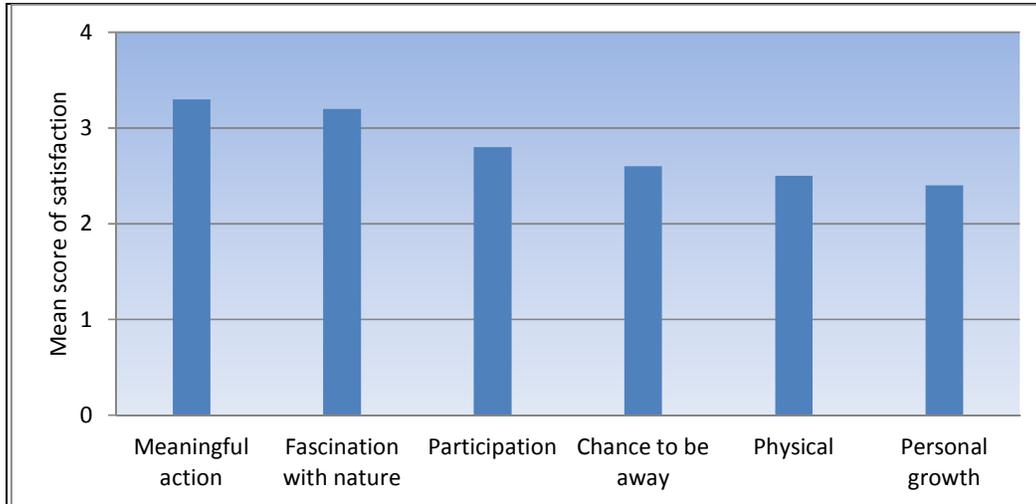
Source: Herzog, *et al*, 1997

Figure 11 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 12). 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.

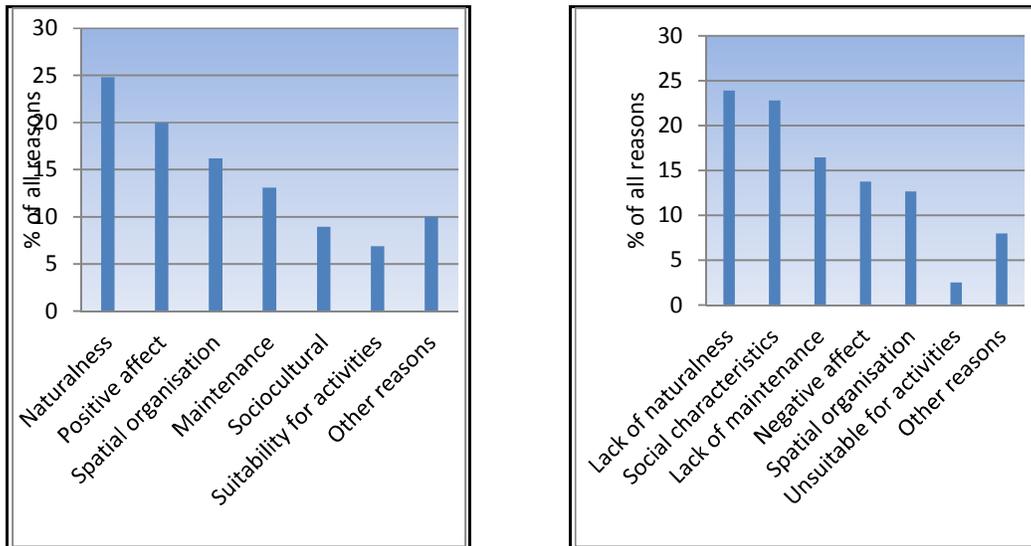
Figure 12 Sources of restoration satisfaction

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

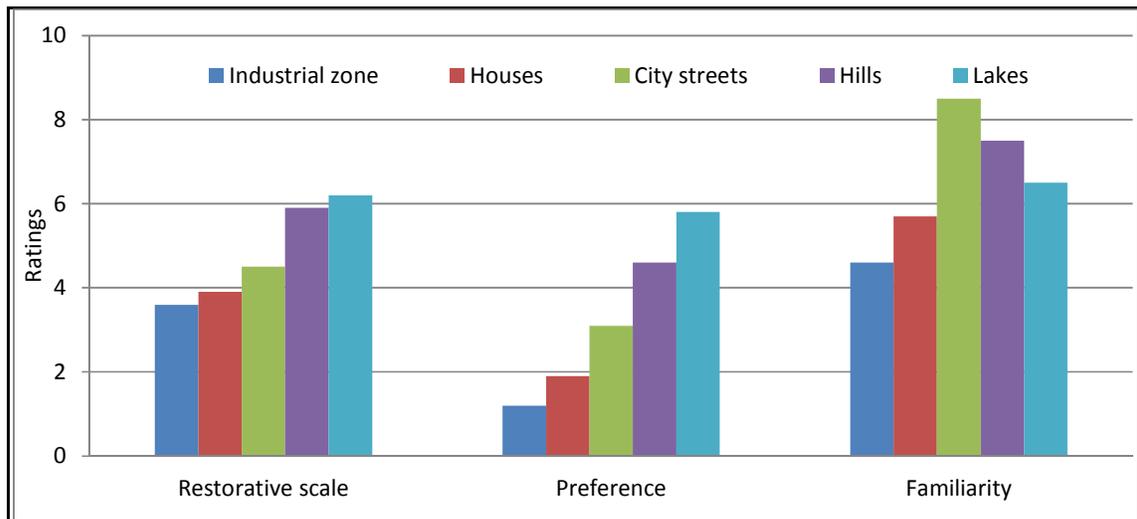
The top reasons for their high aesthetic value scores were the existence of vegetation, feeling of tranquility, and openness/wide area and the top reasons for low aesthetic value scores were lack of vegetation, deterioration/neglect/abandonment, lonely place, traffic/noise/pollution, and feelings of sadness/distress. Figure 13 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 13 Reasons (categorised) for high and low aesthetic value scores

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 14). 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).

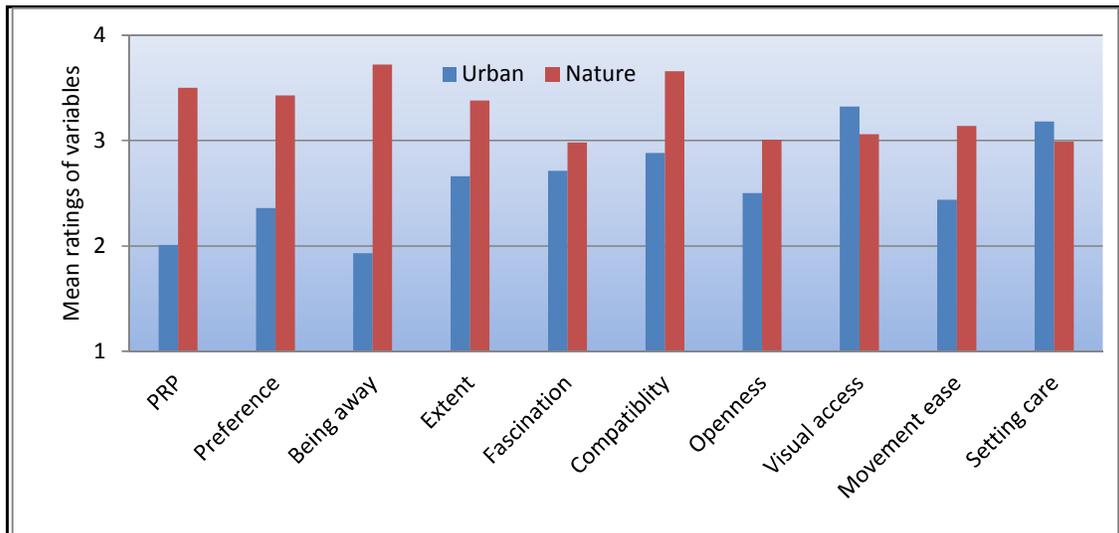


Source: Purcell, *et al*, 2001

Figure 14 Assessment of restoration, preference and familiarity for varying scenes

