DRS2016
Design + Research + Society
Future-Focused Thinking

2016 Design Research Society
50th Anniversary Conference
27-30 June 2016, Brighton, UK

Creating Novel Encounters with Nature: Approaches and Design Explorations

Thomas J. L. Van Rompay[a*], Geke D. S. Ludden[a]

[b]University of Twente
*Corresponding author e-mail: t.j.l.vanrompay@utwente.nl

Abstract: Nature has been a source of inspiration in many ways, ranging from conceptualizations of nature as a source of aesthetic delight to nature as a 'healing force'. So far, however, insights into which characteristics underlie these diverse effects are lacking, and consequently, nature-inspired design approaches are often limited to 'copying' visual aspects of nature in either a concrete or more abstract manner. Recently however, insights from (environmental and health) psychology, fuelled by developments in (multi-sensory) technology, have paved the way for nature-based design approaches which go beyond (merely visual) imitation. In this paper, we will report on these insights and propose three nature-based design approaches with accompanying design cases.

Keywords: nature; creativity; multi-sensory design; interaction

1. Introduction

Wherever we go, we see examples of nature-based designs. Whether it is Goldberg's tree-inspired skyscraper (Marina City; see Figure 1, left panel), a poster or wallpaper of an endless ocean view, or a curtain in a hospital representing 'green' (see Figure 1, right panel), clearly nature is a universal source of inspiration, creativity and aesthetic delight. Sometimes the resemblance is immediately apparent, as when nature is 'used' in a 'copy-like' direct manner, at other times natural elements inspire more creative, abstract designs (e.g., compare the curtain and skyscraper in Figure 1). In still other cases, fine-grained patterns (for instance observed in pieces of tree bark) may be used to design for pleasurable tactile interactions (see mobile phone cover; Figure 1, middle panel). In this paper, we will elaborate on three nature-based design approaches and illustrate these with student-design cases.

1.1 Nature's charms

Arguably, part of nature's appeal is rooted in the deep-seated feeling that nature is not just pretty but also healing and wholesome, and for a good reason, as research from the last two decades has testified to a wide range of beneficial effects nature can have, which extend beyond appreciation or aesthetic delight to include wellbeing, mood, healing processes, sustainable behavior, and creativity (e.g., Jones 2013; Kaplan & Kaplan 1989; Ulrich 1984; Van den Berg et al. 2014; Zelenski, Dopko, & Capaldi 2015). For instance, Ulrich's classic study (1984) documented records on recovery of patients either assigned to a room with a window view of a natural setting or to a similar room with windows facing a brick-building wall. Interestingly, the former had shorter postoperative hospital stays, received fewer negative evaluative comments in nurses' notes, and took fewer potent analgesics. Further underlining the wide range of positive effects enacted by nature, a recent study showed that nature may also promote environmentally sustainable behavior (Zelenski et al 2015).

Figure 1 Examples of nature-based designs

However, access to nature is often limited, either because 'green' settings in urbanized regions are scarce but also because for some, access to nature is troublesome due to mobility constraints or job demands. Furthermore, in settings such as care centers and hospitals, bringing in nature may not be an option due to hygiene or related concerns.

Interestingly, research indicates that representations of nature (such as videos and pictures) might also go some ways towards providing nature's benefits (i.e., indirect interactions; Keniger, Gaston, Irvine, & Fuller 2013). For instance, Beukeboom, Langeveld, and Tanja-Dijkstra (2012) showed that patients in a hospital waiting room reported lower levels of experienced stress when either exposed to real plants or to posters of plants, compared to patients with neither plants nor visualizations present in the waiting room. On the other hand, visualizations are static and do not respond to user input. In addition, they are mostly targeted at the visual sense only. This is where design and technology come in, as they provide the means for creating encounters that are both engaging and wholesome.

