Mikel Subiza-Pérez a,b,*, Kaisa Hauru c, Kalevi Korpela d, Arto Haapala e, Susanna Lehvävirta c

a Faculty of Psychology, University of the Basque Country UPV/EHU, Spain
b Biodonostia Health Research Institute, Spain
c Faculty of Biological and Environmental Sciences, University of Helsinki, Finland
d Faculty of Social Sciences/Psychology Tampere University, Finland
e Faculty of Arts, University of Helsinki, Finland

Perceived Environmental Aesthetic Qualities Scale (PEAQS) – a self-report tool for the evaluation of green-blue spaces

Abstract:

Aesthetic qualities of urban green and blue spaces have received considerable attention in scientific literature but are operationalized in multiple ways and lack clear assessment and measurement techniques. To fill in this gap, we developed a Perceived Environmental Aesthetic Qualities Scale (PEAQS). Based on previous literature both in philosophy and empirical sciences we created a questionnaire with 36 statements and three open questions focusing on the perceived aesthetic qualities of environments. This questionnaire was used to sample 331 respondents in three sites different in their level of naturalness, human intervention and design: a natural-like but managed urban forest, a partly human-made and intensively managed bay-park and a completely human-made green roof. These sites were selected to represent a variety of urban green and blue infrastructure common in cities. The results suggest a scale that consists of 23 statements and five factors that reflect perceived aesthetic qualities of urban green spaces: Harmony, Mystery, Multisensority & Nature, Visual Spaciousness and Visual Diversity, and Sublimity. We give guidelines for further development and testing of the scale in order to prove its potential to develop the field of environmental aesthetics and to demonstrate its usefulness for adaptive, evidence-based urban planning and design.

1.   Introduction

Green and blue infrastructure, including green and blue spaces, such as urban forests, parks, green roofs and open waters, provides not only regulating or provisioning ecosystem services (e.g. heat control or storm water management), but also cultural benefits and experiential qualities. The cultural ecosystem services include aesthetic ones that improve living environments and further, affect the health and well-being of citizens. (Clark et al., 2014; European Commision, 2013; Hoyle, Hitchmough, & Jorgensen, 2017; Jorgensen & Gobster, 2010; Lee, Williams, Sargent, Williams, & Johnson, 2015; Mesimäki, Hauru, Kotze, & Lehvävirta, 2017; Pazhouhanfar & Mustafa Kamal, 2014; Raymond et al., 2017; Velarde, Fry, & Tveit, 2007; WHO, 2005; Zinzi & Agnoli, 2012). For example, the role of aesthetics in relation to psychological well-being, restorative experiences and environmental preferences is described in Ulrich's (1983) Stress Reduction Theory (SRT) by assuming that the (aesthetic) perception of an environment is based on an evolutionary-driven, immediate, and unconsciously triggered affective response, such as preference, dislike or fear, when visually encountering environments. These responses, in turn, may affect the subsequent cognitive appraisal of the environment, physiological responses, behavior, and well-being.

Despite the idea of aesthetic benefits having been widely incorporated into urban planning and management, it is still not clear what is meant by aesthetic qualities, benefits and experiences, and a comprehensive comparative method to measure how people perceive these qualities is in high demand. In this paper, we clarify the conceptualisation related to aesthetics of green and blue spaces and identify experiences that we suggest to belong to the category of *perceived aesthetic qualities*. In this way we aim to characterize and operationalize *perceived aesthetic qualities*, and then develop a pilot version of a self-report scale to test whether these qualities can be assessed in a meaningful way in different types of green and blue spaces.

The need for developing tools to measure aesthetic qualities has been recognized in various

fields. For example, Stamatopoulou (2004) designed a scale to assess the components of aesthetic qualities of art, and more specifically, experiences triggered by the contemplation of works of art. Schindler and colleagues (2017) presented a tool that registers aesthetic emotions, triggered e.g. by music, paintings, and architecture. Closer to our area of research, Kirillova and Lehto (2015) introduced the Perceived Destination Aesthetic Qualities scale (PDAQ scale) that measures tourists' aesthetic judgement of leisure destinations. PDAQ scale emphasizes the novelty aspect, and is being best applied to novel and leisure environments in contrast to home conditions (Kirillova, Fu, Lehto, & Cai, 2014; Kirillova & Lehto, 2015). Furthermore, the scales measuring experienced restorative benefits of green and blue spaces include perceived responses to aesthetic qualities; the Perceived Restorativeness and Restorative Outcomes Scales measure fascination, i.e., the automatic interest and attention toward a pleasant environment, the urge to explore the surroundings and the experience of coherence (Han, 2003; Hartig, Korpela, Evans, & Gärling, 1997; Hartig, Lindblom, & Ovefelt, 1998; Korpela, Ylén, Tyrväinen, & Silvennoinen, 2008, 2010; Staats, Kieviet, & Hartig, 2003).