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

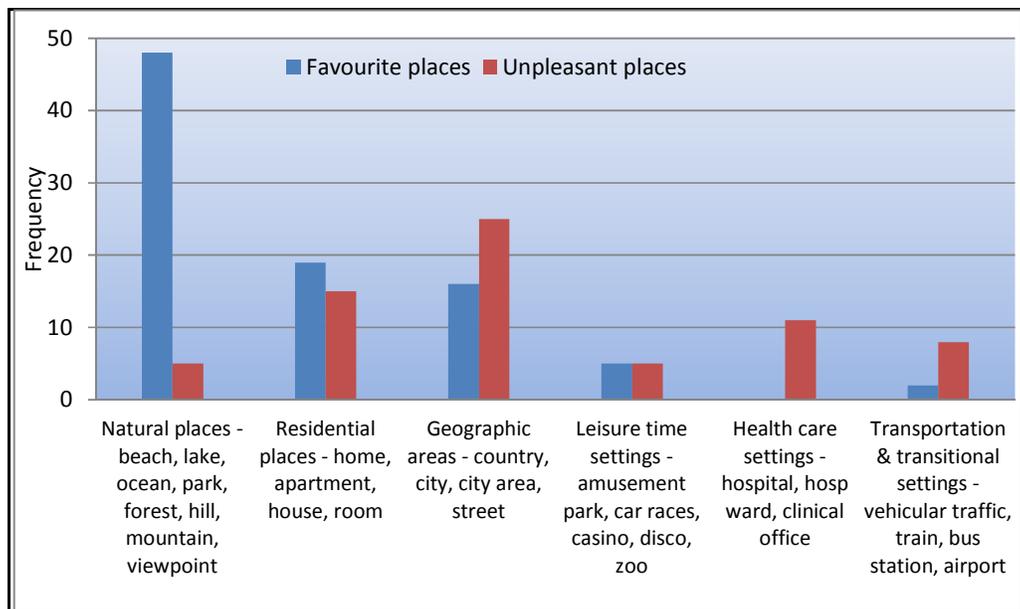
intense and prolonged effort (Figure 15). They also assessed preference for the setting and additional predictor variables (openness, visual access, movement ease, and setting care). Figure 13 shows the mean ratings for all setting categories. Nature rated higher than urban setting in all but two of 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 15 Mean ratings for all rated variables as function of setting

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 16).

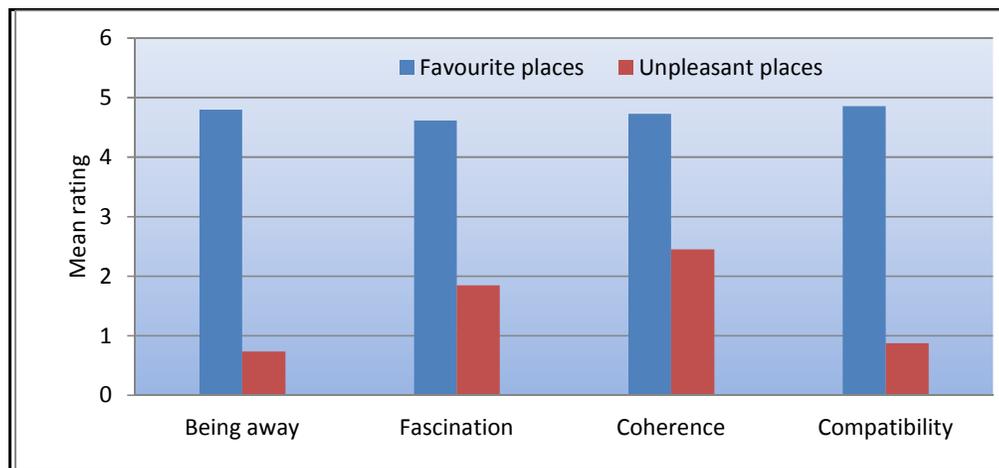


Source: Korpela, *et al*, 2001

Figure 16 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.

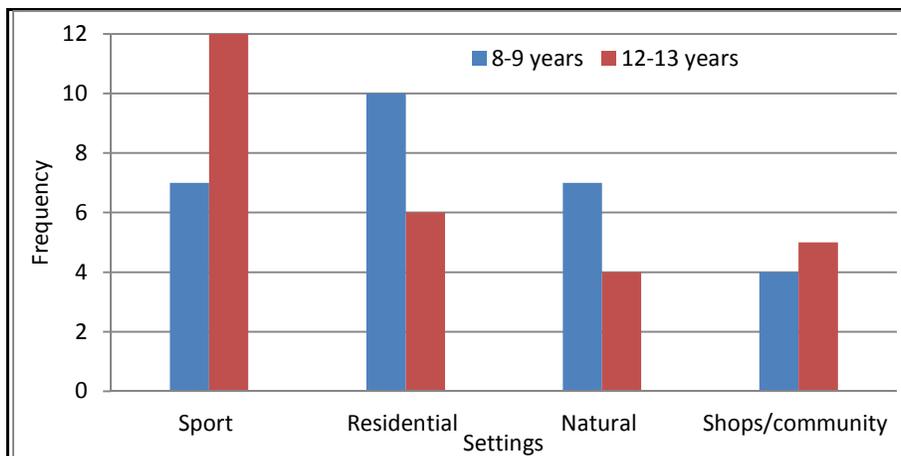
Asked about the experiential qualities of favourite and unpleasant places, the participants spoke of being relaxed, being away from everyday life, forgetting worries, and reflecting on personal matters, all indicative of a link between favourite places and a restorative experience (Figure 17). Places 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 17 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 18). Girls more than boys favoured natural areas. As the children grow older they appear to trade home for sports places.



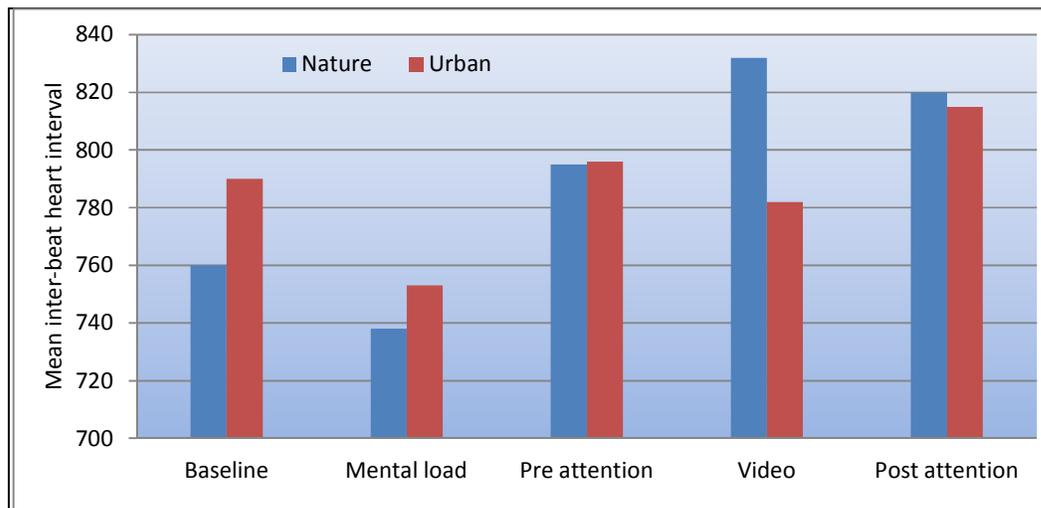
Source: Korpela, *et al*, 2002

Figure 18 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.

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 19). 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”.



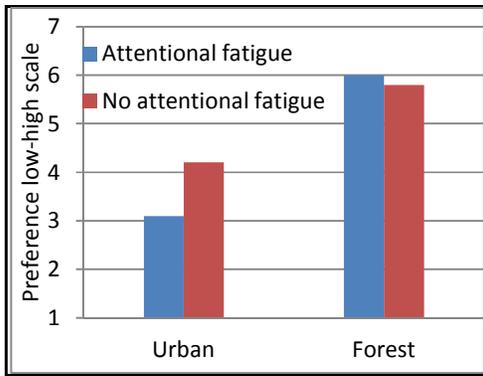
Source: Laumann, *et al*, 2003. Note: Longer IBI = lower heart rate

Figure 19 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 20). 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 21).