As a matter of fact, ambient and tangible technologies that allow for rich interaction are increasingly common in people's home environments. Sometimes, these devices have been developed with aspects of nature in mind. For instance, Philips' wake-up light sets the stage for a natural and pleasurable waking ritual by mimicking sunrise. As another example, consider visualizations and soundscapes using ambient technology aimed at relaxation, mindfulness and wellbeing (e.g., users creating soundscapes through different ways of breathing; Vidyarthi & Riecke 2014), and which also allow for targeting of multiple senses (e.g., vision and sound combined).

In short, the benefits of nature are generally agreed upon and technologies that allow for novel nature-based design approaches are available. However, insights into what it is exactly 'in' natural stimuli that is so beneficial are lacking. When considering that 'nature' encompasses an endless number of objects (trees, rocks) and processes (sunrise, ripples in the water) on different ('micro' and 'macro') levels of experience (compare witnessing a sunset above an ocean versus getting lost in patterns perceived in pieces of tree bark), it becomes all too clear that such insights are very much needed.

On a more general (psychological) level, however, factors have been proposed which go some way toward offering a source of inspiration and guidelines for designers. In the next section, we will briefly review this literature.

2. Theoretical background

In their seminal work on nature experience, Kaplan and Kaplan (1989) propose four factors that attract people, driven by needs for understanding and exploration, to natural scenes: mystery, complexity, legibility and coherence, suggesting that people simultaneously entertain needs for safety and control (understanding) and for new experiences (exploration). Especially the 'mystery' component has been linked to nature's potential to elicit wonder and fascination by engaging the mind and its capacities for imagination (Szolosi, Watson, & Ruddell 2014).

With respect to the 'why' of nature, several researchers have stressed nature's potential to restore energy and direct attention (e.g., attention restoration theory; Kaplan & Kaplan 1989). In line with this proposal, Berman et al. (2008) showed that participants who enjoyed a walk in nature, as opposed to participants who took a walk in an urban environment, performed better on a cognitively demanding task afterwards suggesting that nature might indeed 'replenish'. In a similar study, Gidlow et al. (2016) showed that taking a walk in nature enhanced cognitive performance for at least thirty minutes after leaving the natural setting.

But why does nature replenish and inspire positive affect? One of the things put forward by research and theorizing is the fact that nature is full of stimuli (e.g., natural objects such as trees, clouds and soil) and patterns (e.g., light-shadow contrasts), which allow for endless exploration, whereas it is at the same time experienced as a very coherent entity that does

not demand exploration (i.e., attention) for its unity to be grasped. It is this key characteristic that has been labelled 'soft fascination' (Kaplan & Kaplan 1989). Szolosi et al. (2014) showed that nature imagery high on 'mystery' (i.e., scenes that give the impression that there is more to explore if one were to go into the setting) enhanced recognition performance when compared to images perceived as low in mystery. Importantly, follow-up analyses showed that the effect mystery had on recognition performance occurred through perceptions of fascination.

In line with this emphasis on nature's potential for inducing effortless (soft) fascination, a recent study by Berman et al. (2014) showed that natural stimuli are, amongst others, defined by a low occurrence of straight edges. Similarly, an explorative study involving designers (Lockyer & Bartram 2012) identified alterations in path curvature as powerful means to evoke positive affect, stating that wavy and fluid motions are more organic and engaging. These combined findings suggest that at least part of nature's charms relates to its unpredictable (fascinating) character which finds expression in non-straight, organic (as opposed to predictable, straight) shapes and movements. As such, natural environments contrast clearly with the more structured, geometric and static designs characterizing the built environment.

Having sketched the beneficial effects of nature and having highlighted some features of natural stimuli (on both a micro and a macro level) that might be of particular importance, next we will discuss nature-inspired (student) design projects that have been undertaken at the University of Twente. As a starting point, we have used two loosely-defined approaches (based on analyses of existing nature-based designs) plus an additional approach inspired by research insights. Additionally, students engaged in field trips (and reporting thereof) to better understand how designers can 'design with nature'.

3. Three approaches to design with nature

Based on analyses of existing nature-based designs, academic research into nature's benefits, and field reports of students, three design approaches and corresponding foci are proposed.