In the present study, we aim to develop a tool for evaluating several kinds of everyday green and blue environments from a user-centred point of view where the perception of the aesthetic qualities is central.

1.1 Characterizing perceived environmental aesthetic qualities

A wide range of disciplines, e.g. philosophy, psychology, landscape architecture and landscape preference research, study aesthetic qualities of environments. All these disciplines have given valuable, but also variable, insights into the topic, and clarifying these viewpoints is necessary before we can successfully operationalize and assess perceived aesthetic qualities.

Perceived aesthetic qualities have frequently been operationalized to cover only general

preferences or visual aspects. Firstly, environmental psychology and landscape research have frequently used the concept of preference that refers to direct and immediate liking and pleasantness, often using photos as surrogates, which does not reflect the "engaging" aesthetic qualities of the environment (see van den Berg, Koole, & van der Wulp, 2003; Berleant, 1992, 1995; Stamps ,1990). Secondly, according to e.g. Carlson (1977), Gobster, Nassauer, Daniel and Fry (2007), and Kirillova and Lehto (2015), visual or scenic beauty has been commonly used as a proxy to perceived aesthetic quality, even though it reflects only one type of aesthetic response to the environment (see also Brady, 2003, pp. 16-17; Hauru, 2015, p. 20; Kirillova et al., 2014). Even when environmental psychological and landscape studies do concentrate on multiple qualities of environments, the focus has often been on the visual, such as visual scale (reflecting e.g. openness and visibility in the landscape), complexity (visual diversity and complexity of patterns and shapes), mystery (promise of new information of vista) or coherence (unity of the scene, repeating patterns of colors and texture) (Tveit, Ode, & Fry, 2006). While these immediately experienced and visual aspects are important, they do not reflect the fact that environments are experienced with multiple senses.

Our starting point is that aesthetic qualities of environments are *perceived*. They are multisensory and context-dependent (Brady, 2003; Hauru, 2015; Hauru, Koskinen, Kotze, & Lehvävirta, 2014; Mesimäki et al., 2017; Nasar, 1988), and the information received by one or more of the senses may impact how the information received by the rest of the senses is processed (Lugten, Kang, Karacaoglu, Steemers, & White, 2018; Puyana Romero, Maffei, Brambilla, & Ciaburro, 2016; Van Renterghem, 2018) . They are also experienced within a place (i.e. not from a distance), and thus involve "engagement", which means that a perceiver is "immersed" in the environment (Berleant, 1992, 1995; Carlson & Berleant, 2004; Rolston, 1998). We focus on the *perceived aesthetic quality*, because that is the ultimate outcome of the person-environment interaction, and – taking a user-centred stance – is a key to evaluating the

environments created by planning, design or management processes. In other words, to learn about the aesthetic value of environments, we should collect data concerning the aesthetic experiences therein.

An extensive reading of literature (see the paragraphs below) suggested six major perceived environmental aesthetic qualities to be included in a scale that attempts to operationalise and measure the such virtues of urban green and blue spaces: perceived multisensory beauty, diversity, scale, coherence, mystery, and sublimity.

Beauty is a key concept in philosophical aesthetics, and it has been a matter of intellectual inquiry for western philosophers since Antiquity. The term 'beautiful' refers to what has traditionally been regarded as "aesthetically good" or "(visually) attractive" (Carlson & Berleant, 2004; Lothian, 1999). We emphasize the multisensory nature of the perceived aesthetic experiences, and, accordingly, acknowledge that 'beautiful' can refer to other sensory domains besides sight. Clearly, sounds and auditory landscapes can be beautiful (see also Berleant, 1992, 1995; Brady, 2003, p123-128; Chen, Adimo, & Bao, 2009; Hauru et al. 2014; Mesimäki et al., 2017).

Diversity or complexity as an aesthetic concept refers to richness and variety of e.g. structures, processes, patterns, shapes, sounds, smells and touchable features in the environment, and reflects the observational variety of things (Hauru et al., 2014; Blumentrath & Tveit, 2014; Kirillova et al., 2014). Diversity is an environmental quality that can both challenge and engage the perceiver. Depending on the nature and volume of the stimuli, integrating them all may be challenging but also offer opportunities for satisfactory and rewarding immersion in the environment. Diversity also has the capacity to induce experiences of complexity and mystery to occur (mystery is dealt with as a separate quality below; Hauru et al., 2014; Kirillova et al., 2014; Tveit et al., 2006).