Source: Staats, *et al*, 2003
Figure 20 Preference for environment given attentional fatigue or no attentional fatigue

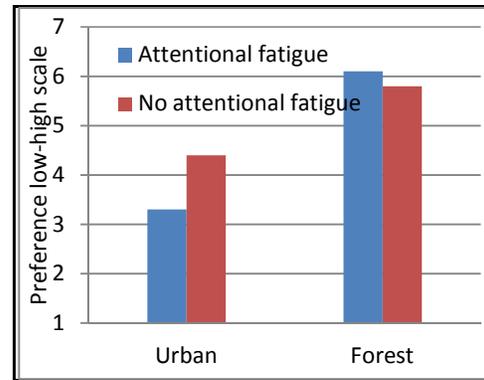
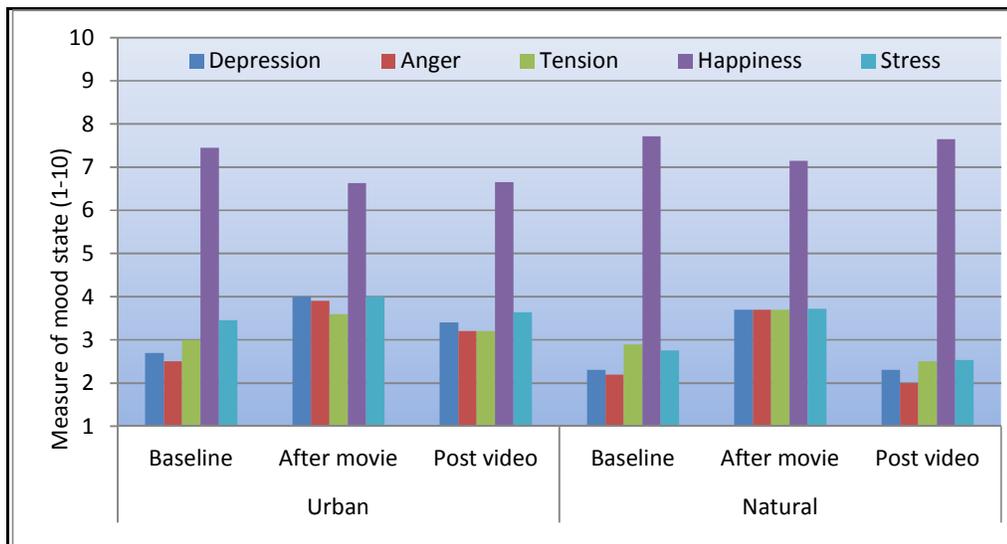


Figure 21 Attitude for walking in environment given attentional fatigue or no attentional fatigue

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.

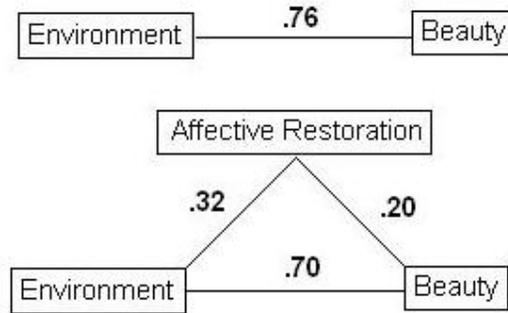
Those who viewed videos of natural environments showed greater restoration on all five affective measures whereas those who viewed the built environments experienced lesser affective restoration (Figure 22). Use of the horror movie also showed that restoration occurs from anxiety-based stress.



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

Figure 22 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 23 – upper part). Natural environments rated 6.75, considerably higher than 3.26 for built environments. In the lower part of Figure 23 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.

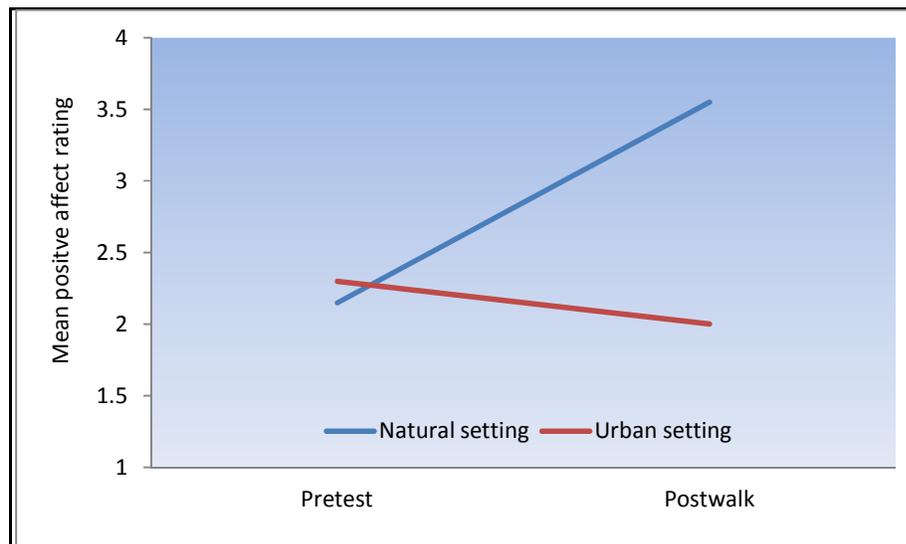


Source: Van den Berg *et al*, 2003. Note: Coefficients are standardized β

Figure 23 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.

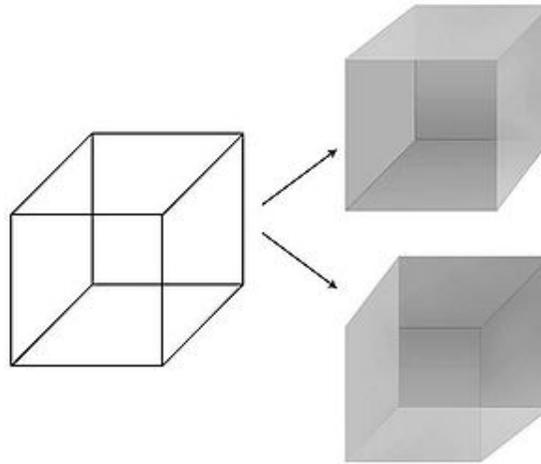
The self-administered measure of overall happiness before and after the walk in natural and urban environments found an increase from the natural setting and a decrease from the urban setting (Figure 24). Other tests showed that anger decreased in the nature reserve by the end of walk, but increased in the urban environment.



Source: Hartig, *et al*, 2003. Scores 1 – 5 range; no task option. Higher scores more positive affect.

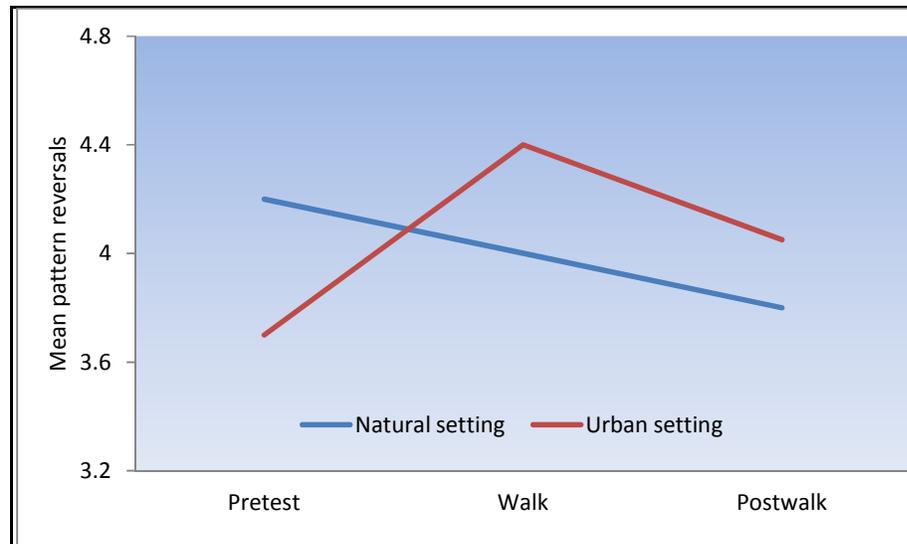
Figure 24 Change in self-reported positive affect as function of environment and task condition

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 25). The number of reversals in over 30 seconds is a measure of attentional fatigue, the fewer the better. Figure 26 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 25 Necker Cube