The first macro-level approach corresponds to many existing nature-based designs in which objects (see Figure 1) or processes observed in nature (e.g., Philips' wake-up light) are copied in a more concrete or abstract manner. The second approach departs from a micro-level and focuses on low-level features apparent in natural stimuli such as pieces of tree bark or soil. The third research-based approach takes its inspiration from recent findings into nature's workings and seeks to make actionable such insights for designers.

Regardless of the design approach and corresponding focus, in all cases presented, the students involved not only departed from the insights presented (during lectures and via papers from the social sciences and design research), but importantly were also instructed to make a field trip themselves and observe and report on the facets of nature they

considered most inspiring. Thus in the cases described next, students were not restricted to one specific approach. Nonetheless, we feel the cases do illustrate how these different approaches to nature-inspired design may be of interest to designers.

3.1 First approach: Holistic macro-level approach

Natural objects such as trees, plants, and leaves are among the objects we may encounter during a field trip and from which designers may take inspiration with respect to, for instance, furniture design. For instance, the Japanese designer Masanori Umeda modelled many of his chairs after flowers. The 'brainstorm' table (designed to facilitate creativity sessions; see Figure 2) was based on the shape outline of leaves and their nerves through which the different parts are connected. Additionally, starting points were found in commonly accepted notions that associations with nature and movement (dynamic postures) are important antecedents of creative thinking (Jones 2013).

Figure 2 Brainstorm, Marie-Luise Peters, Josip Vukoja, Danny Wilmink, Jibing Wu)

These starting points motivated the quite literal copying of a leaf's outline which facilitates different (standing) positions around the table (varying in terms of orientation, interpersonal distance, etc.) thereby contributing to the sought dynamic and natural character conducive to brainstorming. As for the nerves, it is important to realize that depending on the stage of a session, interconnectivity between individuals around the table might be more or less desirable. For instance, in an initial phase (explorative phase of innovation), focus might be on gathering as many ideas as possible (at the individual level), whereas at a later stage (exploitative phase of innovation), working as a team on one specific train of thought might take center stage. In order to respond to these different needs, the LED-light embedded

nerves (modelled after the nerves of a leaf) may become more or less visually salient by adjusting light intensity and/or hue levels of embedded LED-strips.

As an example of a design project based on a dynamic process or series of patterns observed in nature, consider the lighting device presented in Figure 3. This device was developed with patients in mind, who have to spend three to five hours a day (several days a week) in a passive, lying position. During these sessions, boredom and a general feeling of being out of control readily take center stage.

The design basically consists of a light source and a water reservoir, which create reflections varying in appearance depending on direction and speed of movement, and distance between device and the surface on which the ripples are projected. The idea originated from observing light reflected on (moving) water and the intricate circular patterns (ripples) that result. These patterns allow the mind to wander and as such provide a very welcome distraction by presenting a fascinating spectacle. Furthermore, the desire to grant the patient a sense of control was incorporated by allowing the patient to gently sway the device and adjust its height, thereby creating variations in the ripples projected.

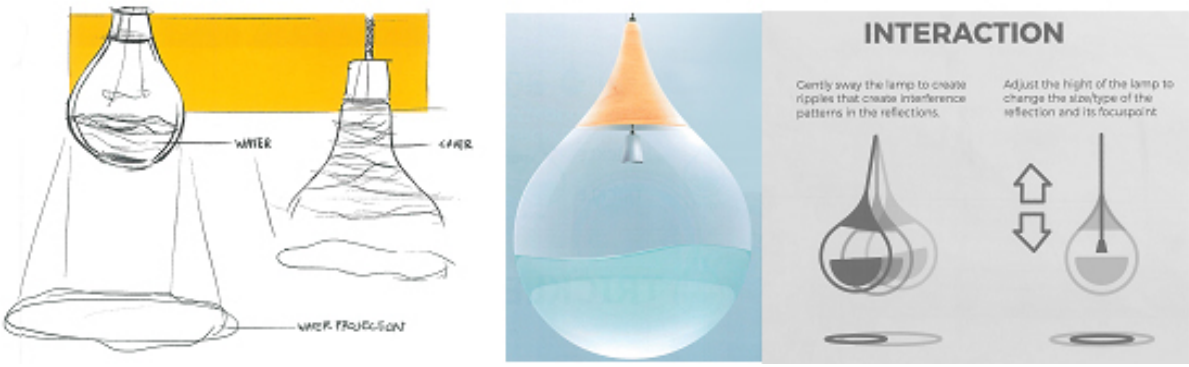

Figure 3 Lighting Device (Julian Claus, Cyriel Dreissen, Ruben van den Hout, Loret Nijmeijer)

