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Short communication

Some reflections on the relevance of fractals for art therapy

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Abstract

Different strands of research show that natural form has a positive influence on human emotional states. Although preliminary, evidence is converging that the fractal geometry characteristic of natural elements can induce similar responses. It is argued that, due to their artful nature, fractal patterns are ideally suited to integrate in art therapy. Art therapists are thereby presented an additional shape grammar to apply in therapeutic settings.
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The aesthetic and restorative value of natural elements

The starting point of this short communication is the field of environmental psychology. Numerous studies within this field show how different types of environments (e.g. urban versus natural settings) have a different impact on human functioning and on human affective states. For example, within the subfield of landscape aesthetics, empirical research has revealed that humans display a universal and consistent aesthetic preference for certain natural elements and settings (vegetative elements, water-elements, and savannah-type landscapes) (Heerwagen & Orians, 1993; Smardon, 1988; Thayer & Atwood, 1978; Ulrich, 1986a).

Apart from aesthetic reactions, empirical research has also been conducted into the therapeutic value of natural elements. One of the main findings is that such elements as vegetation and water-features can reduce stress in human individuals. For example, a well-known study shows that hospital patients having views of outside vegetation, as opposed to patients viewing a brick wall, had shorter hospital stays, received less negative comments from the nurses, and tended to have less post-operative complications (Ulrich, 1984). Similarly, a battery of psychological and physiological tests revealed that nature views were more effective in reducing psychological and physiological stress than urban views, and lead to more positive feelings in subjects (Ulrich et al., 1991; see also: Hartig, Evans, Jamner, Davis, & Gärling, 2003; Ulrich, 1981).

These affective responses towards nature can be explained by reference to our shared evolutionary history in a natural environment (Ulrich, 1983). In such settings, an individual had a clear survival advantage when he or she tended to respond emotionally towards survival-relevant stimuli. For example, a predisposition to develop an "aesthetic" or "liking" response towards vegetative elements entailed that the individual became motivated to approach this element, and eventually to (say) consume it, which contributed to the individual's survival. Similarly, restorative responses were adaptive because they allowed the individual to recover from the physical and psychological stress associated with threatening situations (e.g. a predator) (Ulrich, 1993). Typically, such responses are believed to

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have occurred in open unthreatening natural settings (savannahs) often containing a calm water-feature and sources of food.

The relation between affective responses and nature's fractal geometry

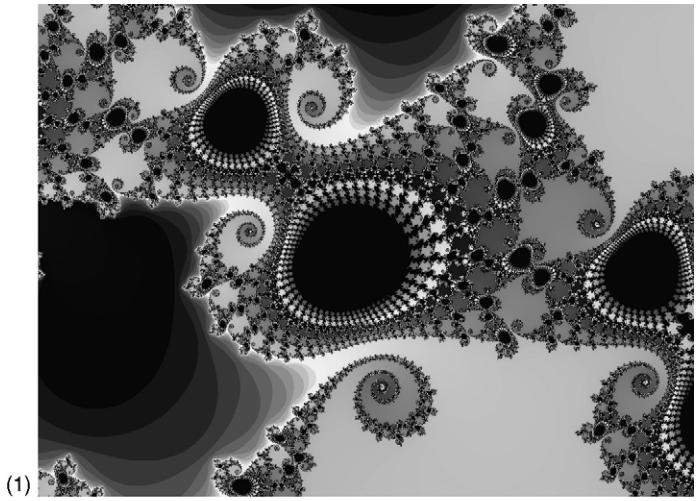
The field of environmental psychology also inquires whether certain abstract structural features correlating with emotional responses can be extracted from natural elements and settings. Among others, researchers have found that preferred settings often show an interesting mix of complexity and order, and are "mysterious" in that the landscape configuration promises to reveal new information beyond the current viewpoint of the subject (Kaplan, 1987, 1988). Importantly, some scholars find that there is reason to believe that the emotional responses associated with naturalness could be rooted in the type of geometry characteristic of natural elements: namely fractal geometry (Mandelbrot, 1977). For example, Purcell et al. (2001) hypothesize that it ". . . may be that variations in both preference and the restorative value of scenes depends on their underlying geometry, with high preference and restorativeness being associated with fractal and low preference and restorativeness being associated with, for example, underlying Euclidian geometry typical of built environments."