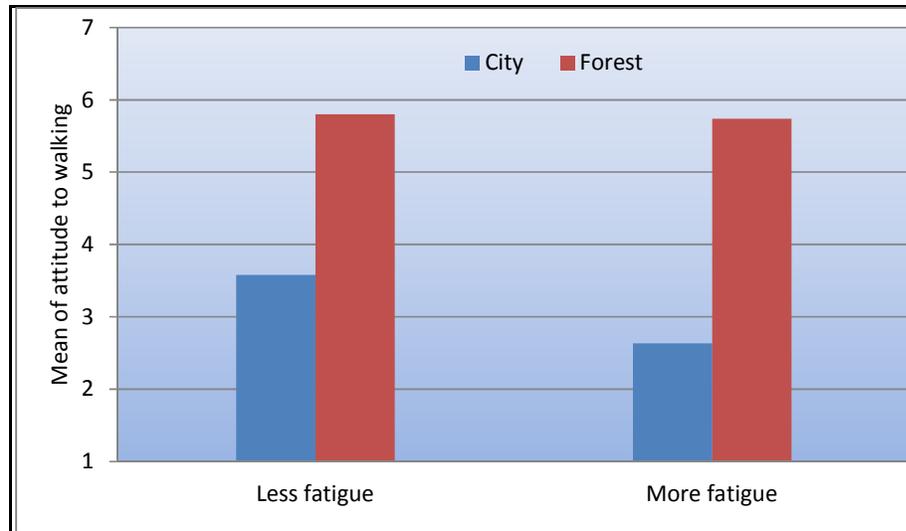


Source: Hartig, *et al*, 2003. Scores 0 – 11. Values represent pattern reversals that occurred despite effort to maintain a focus on one pattern. Downward trend indicates fewer reversals and hence improved performance.

Figure 26 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.

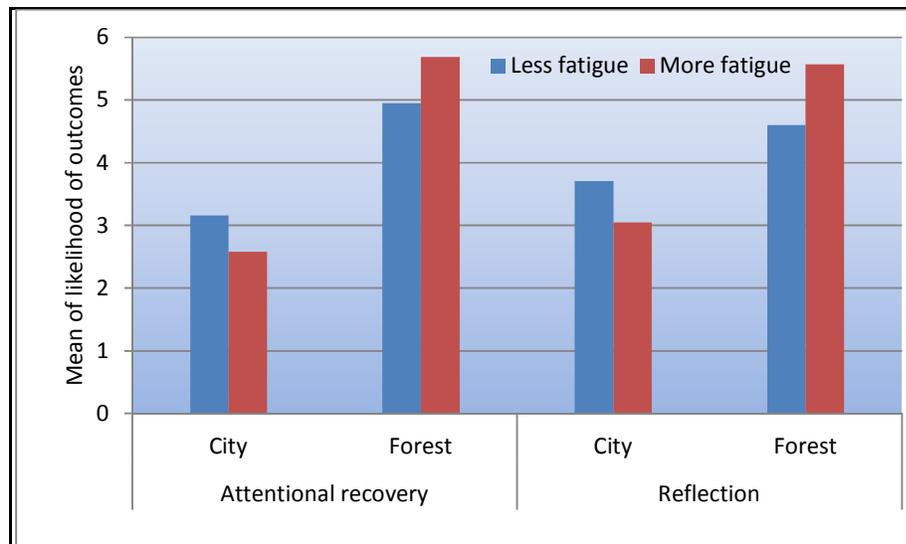
Hartig and Staats (2006) tested the extent to which a walk in a forest or a walk in a city would provide restoration from attention fatigue and allow for reflection. Using over 100 students in Stockholm, they tested them before and after fatiguing lectures. The students reported more positive attitude towards walking in forest than city (Figure 27).



Source: Hartig & Staats, 2006

Figure 27 Attitude towards walking in given environment as function of attentional fatigue

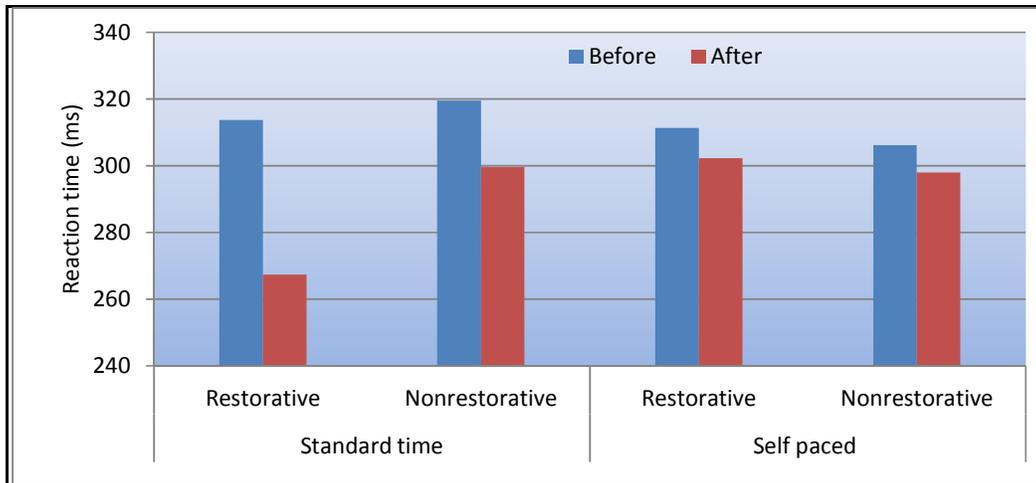
Recovery from attentional fatigue was more likely to occur in a forest than city and this was particularly true for those with more fatigue where a walk in the city hampered recovery whereas a walk in the forest enhanced recovery (Figure 28). The same pattern occurred for reflection where greater reflection 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 28 Judged likelihood of attentional recovery and reflection of walking in given environment as function of attentional fatigue

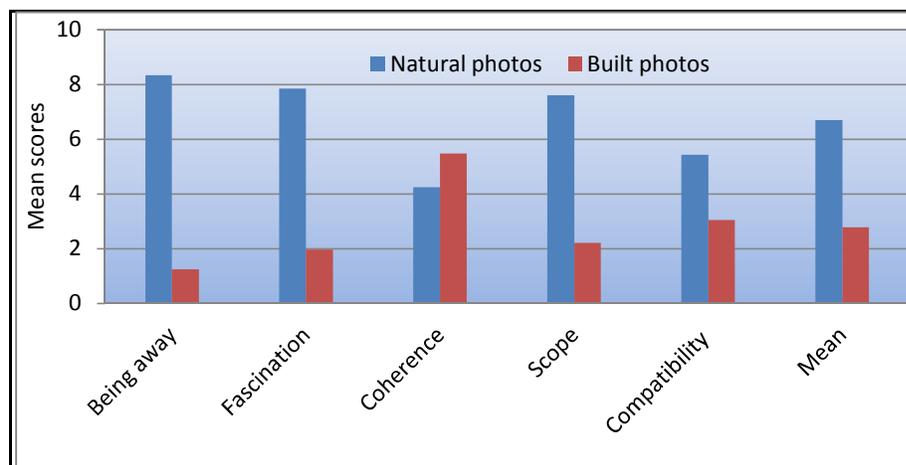
In Padova, Italy, Berto (2005) used photographs of nature and urban scenes to represent restorative and nonrestorative environments and tested them before and after a fatiguing attention test. Only the participants exposed to restorative environments regained their attentional capacity to a sufficient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

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 30). In the *being away*, *fascination* and *scope* factors, the natural scenes scored much higher than the scenes of the built environment.

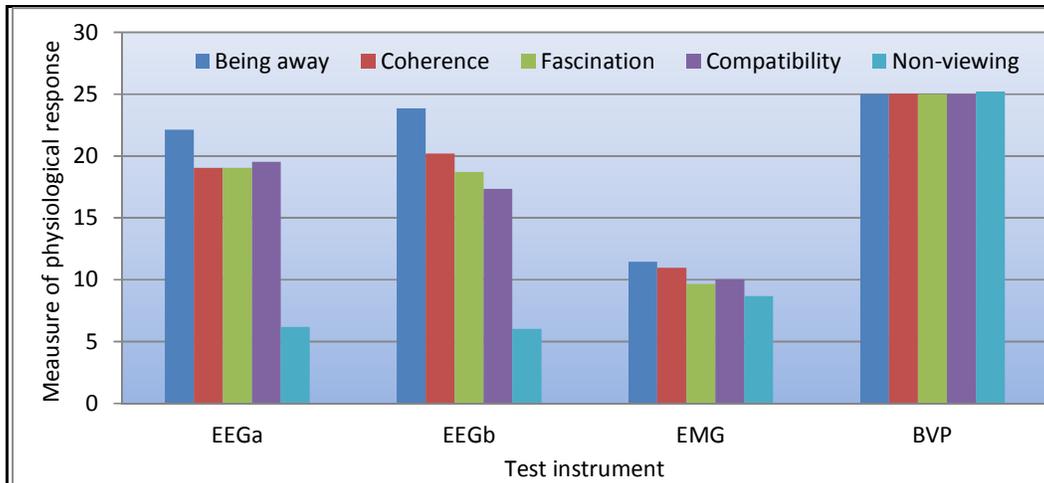


Source: Berto, et al, 2008

Figure 30 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.