3.2 Second approach: "Zooming in", micro-level approach

Our second approach addresses nature encounters as they occur when we zoom in and focus on fine-grained structures and details that may be easily overlooked (or which cannot be perceived) when our focus is more global and holistic. Consider a tree for instance; from a distance we may pay attention to its overall shape, movement of its branches, or shadows cast on the grass below. Up close, however, a new world of lines, textures and hues opens up as when we zoom in on such features as they manifest themselves in pieces of tree bark. From this more fine-grained level, our second approach departs.

This micro-level approach was at the core of a design exploration by Industrial Design Engineering student Valerie Mencke who studied how the rich and dynamic characteristics of nature could be used as a source of inspiration to design a relaxation corner for an office environment. She started by gathering natural stimuli for all the senses and analyzed this collection to eventually define a desired experience for every modality (e.g., an experience

of 'fresh flow'). As an example of this analysis, Figure 4 shows a visual collage in which patterns prevalent in a diverse range of natural stimuli were gathered.

Figure 4 Micro-level (visual) collage of natural elements

The final design of the relaxation corner consists of a set of benches with small cushions and a centerpiece in the shape of an egg (Figure 5). Multiple elements have been used that can be reordered at will but yet create a coherent whole when put together. The different elements offer unpredictable output (for example, a sound can be heard when someone sits on the benches and a scent can be released from the egg), and by their shape and sensory output allow (and stimulate) people to interact with them. For example, the round shape of the egg invites people to push it over, after which it will return to its original upright position. In this way, the relaxation corner aims to allow people to explore (as they would do in nature) and offers them an episode of (soft) fascination. A working prototype of one of the benches and the egg will be used in an experimental setting to evaluate its effects.

Figure 5 Prototype (Valerie Mencke)

As the micro-level approach is arguably somewhat more removed from everyday perception, the continuum concrete/abstract is important here as well, thus 'When do people still recognize more fine-grained structures as 'natural' when applied in designed objects such as, for instance, desk covers or prints?'

As argued before, this question is highly relevant as current solutions oftentimes involve a direct translation (copying) of natural elements. For designers, it is arguably more interesting to transform concrete visual or tactile patterns observed in nature into more abstract designs. However, the question then becomes 'When is a nature-based abstract design still recognizable? In order to explore this very specific question, a student of Industrial Design Engineering (Nienke Vos) felt inspired by pieces of tree bark and from there developed series of visual and tactile samples with varying levels of detail, abstractness, etc. Examples of such series are presented in Figure 6.

Figure 6 Tree-bark patterns (Nienke Vos)

Subsequently, she presented these stimuli (in different orders) to people asking them to indicate at which point they recognized the source of the design. Doing so allowed her to decide on the level of abstractness, seeking a balance between maximum abstractness and recognition. Additionally, this procedure revealed which low-level features are essential for recognition. In her case, the fine-grained structure (Figure 6) turned out to be most essential. Interestingly, this finding concurs with recent findings showing that a high edge density (i.e., presence of in intricate structure), in addition to a low straight edge density (few to none straight, geometric lines and planes) is essential with respect to both recognition and appreciation (Berman et al. 2014).

3.3 Third approach: Research-based approach

Our final approach can be characterized as research-driven and can be considered a continuation of the second approach. That is, the recognition study conducted there brought to the fore elements that are not essential for recognition to occur (color in the tree bark project) versus elements that are essential (high edge density/fine-grained structural features). As suggested, such findings concur with previous research also testifying to the importance of non-straight edge density, corroborating the intuition that straight lines and shapes are rare in nature.