Scale has been an integral concept in visual landscape perception studies as well as in socio-evolutionary theories suggesting that open spaces (prospect) and hiding places (refuge) predict environmental preferences (Appleton, 1975; Nasar, Julian, Buchman, Humphreys, & Mrohaly, 1983; Rudell & Hammit, 1987). Scale can be considered as a property that reflects the size of the environment and the openness of views, referring to the immediate perceptions of scope, prospect, visual and functional accessibility, and spaciousness, which all play an important role in contextual and engaging aesthetic experiences (Brady 2003, 16-17; Coeterier, 1996; Grahn & Stigsdotter, 2010; Kirillova & Lehto, 2015; Ode & Fry, 2002; Tveit et al., 2006; Qiu & Nielsen, 2015).

The origin of *coherence* is in the Kaplan and Kaplan's (1989) informational model that explains environmental preferences by referring to the information we gain from environments to understand them. Coherence has been characterized in numerous ways, e.g. as reflecting unity, balance, harmony, orientation and legibility as well as understanding the wholeness of the place and its relatedness to oneself (Blumentrath & Tveit, 2014; Coeterier, 1996; Hauru et al., 2014; Hauru, Lehvävirta, Korpela, & Kotze, 2012; Kirillova et al., 2014; Peschardt & Stigsdotter, 2013; Sevenant & Antrop, 2009; Tenngart Ivarsson & Hagerhall, 2008; Tveit et al., 2006). Coherence is shown to be apparent in places that are easy to understand, that are ordered, and show repeating patterns and forms, but it may also occur in places that fit well to their surroundings (Berleant, 1992, 1995; Blumentrath & Tveit, 2014; Sevenant & Antrop, 2009; Tang, Sullivan, & Chang, 2015; Tenngart Ivarsson & Hagerhall, 2008).

Mystery is another quality mentioned in the Kaplans' (1989) preference theory, and it is related to perceiving complexity, attractiveness, feelings of excitement, and desire to explore the place (see also Hauru et al., 2014). Mystery can occur in many kinds of environments, e.g. both in visually closed and open environments, as well as diverse and more monotonic ones, but its benefical value depends on whether a person experiences it positively or negatively (see Herzog & Bryce,

2007). The desire to explore would emerge from the human need of making sense of the environment, and the promise of new information therein, but negative feelings could arise e.g. where possible danger is anticipated (Kaplan & Kaplan, 1982).

Finally, the sublime, another key concept in philosophical aesthetics, has traditionally been related to great and powerful landscapes - such as waterfalls, mountains, and the starry sky - that may cause awe, fascination or fear, or be beyond human comprehension (Budd, 2005; Shapsay, 2013; Nicholson, 1963; Webster, 2001). However, nowadays, with the rise of the aesthetics of the everyday life (Haapala, 2005; Leddy, 2012; Saito, 2007), sublime qualities might be found and explicated in more "modest" environments as well. If a person is able to immerse in, or deeply engage with, a given environment, *sublimity* - characterized as genuinely fascinating, owerwhelmingly incredible or great - will be present (Paden, Harmon, & Milling, 2013; Shapshay, 2013).

In this study, our objective was to develop a first version of a Perceived Environmental Aesthetic Qualities Scale (PEAQS), a self-report tool that can be used to empirically investigate the experienced aesthetic qualities of different urban green and blue spaces. Based on the previous literature (reviewed above) as well as our own studies (see section 2.2), we hypothesized that the scale should cover multisensory beauty, diversity, coherence, scale, mystery, and sublimity.

2. Methods

2.1. Study site selection

The sites selected for this study are located in XXXX (blinded for review), cities that belong to the capital region of XXXX (blinded for review) that in 2015 had a population of 1,437,890 (supplementary material, Electronic Appendix A). We selected three sites to represent very different types of green and blue infrastructure: a green roof, an urban park by the bay, and a forest. As the aim of the study was to test and develop the method, not to study the qualities of particular site types, three distinctive sites were considered enough to identify possible gaps in the method and to test its ability to distinguish between different kinds of environments. We chose to collect data in a limited number of sites in order to achieve a sufficient sample per site.

The green roof on top of a single house, surrounded by other single houses and their yards is located in XXXX (blinded for review), in an area that at the time of data collection was newly built and used as a housing fair. There were two small meadows on the study roof, and the site was facing a green roof on a similar single house. There was also a terrace with a sunshade umbrella, two deck chairs, a large pot plant and a small whirlpool bath on the roof (Fig. 1). The popular park by XXXX (blinded for review), (hereafter bay-park) is located right at the centre of XXXX (blinded for review). It is a managed but not very decorative or formal park, next to important buildings. The observed landscape opens up towards the bay and includes water, a dock, a foliage of trees and shoreline vegetation, e.g. reeds. An amusement park and the XXXX (blinded for review) are also visible at the background of the site (Fig. 2). The third site, in the southern part of the Central Park XXXX (blinded for review), is also popular among recreationists and commuters. It is a spruce-pine dominated woodland area with a full canopy cover and *Myrtillus*-type undergrowth (hereafter urban forest, Fig. 3).