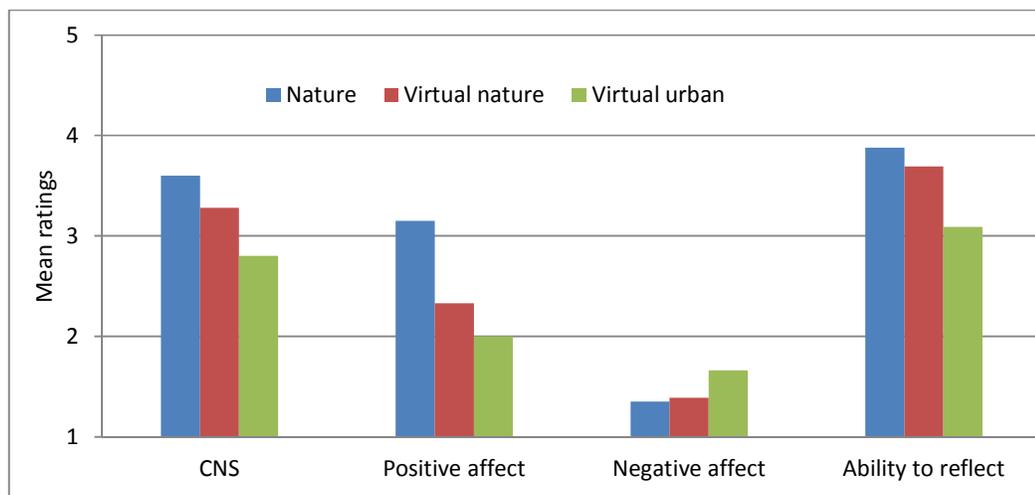
All four physiological measures found improved condition over the non-viewing control condition with EEGa & b and EMG increasing and BVP decreasing. The findings demonstrated a congruency between the psychological response scores and the physiological responses (Figure 31).



Source: Chang, *et al*, 2008. Note: EEGa and b measure alpha waves of the left and right sides of the brain

Figure 31 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 32). 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).

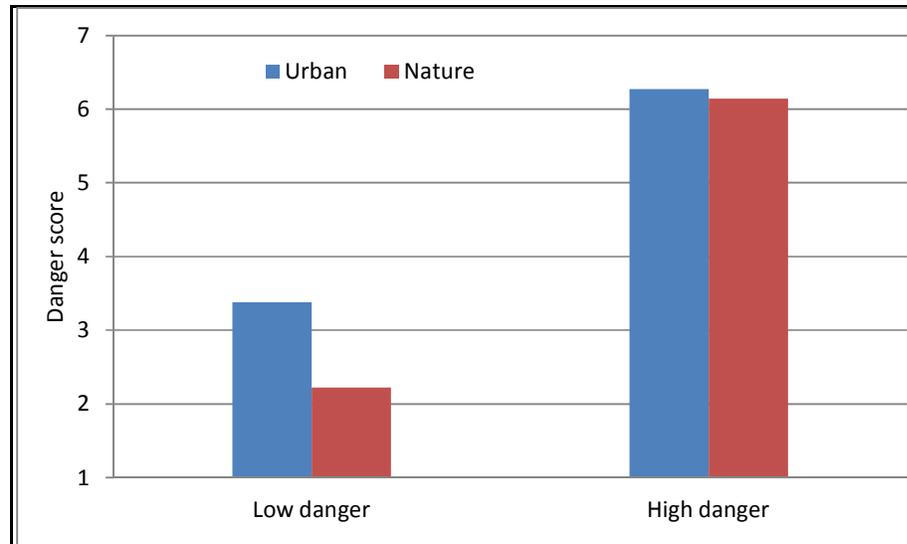


Source: Mayer, *et al*, 2009. Note: CNS = by Connectedness to Nature Scale

Figure 32 Mood states for three conditions

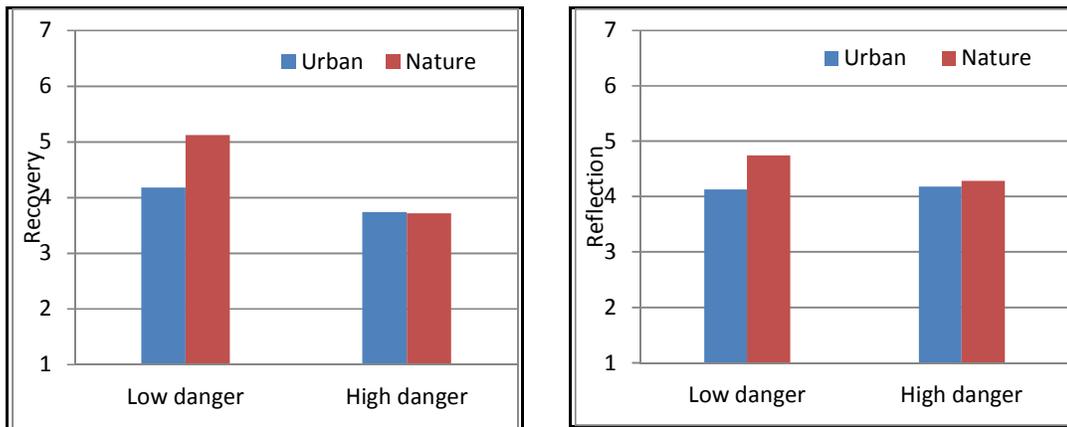
Herzog and Rector (2009) were interested in the degree of danger that is perceived in walking in places that are potentially restorative, including a nature trail and a busy urban street. Students read two scenarios involving two levels of perceived danger – a feeling of danger, and being followed by 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 33).



Source: Herzog & Rector, 2009

Figure 33 Perceived danger for urban and nature settings



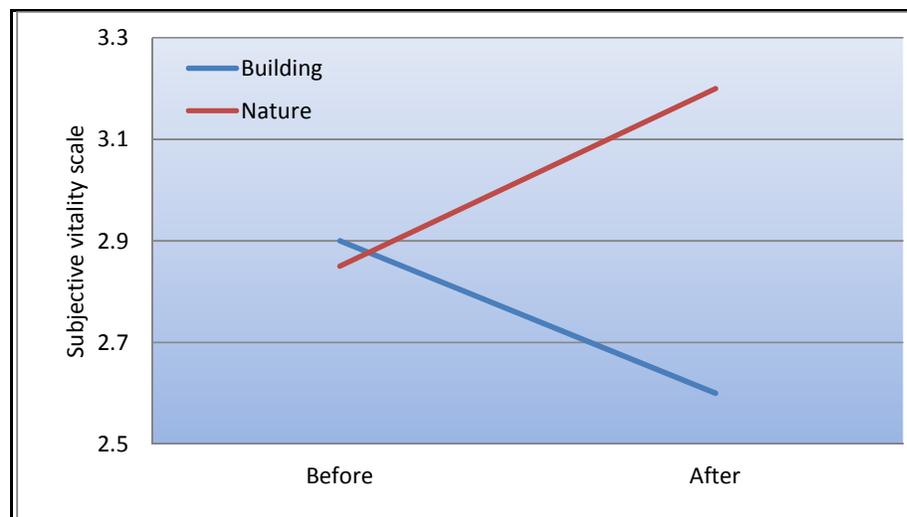
Source: Herzog & Rector, 2009

Figure 34 Recovery and reflection in urban and nature settings when faced by danger

For recovery and reflection, the two settings differed significantly in conditions of low danger but were virtually identical in high danger (Figure 34). 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.