Arguably, it is this aspect, which, amongst others, contributes to nature's unpredictable and thus fascinating character. Inspired by this notion, a student at the communication science department at our university (Tineke Jol) conducted a study in which she explored the extent to which nature's unpredictable (mysterious) character contributes to creativity. In addition, she explored the effects of spaciousness in nature as spaciousness has been linked previously to self-expression and creativity (Meyers-Levy & Zhu 2007; Okken, Van Rompay, & Pruyn 2014).

Figure 7 Forests and parks varying in spaciousness and unpredictability

In order to examine the potential of these factors, she first conducted a large-scale pretest in which she had people rate to what extent they considered a large scale of nature images (comprising wild forests and parks) as spacious and mysterious. Based on this pretest, she created 4 conditions (+ one additional control condition comprising urban scenery); unpredictable-open (Figure 7; top row), unpredictable-closed (second row), predictable-open (third row), predictable-closed (fourth row).

The subsequent main study took place among 120 high school students (13-15 years of age) who completed a drawing-based creativity test (Urban, 2005). It is widely used as a holistic, non-verbal measure of creative potential. The task starts out from a sheet including five graphical elements inside a rectangular frame and one element outside the frame (see Figure 8). Participants are instructed to make a drawing(s) using the elements or fragments any way they choose to (see Figure 8 for example drawings). Fourteen criteria are used to evaluate the drawings. Amongst others, they are evaluated on the extent to which drawings extend beyond the 'frame' presented, incorporate the element outside of the frame, and on whether drawings incorporate stereotypical elements (e.g., concrete objects such as a tree, house or sun). On each criteria, a maximum score of thee or six points can be obtained. Subsequently the scores across the 14 dimensions are added up in order to arrive at a final creative performance score.

