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Short communication

Why viewing nature is more fascinating and restorative than viewing buildings: A closer look at perceived complexity

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ABSTRACT

The present paper addresses the question which visual features trigger people's often more positive affective responses to natural compared to built scenes. Building on notions about visual complexity and fractal geometry, we propose that perceived complexity of magnified scene parts can predict the greater fascinating and restorative qualities of natural versus built scenes. This prediction was tested in an experiment in which 40 participants viewed and rated 40 images of unspectacular natural and built scenes in their original size, and at 400% and 1600% magnification levels. Results showed that the original, unmagnified natural scenes were viewed longer and rated more restorative than built scenes, and that these differences were statistically mediated by the greater perceived complexity of magnified parts of natural scenes. These findings fit with the idea that fractal-like, recursive complexity is an important visual cue underlying the restorative potential of natural and built environments.

1. Introduction

Research has consistently shown that interacting with natural environments can improve mood and attention, reduce stress levels, and lead to many other healthy and restorative outcomes (Hartig et al., 2014). Merely viewing trees or plants from a window, or even images of nature can already have measurable positive effects (Grinde and Patil, 2009; Honold et al., 2016; Van den Berg et al., 2003). This suggests that, besides physical factors like the stimulation of exercise and improvement of air quality, psychological mechanisms play an important role in the beneficial effects of nature.

Attention Restoration Theory (ART; Kaplan and Kaplan, 1989; Kaplan, 1995) has described one of the basic psychological mechanisms by which viewing nature my lead to beneficial effects. According to ART, most natural scenes capture attention in a pleasant and effortless manner, allowing the mind to rest and wander freely while the capacity for directing attention is replenished. This gentle capturing of attention has been described as 'soft' fascination, to distinguish it from more hard forms of fascination that capture attention dramatically and cause depletion of executive attentional resources.

The mechanism of soft fascination is widely acknowledged and supported by analyses of people's eye movements when viewing high and low fascination images (Berto et al., 2008). It leaves, however, unanswered the fundamental question which distinctive visual characteristics make viewing natural scenes more fascinating than viewing built scenes (Valtchanov and Ellard, 2015). Finding this missing piece of the puzzle is not only of theoretical importance, but may also contribute to a more effective design of urban green space that makes optimal use of its health-supporting ingredients.

A potential candidate for being that special cue that triggers soft fascination with nature is visual complexity (Berlyne, 1971; Nadal et al., 2010). Natural environments tend to be characterized by intermediate levels of visual complexity, which appear to be just right for attracting attention in a moderate, pleasant way. By contrast, most human-made environments are either highly complex (evoking hard fascination) or virtually lacking in visual complexity and unable to capture attention at all (e.g., Wohlwill, 1983). However, environmental perception studies have revealed that subjective measures of perceived complexity, such as the question "how many different elements are there in this scene", only predict

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fascination and other positive responses within natural and built domains. These measures cannot account for differences between these domains (Kaplan et al., 1972; Sparks and Wang, 2014).

A scene's overall level of visual complexity is not only determined by the number and amount of elements, but also by the degree to which visual information is structured and ordered across scale levels (Nadal et al., 2010). This latter, more hidden dimension of visual complexity is not readily perceivable and cannot be assessed with standard subjective measures. To capture the interplay between variety and order, researchers have increasingly used objective measures of visual complexity based on notions of information theory (e.g. Kolmogorov complexity and Shannon entropy) and fractal geometry (Machado et al., 2015; Marin and Leder, 2013). Especially fractal geometry has been found useful in describing the visual complexity of natural environments (Taylor et al., 2011). Fractals capture the order and structure in natural environments by the recurrence of similar visual information across multiple scale levels. This is illustrated by the fact that natural scenes retain roughly the same amount of elements and form as one zooms in and out of the scene.

The fractal dimension is an index of the extent to which a space is filled by details, and as such can be considered a measure of visual complexity (Machado et al., 2015). Research has shown that people respond most positively to fractal images and patterns with an intermediate fractal dimension that is commonly found in nature, which suggests that the visual system might be tuned to the processing of natural information (Aks and Sprott, 1996; Taylor et al., 2011). Furthermore, EEG recorded alpha waves, an indicator of a wakefully relaxed state, tend to be larger for natural (statistical) fractals than for artificial (exact) fractals (Hagerhall et al., 2015). Thus far, however, research on human responses to fractals has exclusively relied on objective methods such as the box-counting technique to measure fractal characteristics. Although such measures are highly informative, they do not capture the more subjective components of environmental perception.