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 35).



Source: Ryan, *et al*, 2010

Figure 29 Interacting effects of nature or building slides on vitality over time

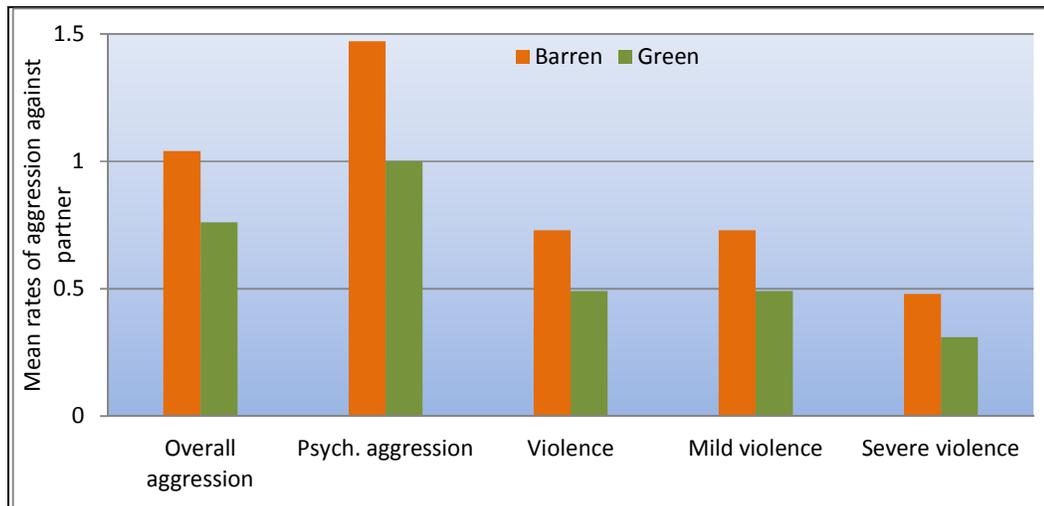
5. ADDITIONAL RESEARCH OF THE HEALTH ASPECTS OF NATURE

5.1 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 36). 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 36 Comparison of aggression against partner over past year in green vs barren conditions

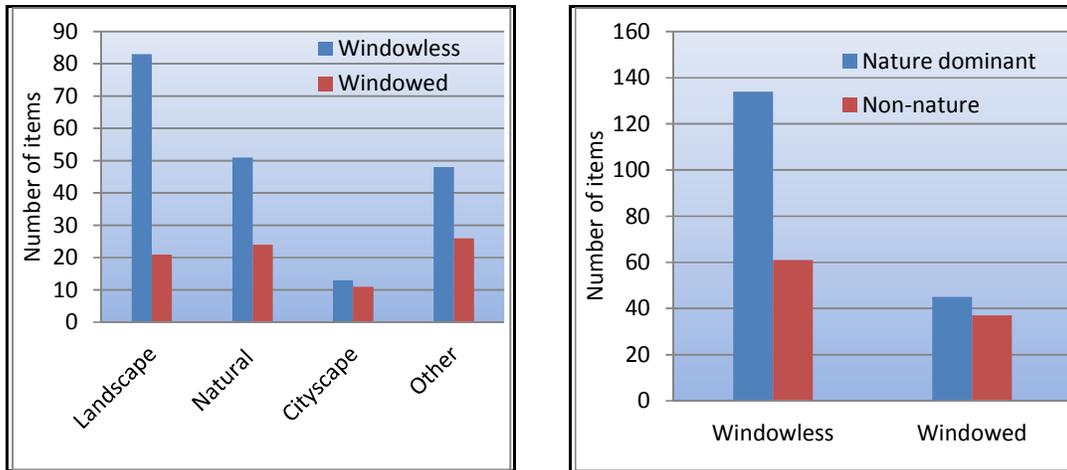
Anti-social behavior extends to the neighbourhood in the form of crime. It has been conventional wisdom that thick vegetation and trees promote crime but Kuo and Sullivan (2001b) found the opposite to be true. In a poor public housing neighbourhood of Chicago they found that the greener a buildings surrounds, 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.

5.2 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 37a).

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 37b).

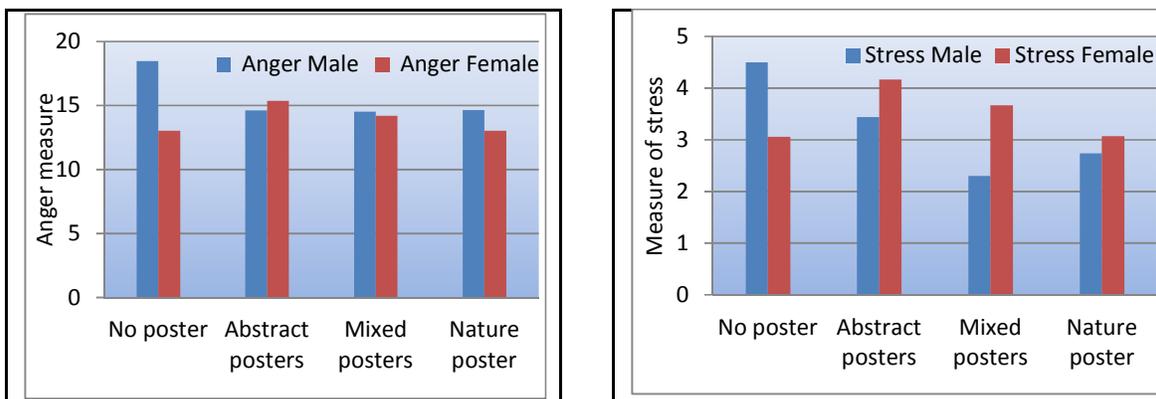


Source: Heerwagen & Orians, 1986

Figure 37a and 37b 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 2, Figure 38). 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

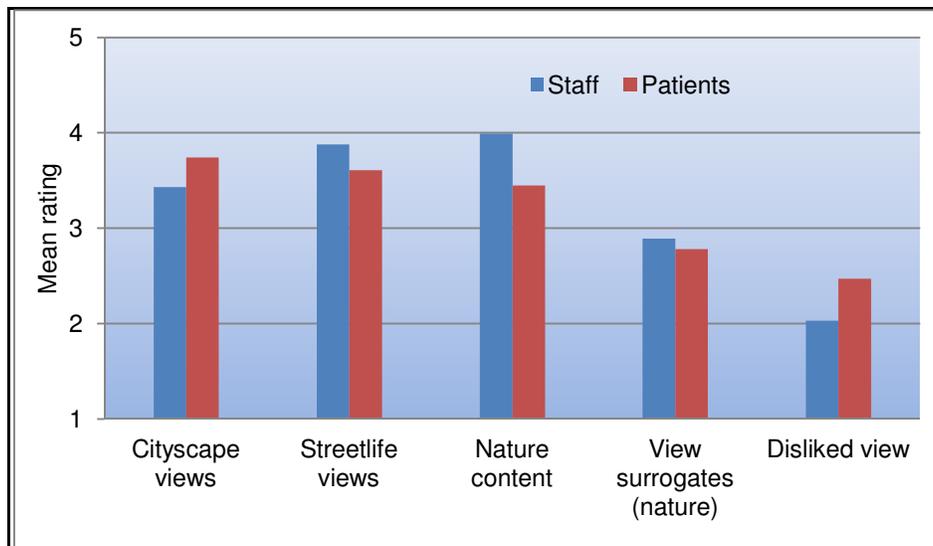
Figure 38 Anger and stress associated with office posters

Table 2 Stress and anger associated with office posters
Kweon, *et al*, 2008

Office conditions	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

5.3 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 39). Among patients, 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

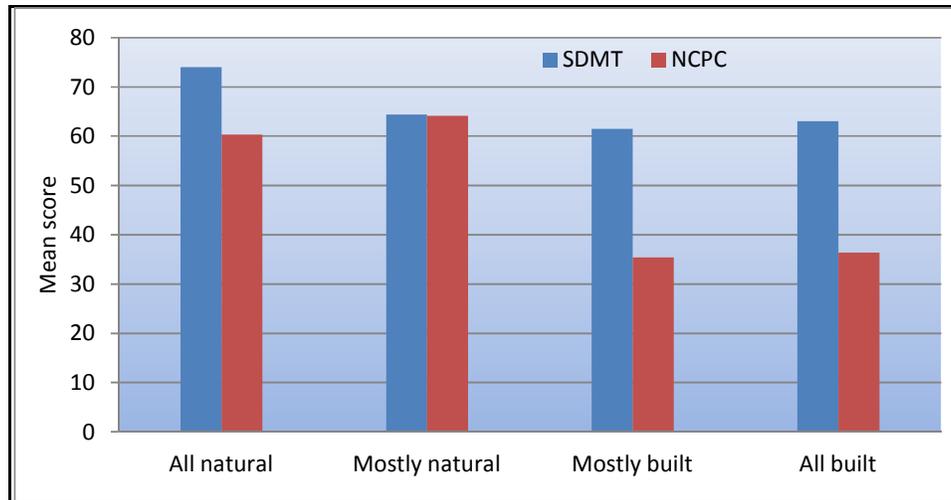
Figure 39 Influence of view on preference ratings, Chicago hospitals

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, and
- 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.

