NATURE

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Nature › Calm

Nature and well-being

Interacting with nature, whether from living close by (Thompson et al., 2012), taking walks (Berman et al., 2012), or viewing nature simulations (Lynn, 2014), is closely associated with enhanced relaxation and relief from stress and cognitive fatigue.

Ensuring the scene and the elements of a natural environment are appropriate, incorporation into virtual reality experiences can prove very powerful. For example, relaxation exercises have been found significantly more effective when conducted in outdoor, natural settings compared to indoors (Sahlin et al. (2012).

Nature provides context which we often associate with pleasant memories and feelings. However, context is not universal and so the pleasantness of an environment may not be

shared by all users (see implementation considerations).

The psycho evolutionary theory

This theory, based on the biophillia hypothesis (Wilson, 1984) was introduced by Ullrich (1991) claiming that there is a direct causal relationship between nature and stress relief. In other words, interacting with nature evokes feelings of interest and pleasantness which in turn allows psychophysiological stress recovery.

If natural environments are perceived as non-threatening, interactions with those environments are known to cause a wide range of positive physiological responses (Kjellgren & Buhrkall, 2010; Ottosson & Grahn, 2006). Using a large sample size of 420 subjects, Miyazaki, Ikei & Song (2014) assessed the impact of sitting in natural environments. They found a 12.4% decrease in cortisol levels, 7.0% decrease in sympathetic nervous activity, 1.4% decrease in systolic blood pressure and 5.8% decrease in heart rate. Some positive effects were maintained for over a month after returning to urban life.

Restoration theory

This theory emphasises the restorative importance of natural environments (Kaplan, 1995). Essentially nature provides a mental break from the highly complex stimulus processing required in urban environments.

Restorative effects can be characterised by reductions in cognitive fatigue, increased focus, increased positive mood, and decreased negative mood (Hartig, Mang & Evans, 1991). Restoration has a close and consistent relationship with decreased stress levels (Jonsdottir et al., 2013; Sahlin et al., 2014).

Research evidence – virtual nature and well-being

Actual vs. virtual nature

Research conducted by Lynn (2014) suggests that relaxation effects are not reliant on physical proximity to an environment itself. By viewing and listening to simulated camp and hearth fires, participants had reductions in blood pressure indicative of a relaxation response.

Greater immersion enhances well-being

The immersive properties of VR may serve to amplify the calming effects of simulated nature. de Kort et al. (2006) compared the restorative effects relative to stress when natural environments were viewed on a small screen (31"), deemed "low immersion", or a large screen (72"), deemed "high immersion". The high immersion condition caused greater stress reductions evidenced by reduced heart rate and skin conductance levels for the larger screen size condition. The authors conclude that greater immersion enhances the restorative potential of natural environments.

Nature in virtual reality

There is a significant amount of research evidence demonstrating the calming/relaxing effects of virtual nature environments. Implementation within Liminal VR calm experiences is well supported, as we can fully immerse users in natural environments with representative visuals, audio and interactive components.

Valtchanov, Barton & Ellard (2010) examined whether immersion in computer-generated VR nature settings could produce restorative effects. They found increased positive mood and decreased stress following 10 minutes in a VR nature environment compared to a control.

Computer-generated explorable forest environment (1600m2) (Valtchanov et al., 2010).

Preferable calming nature scenes

Tended vs. wild

Tended/less wild natural environments are generally perceived as more calming.

Martens, Gutscher, and Bauer (2011) examined whether two different nature conditions (tended Vs wild forest) would affect well-being differently in healthy adults. They found increased positive mood and calmness following a walk in the tended forest vs. the wild forest.

Prospect and refuge

Highly accessible environments with clear fields of vision and few hiding places are preferable.

Gatersleben & Andrews (2013) compared the restorative effects of nature scenes in terms of 'prospect' and 'refuge'. Prospect refers to the extent to which nature scenes provide a clear field of vision. Refuge refers to the number of potential places to hide there are within a scene. The investigation found that environments with high prospect and low refuge were perceived to be considerably more restorative and less dangerous than low prospect/high refuge environments. In a follow-up study, it was found that high prospect/low refuge environments are also more likely to induce greater psychological (through reduced negative mood and improved positive mood) and physiological calming effects (reduced heart rate).