A fractal (Figs. 1–3) is a mathematical entity whose essential characteristic is its self-similarity. This means that the details appearing by increasingly zooming in on a fractal are (statistically) similar to the entire fractal. Importantly, this scale invariance seems to be characteristic of many natural structures. For example, when observing a tree, the structure of the leaves, twigs, and branches all seem scaled-down versions of the entire tree. Within fractal geometry, the degree in which similar structure recurs at different hierarchical scales is quantified by the fractal dimension D. Contrary to Euclidean geometrical objects, the fractal dimension of a fractal curve is not an integer. For fractals in the plane, the fractal dimension lies between the first and the second dimension, resulting in a value between 1 and 2. The reason is that, due to its "wrinkled" character, a fractal fills more space than a line (1st dimension), while it does not fill the entire plane (2nd dimension). For fractals in space, the fractal dimension lies between 2 and 3 (Voss, 1988).

The close relation between fractals and nature can be further illustrated by the fact that fractal geometry is often used to mathematically model natural elements (e.g. plants). Moreover, there are indications that fractals elicit semantic associations of naturalness (Geake, 1992). Despite this intimate link between nature and fractals, surprisingly little research has been devoted to the question whether fractals can cause the emotional responses that are ascribed to naturalness (e.g. stress-reduction, preference). An exception is a survey by Richard Taylor, showing that fractals have a strong aesthetic "pull." From a group of 120 students, Taylor found that more than 90% preferred fractal patterns over non-fractals (discussed in Taylor, 1998).

Other research into fractal aesthetics has mainly focused on the relation between preference and the fractal dimension D. It was Aks and Sprott (1996) who conducted one of the first empirical studies into this subject. They found that, from a set of computer-generated fractal patterns, subjects preferred those with a fractal dimension between 1.17 and 1.38. More recently, Spehar et al. (2003) used three different types of fractal patterns for aesthetic evaluation: natural fractals (e.g. mountains, trees); mathematical fractals (computer simulated coastlines); and human fractals (Jackson Pollock paintings). For all three categories of patterns, they found that preference was highest for pictures with a fractal dimension between 1.3 and 1.5. An experiment by Abraham et al. (2003) had a similar outcome. The study showed that chaotic attractors with a fractal dimension ranging from 1.4 to 1.6 and with a mean fractal dimension of 1.54 were most preferred. Overall, there seems to be a (universal) tendency to prefer fractals with an intermediate fractal dimension.