In the present research, we take a more subjective, psychological approach toward assessing recursive, fractal-like complexity. Specifically, we adapted a method described by Mandelbrot (1981), in which an image of an environment is cut into parts, after which the parts are magnified to the same size as the original image. The more elements remain visible in the magnified parts, the higher the environment's fractal complexity. Following this example, we asked participants to rate the perceived complexity of photographs of natural and urban settings, and cropped segments of these photographs at two magnification levels. We also assessed participants' free viewing times of the images as a well-established behavioral measure of fascination (Lang et al., 1993), which has been previously applied in restorative environments research to assess differences in fascination between natural and built settings (Berto, 2005). Furthermore, we obtained self-reports of fascination and other restorative outcomes for the original, unmagnified images.

We had three hypotheses. First, in line with previous restorative environments research, we predicted that unmagnified natural scenes would be viewed longer, and rated as more restorative, than unmagnified built scenes. Second, reflecting the recursive, fractal complexity of nature, we predicted that magnified parts of natural scenes would maintain higher levels of perceived complexity and fascination than magnified parts of built scenes. Third, based on the idea that positive responses to nature are partly triggered by recurring visual information on lower scales that only becomes visible with magnification of scene parts, we predicted that perceived complexity of magnified scene parts would statistically mediate differences in viewing times and restorative quality between the unmagnified natural and built scenes.

2. Method

2.1. Stimuli

The stimulus set consisted of 40 photos of everyday, unspectacular scenes in Belgium and The Netherlands. Half of the scenes depicted common natural objects and places such as trees, bushes and grassy spots, the other half depicted residential and office buildings. We selected small-scale setting types instead of more panoramic views to minimize the influence of compositional variables such as mystery or openness, which may influence people's responses to a scene independent of its naturalness. To ensure sufficient variability in fractal complexity within the built sample, half of the built scenes depicted modern and traditional buildings with a high degree of ornamentation and detail (e.g. photos B1–B10 in the online Supplementary material), while the other half depicted modern and traditional buildings with little ornamentation and detail (B11–B20). We also varied the fractal complexity of natural scenes by including both information-rich natural scenes like treetops and forest scenery (N1–N10) as well as more plain shrubs and grassy fields (N11–N20). None of the scenes contained water features, humans, animals or other potentially confounding features like unusual architecture or dramatic sunsets.

All photos were taken in autumn with a Canon EOS 1200D digital camera with an EF 70–200 mm f/4.0L IS USM lens, at full resolution of 18 megapixels. Adobe Photoshop was used to create magnified versions of each original image. 'Medium magnification' images showed a 1/16 part of the original photo magnified to 400%. 'High magnification' images showed a 1/256 part of the original photo magnified to 1600% (See Fig. 1). All images were sized to 712×475 pixels (475×712 for vertical pictures).

2.2. Participants

Forty students and employees (17 males) of a Dutch university with a mean age of 21.8 years (range 18–45) participated in the study for a compensation of 7 euros. Participants represented various departments and disciplines, about half of which were nature-oriented (e.g. landscape planning, forest management). Fifty-two percent of the participants considered themselves a "nature person", 15% considered themselves a "city person", and 33% considered themselves a bit of both.

2.3. Procedure and measures

The photos were presented on a laptop in three blocks, with order randomized within blocks. The first block showed the environments in their original size, the second block showed the four times magnified parts of the environments and the third showed the sixteen times magnified parts.

To obtain a behavioral measure of fascination, participants first watched the three blocks while their free viewing times for each photo were recorded using Macromedia Authorware. Participants were instructed to "*watch the photos in the same manner as you would watch someone's holiday pictures. If one picture is more interesting than the other, you watch it for a longer time. So please look at each setting until you no longer find it interesting*". At the beginning of the second and third block, participants were informed that they were going to view magnified parts of the previously presented environments.

After free viewing, participants rated the unmagnified photos on statements measuring perceived complexity ('*there are many different elements to see in this environment*') and four dimensions of restorative quality, including fascination ('*this environment is fascinating*'), beauty ('*I find this environment beautiful*'), relaxation ('*I experience a feeling of relaxation when I look at this environment*')