Combination of high, medium and low prospect and refuge environments (Gatersleben & Andrews, 2013)

Low prospect – high refuge

Medium prospect – medium refuge

High prospect – low refuge

Preferable calming natural elements

Chen (2012) summarises a large range of natural elements experimentally proven to promote calming effects by reducing physiological stress across various parameters including blood pressure, heart activity, muscle tension, and brain electrical activity.

The natural elements include: views of trees, forests, fields dominated by rich vegetation, park-like forests with creeks, open water views, seas/lakes with distant mountains, mountains with waterfalls, mountains with streams, aquariums with swimming fish, birds, gardens and lawns, fruit trees, various species of flowers, sunsets, clouds and open spaces.

Virtual nature scenes used by Chen (2012)

Garden theme

Forest theme

Marine theme

Night theme

Persistent, validated design factors for calming effects

Semi-structured interviews conducted following use of the installation identified a key range of design factors which participants identified to be the most relaxing. These findings are in line with prior studies by Ulrich (1984), Biederman (2003), Birren (1950) and

Cooper & Foster (2008) who identified calming and relaxing effects associated with a similar range of design factors including: growing flowers and plants, sunbeams shifting through leaves, tree branches blowing gently in a breeze, scenery of a forest, the colour green, natural birdsong, and music with the sound texture of a flute or piano.

Additional calming natural elements

The interview sessions highlighted a range of additional relaxing design factors which have not been validated through other research investigations. These included: a water lily and lotus in a pond, skipping stones on a lake surface, seeing jellyfish floating gently, making dandelion seeds blow away, seeing a shooting star, sounds of an owl, and a night time environment.

These additional findings suggest a wide range of possible natural elements, containing movement or interactive capabilities that have great potential for inducing calm and relaxation. It's recommended that use of any non-validated forms of calming natural elements be implemented amongst more verified alternatives.

Incorporating both naturalistic and abstract elements can be problematic:

Liminal have experimented with the use of both natural and abstract elements to produce calming effects. One prototype began in a representative nature setting which gradually changed into a more abstract virtual environment over time. This involved the natural environment morphing into abstract forms which was very unsettling for some users.

There's certainly scope to include representative natural elements amongst abstract forms. However, these need to be combined in a way which is comfortable, calming and pleasurable.

Nature › Awe

Experiences of nature have been listed amongst the most frequent elicitors of awe (Shiota, Keltner & Mossman, 2007). In light of these findings, exposure to pictures, video clips and now VR experiences containing vast natural scenes (e.g. grand waterfalls and huge mountain ranges) have been used as a common source to induce awe in psychological studies. This has now contributed to a better understanding of the elements of nature which determine the extent and types of awe that can be experienced.

The role of unusual/beautiful nature

Aesthetic pleasure has been conceptualised as a type of awe experienced when we encounter stunning visual imagery which challenges our current mental schemas (Keltner & Heidt, 2003). The most extraordinary and beautiful scenes from nature can produce these effects.

Silvia, Fayn, Nusbaum and Beaty (2015) compared ratings of awe from participants who viewed 14 images of the sky and space. The images were taken from the NASA Photojournal site (http://photojournal.jpl.nasa.gov) and the NASA Astronomy Picture of the Day site (http://apod.nasa .gov). Examples of the most and least awe-inspiring images are displayed below:

Most awe-inspiring

Example images rated most highly for awe (Silvia et al., 2015). The images depict the most wonderous and extraordinary scenes from the natural world.