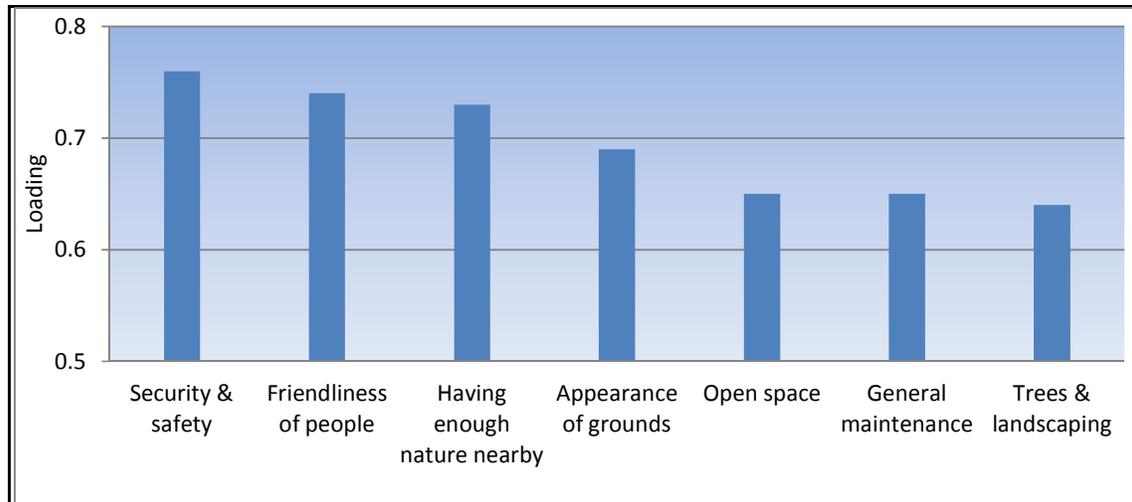
Natural views from their windows enhanced the student's capacity for directed attention compared with those with less natural views (Figure 40). The results also support the link in the Attention Restoration Theory between the natural environment, fatigue derived from directed attention, and restoration 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%.

Figure 40 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 41 indicates the degree of satisfaction in the apartments and shows the importance of nature, open space and trees.

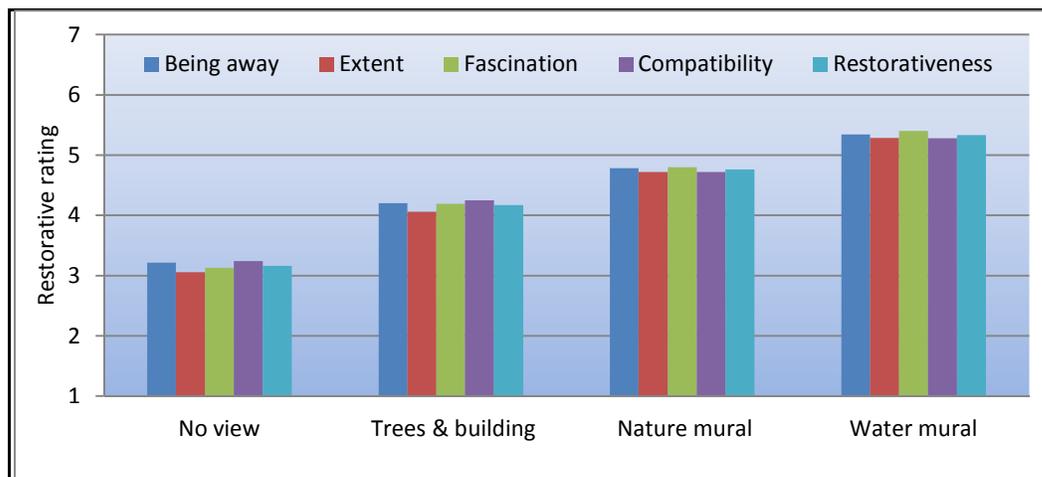


Source: R. Kaplan, 2001. Note: Uses loadings from factor analysis

Figure 41 Satisfaction measures of apartments

From this analyses, 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.”

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 42).



Source: Felsten, 2009

Figure 42 Restorative capabilities of differing views

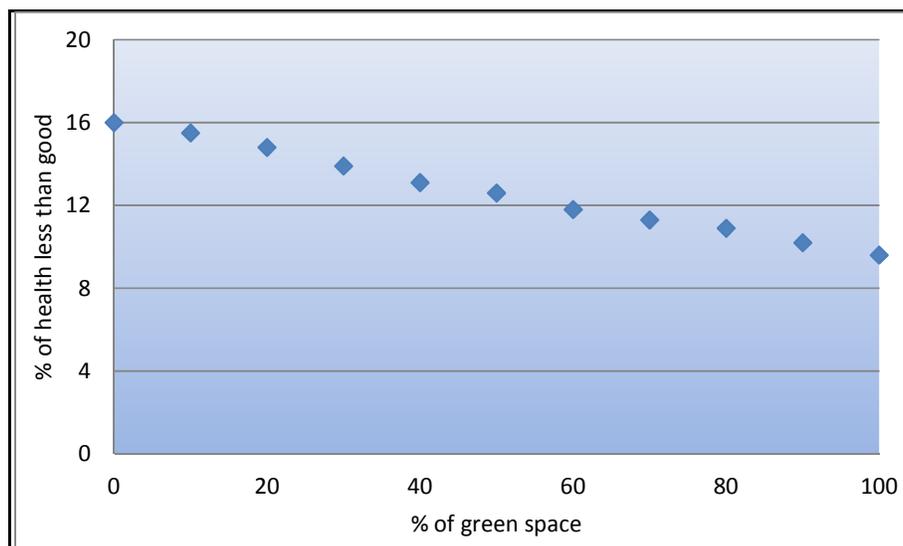
5.4 View along road

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.”

5.5 Health and green space

Extensive data sets of people’s health and of green spaces in Holland enabled Maas *et al* (2006) to compared 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 43).



Source: Maas *et al*, 2006

Figure 43 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.”

6. SUMMARY

6.1 Theory

The belief that nature provides healing and restoration, particularly in the psychological sense, is long-standing, however the evidence for this to be true is relatively recent and many studies have provided evidence of the health and restorative effects of viewing nature.

Ulrich's psycho-evolutionary theory postulates that survival benefits derive from the positive emotional and physiological effects of exposure to nature. He regards such effects as immediate affective responses, without the intermediary of cognition. In contrast, Stephen Kaplan's Attention Restoration Theory (ART) postulates that restorative exposure to nature helps to overcome the fatigue associated with prolonged mental activity which affects one's directed attention on the task at hand. The soft fascination of nature, the many aesthetically pleasing and restorative environments it provides, restores one from fatigue as it effortlessly holds our attention.

6.2 Findings of Psycho-evolutionary Theory

Ulrich's studies found the following:

- Viewing nature scenes significantly reduced feelings of fear and increased positive feelings of affectation and delight, compared with scenes of treeless city scenes; thus visual landscapes produce emotional states: negative when viewing urban scenes and positive from nature scenes (1979).
- Scenes of vegetation induced relaxation and low arousal while urban scenes provoked anxiety; responses to water lay in between (1981).
- Viewing natural scenes resulted in significantly increased positive affect scores compared with either a pedestrian mall or traffic scenes. Nature scenes reduced stress and resulted in more rapid recovery from stress. Exposure to natural settings resulted in high scores for positive affects and low scores for violence, aggression and fear (1991).
- The content of television, specifically scenes of nature or of urban environments had a significant effect on stress felt by blood donors watching the screen while donating. Scenes of nature significantly lowered blood pressure and pulse rates compared with urban scenes (2003).
- Other research (Regan & Horn, 2005) found preferences for wild nature and cultivated nature were associated with a relaxed mood state, while natural water was associated with relaxed and happy moods.