Preliminary research into the relation between fractal dimension and stress reduction has been carried out by Wise and Taylor (2003) (see also Taylor et al. (2005)). In this experiment, subjects had to undergo stressful mental tasks, while being continuously exposed to either a forest photograph or an unrealistic savannah picture. By measuring skin conductance, it was found that, contrary to expectations, the savannah picture was more effective in reducing stress than the forest photograph. Because both representations were fractal-like, the researchers calculated their respective fractal dimensions. It was found that the savannah picture had a fractal dimension (1.4) that was previously found to correlate with highest aesthetic preference (1.3–1.5) (see Spehar et al., 2003), whereas the fractal dimension of the forest setting fell outside this range (1.6). The authors therefore speculate that "[t]hese results . . . raise the intriguing possibility that the visual appeal of mid-range D fractals affects the physiological condition of the observer" (Taylor et al., 2005).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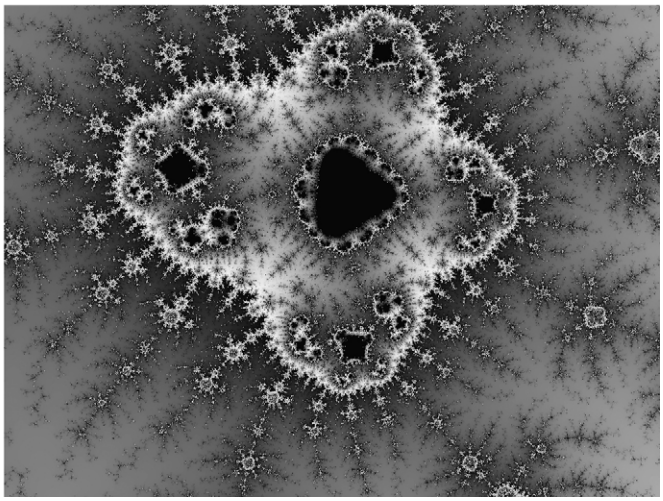
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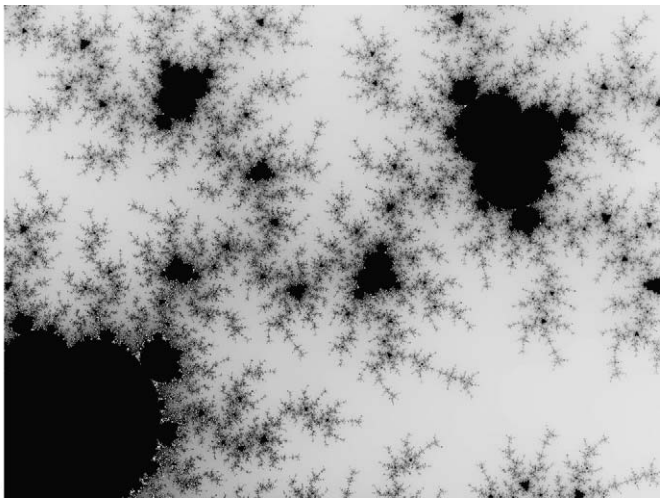
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Figs. 1–3. Three examples of computer-generated fractals. Free software to generate such pictures is easy to use and widely available on the internet. These examples are scalings of the Mandelbrot Set.

Interestingly, these studies into the relation between fractals and emotion can be broadened by including research from outside the field of environmental psychology. For example, Anderson and Mandell (1996) argue that human evolution in a fractal world has required "... the incorporation of fractal structures as well as fractal processes, and these in turn would be integrated into sensory systems, recognition, memory, and adaptive behaviors." (114) Indeed, studies indicate that the human nervous system is characterized by fractal-like processes, often referred to as "1/*f* noise." According to this approach, the aesthetic appeal of fractals can be explained in terms of a "resonance" between the human perceptual system and the perceived (fractal) object, leading to an act of self-recognition (Goldberger, 1996; Short, 1991). It is not implausible to assume that, due to their fractal nature, such objects are easily decoded, and that this efficiency is "rewarded" with an aesthetic reaction.

Implications for art therapy

Some authors argue that the findings from the field of environmental psychology (see Section "The aesthetic and restorative value of natural elements") need to be introduced in medical therapy (Frumkin, 2001). Yet, one could even go a step further and claim that they could be integrated in art therapy. Integrating art with a naturalistic character into certain settings (e.g. a stressful working environment) could contribute to positive shifts in feeling tone and could make subjects feel more wakefully relaxed (Ulrich, 1986b). Another approach would be to go explore nature and study its forms in an artistic context. Due to the formal diversity of nature, new shape grammars could be learned, leading to new inspiration and probably to a pleasurable artistic experience. At the same time exposure to natural forms and their respective artistic outcomes can have therapeutic effects (Figs. 1–3).

The implication of the brief discussion of fractal aesthetics (see Section "The relation between affective responses and nature's fractal geometry") is that the beneficial effects of contact with nature could be tapped without the presence of actual representations of nature, but with the fractal geometry that is characteristic of natural elements. Often, fractals are introduced in a mathematical education context. Due to their artful nature they are an ideal "instrument" to draw attention to certain mathematical and physical concepts. Yet, the emerging field of fractal aesthetics shows that the use of fractals could transcend the strictly scientific sphere, and hints at the positive impact of these patterns on human functioning. Due to the artistic nature of fractal patterns they seem to be most suited to be integrated in art therapy, and the current paper aims to awaken the interest of art therapists in these issues. The therapeutic value of such artful pictures seems especially urgent in technology-oriented societies. The reason is that people have increasingly less contact with natural forms, and this seems to have psychological and physiological costs (Gullone, 2000). Although the research into fractal aesthetics is still in its infancy and should therefore be treated with caution, the first results indicate that it is a promising route to explore.

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