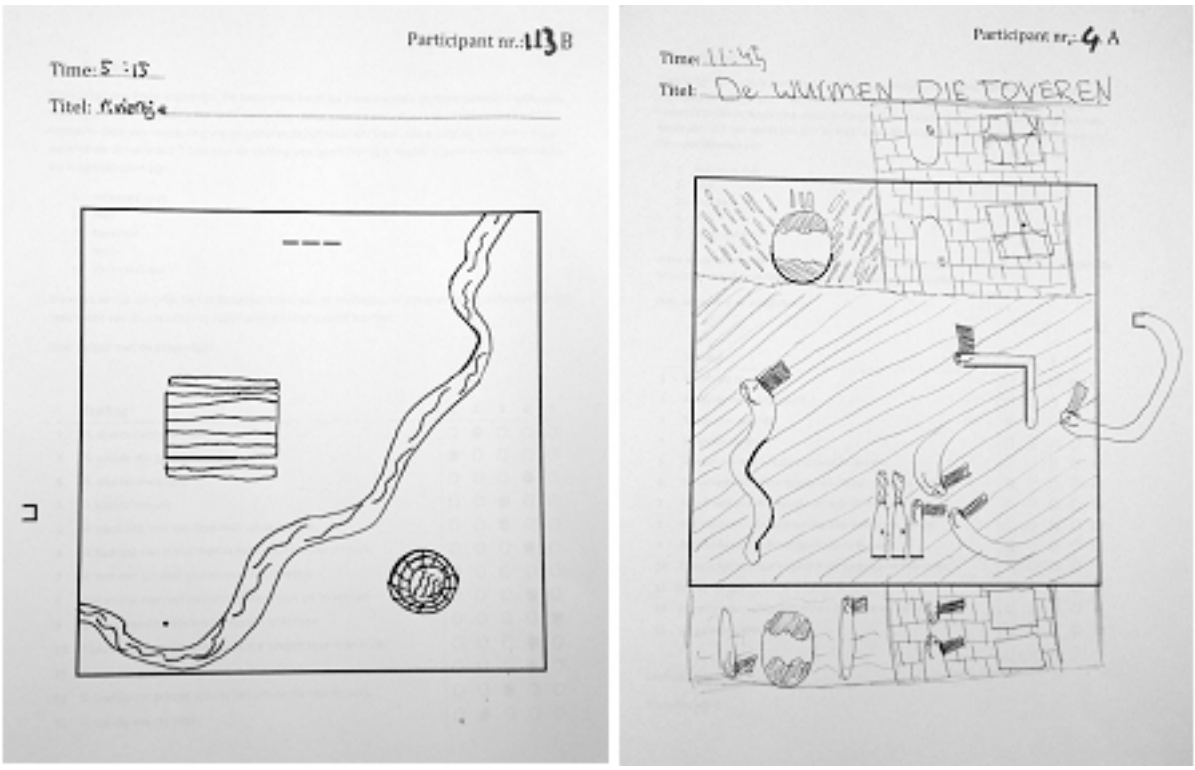

Figure 8 Example drawings (left panel: low creativity; right panel: high creativity)

While completing this test, a slide show (with the respective images for each condition) was presented (and on 'repeat') till the end of the test. (Note that the participants participated in one of the four conditions only). Analysis of means showed that the condition containing visualizations both high on unpredictability and high on spaciousness outperformed all other conditions (all p's < .001). The differences amongst the remaining condition were non-significant (all p's > .10).

These findings suggest that the constructs 'open' (spaciousness) and 'unpredictable' (mystery) are important antecedents of creativity (especially when combined). From a designers' point of view, such findings are highly relevant as they provide starting points without in any way limiting designers' creativity. After all, constructs such as 'unpredictable' and 'open' can be related to design in numerous ways, again varying in terms of abstractness (compare for instance a spacious, abstract Mondriaan painting with a graphic rendition of an open forest).

4. Conclusion and discussion

In this paper we proposed three ways of 'working' with nature that go beyond mere copying and that allow for exploration of the rich and multisensory characteristics of nature. In addition, in most cases the benefits of nature were studied in the context of a specific domain involving people with specific needs and with specific behaviors and types of wellbeing in mind.

Although presented as three approaches, clearly they are highly intertwined. For instance, a phenomenon that grabs one's attention from a distance (e.g., the outlines of an ancient tree; approach 1) may subsequently prompt one to get closer and study its surface texture from up close, opening up a new vista of lines, hues, textures, etc. (micro-level dimension; approach 2).

Likewise, a scene in which a tree figures in an open field may grab one's attention for its spatial quality, perhaps inspiring a sense of freedom or endlessness. On subsequent nature trips, scenes involving elements of spaciousness may be purposefully sought out as they have proven to instill desirable qualities on previous encounters. Hence, in this final example, nature is approached with a specific idea of what type of interaction one is looking for (similar to how based on the findings from the research reported in approach 3; a designer may start out from the idea of creating a nature-based design both open and mysterious in character).

With respect to our third approach then, and in our search for ways to make scientific insights actionable for designers, one could consider design workshops in which designers either depart from 'nature' presented in a global, macro-level manner (corresponding to approach 1) versus designers who (additionally) are presented with in-depth pinpointing of essential features (e.g., cut-outs of specific features or patterns). One could then study effects of both instruction sets on designers' evaluations of the design process and perhaps on the effectiveness of their designs (i.e., are designs more 'effective' when more specific starting points are available on the outset?).

Another very intriguing question relates to the dimension abstract-concrete. For instance, do designs devoid of concrete natural content but which do embody a high degree of spaciousness and mystery still 'work' or should they be recognized as representations of nature in order to provide the benefits discussed. The answer to this question may be different depending on the modalities the design is presented through. With respect to sound for instance, clearly we can distinguish between concrete (e.g., the sound of wind through leaves) and abstract (e.g., more ambient) sounds, but what are features or patterns which sound should embody in order to come across as natural, and how can these be used in more abstract sound designs?