Least awe-inspiring
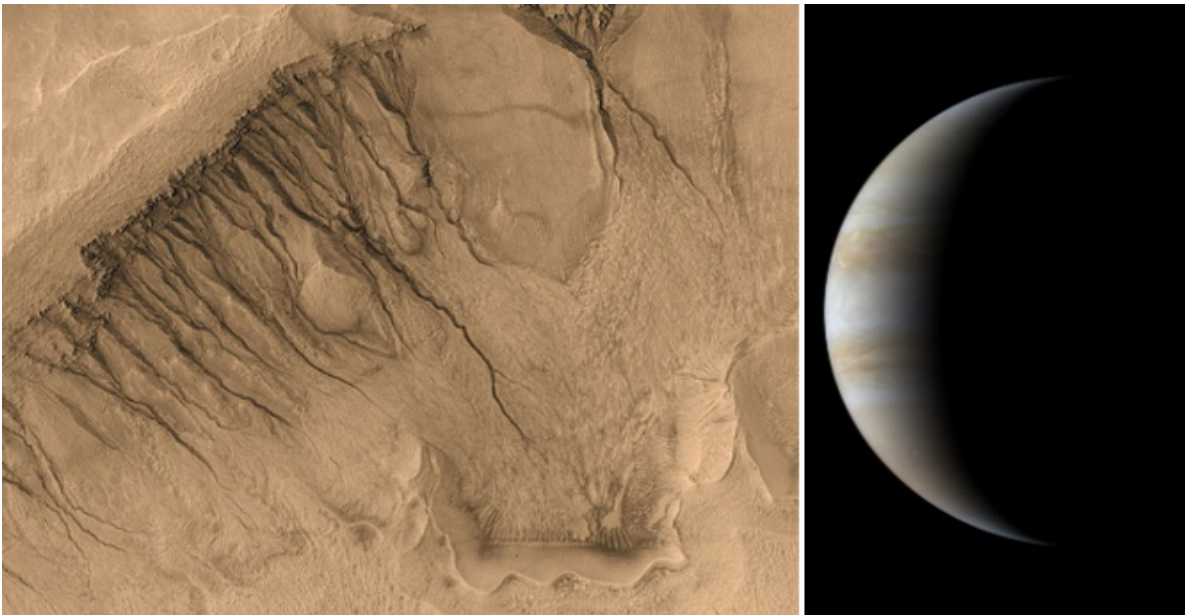
Example images rated poorly for awe (Silvia et al., 2015). Although both images are unusual they failed to convey the same level of beauty and wonder. The left image was also rated most highly for confusion which may have contributed to its overall poor perception.

Awesome vs. mundane nature

In a study by Joye and Bolerdijk (2015) participants viewed slideshows of photos depicting 'awesome' or 'mundane' nature scenes. As expected, those who viewed the slideshow of the awesome nature scenes reported significantly greater feelings of awe compared to the

mundane nature condition. Nature can provoke awe, but it must also convey a sense of beauty and vastness in a way which differs from our normal interactions with nature.
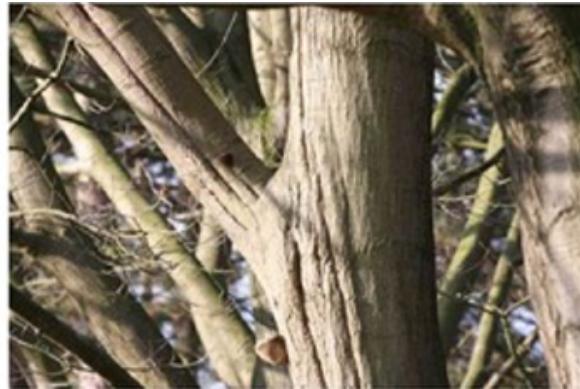
Example images for the 'awesome' slideshow (left) and the mundane slideshow (right) used by Joye and Bolerdijk (2015).

When nature challenges our expectations

We all have a range of basic mental schemas or knowledge structures that we rely on to predict the behaviour of natural elements (e.g. rain falls, birds fly, the sun shines). VR provides the ideal medium through which to violate these expectations and present users with a need for accommodation as they attempt to process a novel situation.

The wave scene from the film 'Interstellar' provides a great example. The sheer vastness of the wave challenges every notion and understanding we have for waves. Combined with the grandiosity and tension provided by the music it's hard not to stare in awe at the wave as it approaches.

Interstellar - Waves Scene 1080p HD

Positive and threat-based awe

Awe is a unique emotion in that it can be experienced with a positive valence (feelings of pleasantness and wonder) or a negative valence (with feelings of fear and anxiety). The level of awe experienced does not change with the positive/negative nature of a stimulus, so long as it's ability to convey vastness and provide a need for accommodation remains the same.