6.3 Findings of Attention Restoration Theory

Research that has sought to validate Kaplan's Attention Restoration Theory (ART) has found the following:

- Favourite places were associated with being away, fascination, coherence and compatibility, and were mostly places of greenery, water and scenic quality (Korpela & Hartig, 1996).
- Comparing natural and urban settings, it was found that the natural environment engendered more positive emotional states (Hartig, *et al*, 1996).
- Natural settings had high restorative potential while urban settings had low restorative potential (Herzog, *et al*, 1997).

- The two highest rated sources of satisfaction in participating in restoring nature were meaningful action and fascination with nature (Miles, *et al*, 1998).
- Aesthetic preferences correlated highest with comfortableness and excitement, demonstrating the psychological benefits provided by attractive environments. The top reasons for their high aesthetic value scores were the existence of vegetation, feeling of tranquility, and the openness of the area. Positive feelings (tranquility, comfortable, pleasant) were among the main reasons for high aesthetic value scores (Galindo & Rodriguez, 2000).
- Comparing scenes of industry, housing, streets with hills and lakes, found that hills and lakes provided the greatest restorativeness and preference. Interestingly familiarity was not related to either restorativeness or preference (Purcell, *et al*, 2001).
- The restorative potential of an urban or a field/forest setting to provide a break from intense mental effort found the natural setting rated higher than urban scenes in the components of ART (i.e. potential restoration, preference, being away, extent, fascination, compatibility and openness) (Herzog, *et al*, 2003).
- Asked about their favourite places, participants identified the beach, lake, ocean, park, forest, hill, mountain, and viewpoints while among unpleasant places, natural areas were under-represented. Their experiential qualities included being relaxed, being away from everyday life, forgetting worries, and reflecting on personal matters, all indicative of a link between favourite places and the restorative experience (Korpela, *et al*, 2001).
- Extending the research on favourite places to children found that natural areas did not dominate, rather their house and sports venues were the favourite places although more girls than boys liked natural areas (Korpela, *et al*, 200).
- Viewing a nature video produced a lower heart rate than those who watched an urban video which suggests that the “nature video had a relaxing effect on autonomic functions” (Laumann, *et al*, 2003).
- Participants had a stronger preference for the natural environment than the urban environment, particularly when feeling attentionally fatigued, and also a stronger preference for walking in a natural environment (Staats, *et al*, 2003).
- Following the viewing of a horror movie, participants who were then shown a nature video exhibited greater restoration on five affective measures (depression, anger, tension, happiness and stress) compared with those who viewed a video of built environments (Van den Berg, *et al*, 2003).
- Happiness increased from a walk in a natural setting and a decreased from the urban setting, while anger decreased by the end of nature walk, but increased in the urban environment. The natural setting yielded lower blood pressure, greater happiness and better attentional performance while for the urban setting the opposite applied (Hartig, *et al*, 2003).
- Students experienced more recovery from attentional fatigue from a walk in a forest compared with a city walk which actually hampered recovery. A forest walk aided reflection whereas a city walk reduced it (Hartig & Staats, 2006).
- Viewing photographs of nature scenes representing restorative environments enabled participants to regain their attentional capacity to a sufficient degree to perform well on a post-test compared with those who viewed urban scenes (Berto, 2005).

- Physiological measures of participants viewing scenes which represented the restorative components of being away, extent, fascination and compatibility, demonstrated improvement and congruency between the psychological response scores and the physiological responses (Chang, *et al*, 2008).
- Comparing walks in nature (real nature) with viewing nature videos (virtual nature), found that exposure to real nature provided much more psychological benefits than did virtual nature (Mayer, *et al*, 2009).
- Although natural areas usually offer emotional and cognitive restoration, it was found that where high danger is perceived to exist, it offers no more restorative potential than urban areas, although in low danger conditions, it does still offer better recovery and reflection than urban settings (Herzog & Rector, 2009).
- Participants viewing nature scenes experienced an increase in vitality (i.e. high-energy states) while those viewing building scenes suffered a decrease (Ryan, *et al*, 2010).

6.4 Other findings

Views from windows provide short but frequent glimpses of nature with positive benefits:

- Hospital patients with a view of trees recovered quicker, needed fewer analgesics, and were better patients than those who viewed a blank wall (Ulrich, 1984).
- Patients and staff preferred windowed rooms rather than windowless rooms and staff preferred nature viewed through the window over city or street views. Nature surrogates (e.g. posters) were preferred less than the real views (Verderber, 1986).
- Views of nature from dormitory windows aided study for students compared with views without nature, and they also assisted restoration from the fatigue associated with study (Tennessee & Cimprich, 1995).
- Apartment residents with access to and views of nature contributed to the resident's satisfaction with their neighbourhood and sense of well-being (R. Kaplan, 2001).
- Public housing residents whose apartments looked out over trees and grass had much lower levels of aggression and violence than those lacking this view (Kuo & Sullivan, 2001a). Similarly, public housing amidst high levels of vegetation experienced less property crime and violent crime than buildings with low levels of vegetation (Kuo & Sullivan, 2001b).
- Comparing views from windows with large wall murals of nature and water scenes for their restorative potential, found that settings without a view rated poorly, settings with a window view of leafless trees and buildings rated moderate, nature murals rated moderate-high and murals with water rated high (Felsten, 2009).

Several studies examined the benefits of office posters as a surrogate for views:

- Windowless offices had far more posters, and landscape posters in particular, than the windowed offices (Heerwagen and Orians, 1986).

- Students undertaking frustrating tasks on a computer had lower levels of anger and stress in rooms that had posters, particularly nature posters, on the wall than room without posters or with abstract art posters (Kweon, *et al*, 2008).

The findings of other studies covered were:

- Although scenic beauty, preference and restoration are highly correlated and can be distinguished within natural landscapes, they are different constructs and theory needs to discriminate the subtle differences between them (Han, 2010). Preference for a given landscape appears to play a strong role in mediating the effect between scenic beauty and restoration.
- In Holland, the availability of large data bases covering the population's health and the amount of green space (i.e. agricultural, forests, nature areas, urban green) enabled the perceived general health of an individual to be correlated with the amount of green space within a 3 km radius; where 90% of the environment was green only 10% of the population felt unhealthy, compared with 15.5% where there was only 10% green space (Maas, *et al*, 2006).

For our purposes these studies provide data covering the preference for nature scenes over urban scenes and the restorative power of nature.

6.5 Synthesis: Preference for nature scenes over urban scenes

Table 3 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 174% (SD 61%) which means that the preference for nature is nearly double that for urban scenes.

Table 3 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
Mean	174%	

6.6 Synthesis: 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 4).

Table 4 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.

6.7 Synthesis: Other findings

The levels of violence and aggression among residents in public housing was 30% lower for those whose apartments looked out over trees and grass compared with residents lacking this view (Kuo & Sullivan, 2001).

The two highest rated sources of satisfaction in participating in restoring nature were meaningful action and fascination with nature – 80% of maximum score (Miles, *et al*, 1998).

6.8 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.

7. CONCLUSIONS

The past several decades has seen considerable research into the healing and restorative effects of viewing nature. Thirty-three 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.

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APPENDIX 1 RESEARCH TABLES (Chronological order)

Ulrich, 1979

Affect scores before and after slides for urban and nature groups

	Urban Group		Nature Group	
	Before slides	After slides	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		Break	Second period		
	Slides 1-10	Slides 11-20		Slides 21-30	Slides 1-10	Slides 11-20
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

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. Böök, 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

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. Kytta & 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
Compatiblity	2.88	3.66	<0.001
Openness	2.5	3.01	0.019
Visual access	3.32	3.06	0.187
Movement ease	2.44	3.14	0.085
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.

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 nat. 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

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

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. Tassinari, 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

 $p < 0.01$