Clearly, the cases presented here are just starting points of an ongoing project. In our opinion, they most of all testify to the potential of combining design methods, technology, psychology, and first-hand observations 'in the wild'. The importance of this latter aspect may sound all too obvious from a designers' point of view, but also from a research point of view, such first-hand observations are important for taking experimental studies addressing specific nature features and their effects to the next level (especially when realizing that besides the few studies cited in this paper, experimental research pinpointing specific nature essentials are non-existent). Finally, it would be very interesting to study effects of specific nature elements as a function of people's needs or concerns. For instance, would more arousing nature visualizations high on mystery 'work better' for patients in hospitals

suffering from boredom (and thus in need of stimulation) compared to patients in recovery and in need of tranquility (and do the latter respond better to a more predictable, open landscape?). In addition to self-report measures indicative of (psycho-social) wellbeing, such studies could also incorporate behavioral responses (e.g., restlessness or task performance) and physiological measures indicative of arousal such as heart rate and galvanic skin response.

5. References

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science, 19*, 1207-1212.

Beukeboom, C. J., Langeveld, D., & Tanja-Dijkstra, K. (2012). Stress-reducing effects of real and artificial nature in a hospital waiting room. *Journal of Alternative and Complementary Medicine, 18*, 329-333.

Berman, M. G., Hout, M. C., Kardan, O., Hunter, M. R., Yourganov, G., Henderson, J. M., Hanayik, T., Karimi, H., & Jonides, J. (2014). The perception of naturalness correlates with low-level visual features of environmental scenes. *PLoS ONE, 9*. Doi: 10.1371/journal.

Gidlow, C. A., Jones, M. V., Hurst, G., Masterson, D., Clark-Carter, D., Tarvainen, M. P., Smith, G., & Nieuwenhuijsen, M. (2016). Where to put your best foot forward: Psycho-physiological responses to walking in natural and urban environments. *Journal of Environmental Psychology, 45*, 22–29.

Jones, J. K. (2013). Re-discovering the arts: the impact of engagement in a natural environment upon pre-service teacher perceptions of creativity. *Thinking skills and creativity, 8*, 102-108

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: a psychological perspective*. Cambridge University Press.

Keniger, L. E., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the benefits of interacting with nature? *International Journal of Environmental Research and Public Health, 10*, 913–935.

Lockyer, M., & Bartram, L. (2012). Affective motion textures. *Computers & Graphics, 36*, 776–790.

Meyers-Levy, J., & Zhu, R. (2007). The influence of ceiling height: The effect of priming on the type of processing that people use. *Journal of Consumer Research, 34*, 174-186.

Okken, V. S., Van Rompay, T. J. L., & Pruyn, A. T. H. (2013). Room to move: On spatial constraints and self-disclosure during intimate conversations. *Environment & Behavior, 45*, 737–760.

Szolosi, A. M., & Watson, J. M., & Ruddell, E. J. (2014). The benefits of mystery in nature on attention: assessing the impacts of presentation duration. *Frontiers in Psychology, 25*, 1-13.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science, 224*, 42-421.

Urban, K. K. (2005). Assessing creativity: the test for creative thinking – drawing production (TCP-DP). *International Education Journal, 6*, 272-280.

Van den Berg, A. E., Jorgensen, A., & Wilson, E. R. (2014). Evaluating restoration in urban green spaces: Does setting type make a difference? *Landscape and Urban Planning, 127*, 173-181.

Vidyarthi, J., & Riecke, B. E. (2014). Interactively mediating experiences of mindfulness mediation. *International Journal of Human-Computer Studies, 72*, 674-688.

Zelenski, J. M., Raelyne, D. L., & Capaldi, C. A. (2015). Cooperation is in our nature: Nature exposure may promote cooperative and environmentally sustainable behavior. *Journal of Environmental Psychology, 42*, 24-31.

About the Authors:

Thomas van Rompay is assistant professor in the department of Communication Science at the University of Twente. His work addresses symbolic meaning portrayals via visual communication and (product and environmental) design and their impact on behaviour and wellbeing.

Geke Ludden is assistant professor in the Interaction Design group at the University of Twente. Her work focuses on the (theoretically informed) development and evaluation of products and services that support healthy behaviour or that otherwise contribute to people's wellbeing.