The amount of research in this area is limited, but findings suggest that positive behavioural changes in response to awe (e.g. social values) still remain regardless of the positive/threat-based nature of the awe stimuli (Piff, Dietze, Feinber, Stancato and Keltner, 2015).
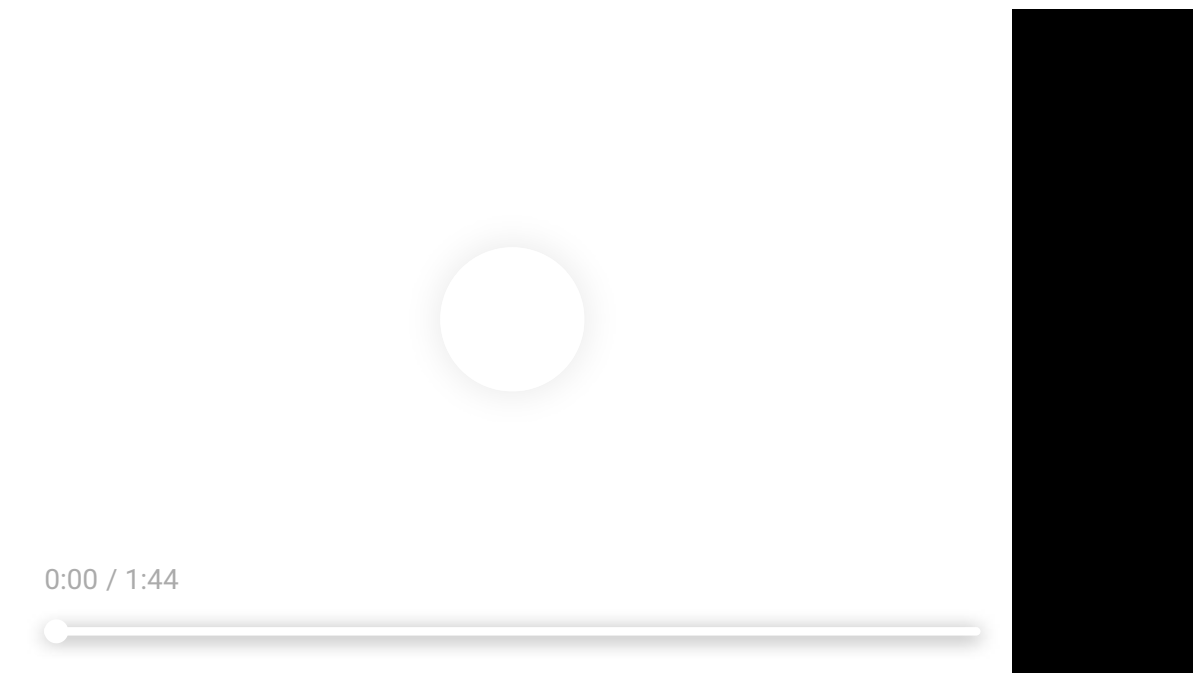
Positive and threat-based awe examples

Gordon et al. (2017) compared self-reports and physiological data for participants viewing positive and threat-based awe videos. The positive awe video showed scenes from the BBC's Planet Earth series in which the camera sweeps over the Earth's landscape with scenes of mountains, plains, forests, waterfalls, and canyons, accompanied by uplifting music. The threat-based awe video showed scenes from the Discovery Channel about the birth of tornadoes set to ominous music.

The level of awe experienced remained the same, the only difference was the level of fear and anxiety reported.
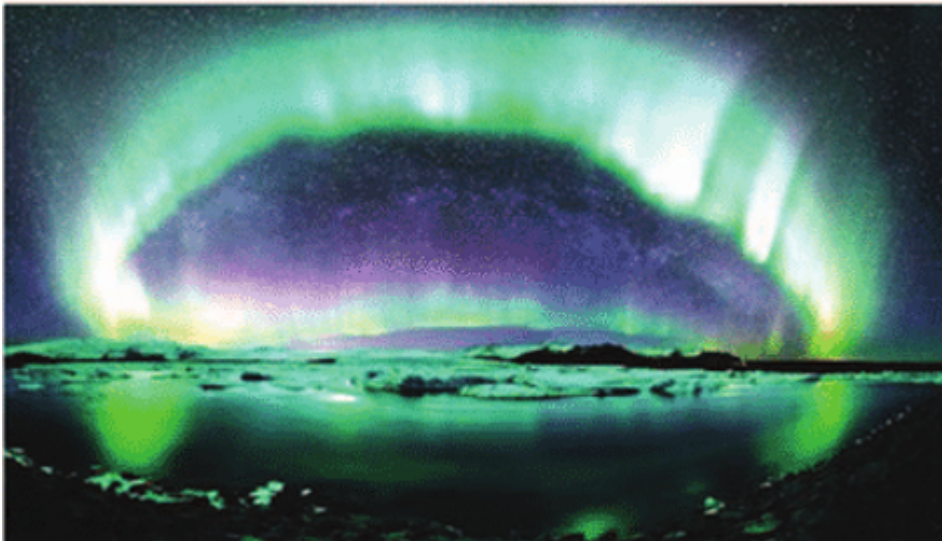
BBC Planet Earth Series Part - II

BBC's Planet Earth (positive awe video example)

0:00 / 1:44

Discovery Channel's Weather Extreme – Tornadoes (threat-based awe video example)

Another example of positive vs. threat-based awe comparisons include images used by Gordon et al. (2017):

Aurora Borealis (positive awe image) (Gordon et al., 2017)

Super Cell (threat-based awe image) (Gordon et al., 2017)

Research evidence – Nature and awe in virtual reality

Nature has recently been incorporated within a small number of VR experiences to induce awe in experimental settings. These examples demonstrate the most recent attempts made to incorporate nature, vastness and a need for accommodation within immersive experiences for the specific purpose of inducing awe.

Nature within 360° video

Chirico et al. (2017) exposed participants to awe-inducing natural scenes of tall trees in a forest. The videos were filmed looking up from the base of the trees providing viewers with a greater sense of smallness and appreciation for the scale of the trees. Participants reported feelings of awe after watching the video which were more intense and matched by greater feelings of presence when watching the videos as 360° footage through a HMD, as opposed to viewing on a 2D screen.

Screenshot taken from nature video used by Chirico et al. (2017).

Nature within VR experiences

Chirico et al. (2018) exposed participants to three different virtual environments including two awe inducing nature settings and one 'neutral' virtual environment. The concept of vastness was portrayed through width and openness (a mountain range) and height (a forest). The target environments each induced significantly greater reports of awe than the neutral environment.

Each experience contained a path which could be navigated by users to generate surprise (and prevent frustration/boredom) as users encounter different aspects of the environments. Surprise was used to impose a need for accommodation; by presenting unexpected scenes and elements which force users to re-structure there current understanding and interpretation of the virtual environments.

**VR experiences designed to induce awe (Chirico et al., 2018)**

Forest theme

Luxuriant tall forest with a high waterfall hidden behind trees to provide an element of surprise and need for accommodation. Incorporates localised sounds (birds chirping, wind flowing through trees) contributing to the sense of presence.

Mountain theme

Path of stones leads users through high snow mountains with a beautiful panorama. Component of need for accommodation supported through unexpected views of the panorama. Background inclusion of wind blowing through the peaks enhancing the sense of presence.

Neutral theme
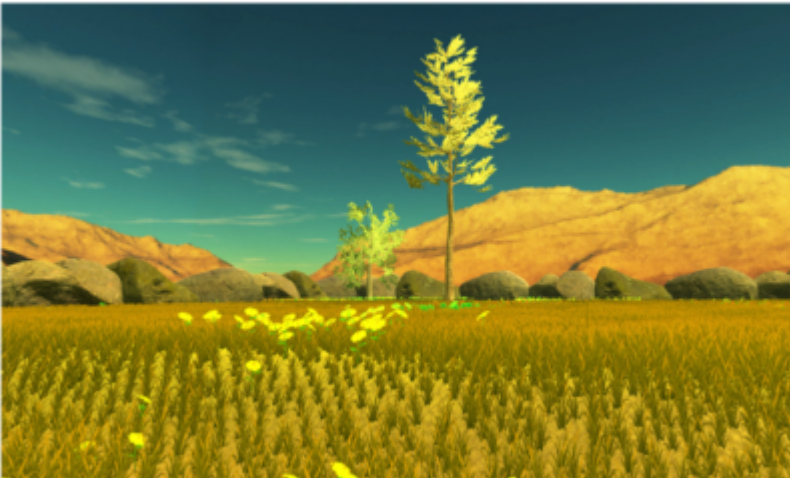
Designed to be neutral, the environment was deprived of several cues used in the other scenarios. To contrast the effect of vastness the whole scene was surrounded by high stones which obstruct the view outside the woodland. Ensuring the environment did not convey a need for accommodation, all elements that could result as unusual or unlikely were excluded.

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