Here we would like to place Figures 1, 2 & 3.

These three sites offered a variety of environmental properties and design: the degree of naturalness versus built green (urban forest being the most and green roof being the least natural-like), human intervention (lightly managed urban forest, intensively managed bay-park and very

intensively managed green roof), height (green roof on top of a building, bay-park and urban forest at the ground level), size and scale (green roof being a small and closed area with a visual access to the surroundings, bay-park being spacious and open with high levels of prospect and good visibility, urban-forest being large, but with relatively closed visual accessibility due to the trees that block the view), type of vegetation (meadow-like and rather ascetic on green roof, rich and diverse including different ecosystems from mature trees to bed of reeds and flowering plants on the shore in bay-park, and forest plant species in urban forest), and presence of water (human-made whirlpool on green-roof though empty during data collection, natural-like bay in bay-park, no water in urban forest). Including sites with different properties, we aimed at capturing a wide variety of the perceived environmental aesthetic qualities presented in section 1.2.

2.2 The questionnaire

We compiled a set of statements that would measure the six perceived environmental aesthetic qualities of green and blue spaces: multisensory beauty, diversity, coherence, scale, mystery, and sublimity. We selected most of the statements (21 items) from questionnaires that we had used earlier in our studies exploring experiential qualities in urban forests (Hauru et al., 2014, 2012; Koskinen, 2013), urban parks (the authors, unpublished data), and on green roofs (Mesimäki et al., 2019), and rephrased some of them to better meet this study's objectives. The rest of the statements (15 items) were generated specifically for this study, based on the literature introduced in section 1.1. During different phases of our current and previous studies, we consulted experts from different fields (environmental psychologists, philosophers, a sociologist, a landscape architect, a horticulturist, ecologists and environmental scientists) for content validity and phrasing of each statement. We also tested the pilot versions of the scale with small groups of environmental scientists, ecologists, random recreationists and upper comprehensive school pupils.

9

We hypothesized that the statements would sufficiently operationalize the 6 qualities, see Table 1. The 36th statement, "I like this place", was included in order to test whether the perceived environmental aesthetic qualities correlate with preference. The statements were presented in a 1 to 7 Likert scale (agreement from 1= not at all, to 7= completely). We used 10 different versions of the questionnaire, each with a randomized order of the statements, so as to avoid bias due to order effect. We did not test for the possible order effect, which is thus included in the error variation in the statistical tests.

The questionnaire also included three open-ended questions to explore 1) disturbing things, 2) especially pleasing things, and 3) the feelings aroused by the environments. The free-form answers were meant to support or challenge the factors emerging from the factor analysis and to offer a possibility to capture qualities and perceptions not covered by the 36 statements. The results of the free-form answers are shown in the supplementary material (Electronic Appendix C).

Finally, we included a section for background information (gender, age, place of residence, duty/denomination/education, frequency of visits to the site, and frequency of visits to green areas), to get a profile of the respondents. The Finnish questionnaire was translated into English before analyses.

Table 1. *The 35 statements included in the questionnaire to operationalise the six perceived environmental aesthetic qualities, and the last 36th statement to measure preference . We used 10 different versions of the questionnaire, where the order of the statements was randomised.*

Multisensory beauty

1. It's beautiful here.
2. The view here is picturesque.
3. The soundscape here is pleasant.
4. The surface underneath my feet feels comfortable.
5. There is a nice/good smell here.

Diversity

6. The view here is diverse.
7. The soundscape here is varying.
8. There are many scents in the air.
9. There are many colors in this place.
10. The manifold materials here attract to touch and feel.
11. Nature is diverse here.

Coherence

12. Things here seem to be right in place.
13. The different parts of this place form a coherent whole.
14. It is easy to understand this place.
15. This place fits well with its surroundings.
16. This is a harmonious environment.

Scale

17. The scale of this place is pleasing for me.
18. This place is spacious.
19. The horizon here seems to be somewhere far away.
20. There is enough room here.
21. Visibility here is good.

Mystery

22. I feel like exploring this place.
23. This place is mysterious.
24. This environment could provide me with surprises.
25. This is an interesting place.
26. This is an exciting environment

Sublimity

27. This place is unique.
28. This place is striking.
29. Here I can clearly sense the presence of nature.
30. This place is unspeakably spectacular.
31. This place exudes a deep (sense of) peace.
32. This place is scary in a fascinating way.
33. In places like this, a person can perceive his/her smallness (in relation to all being).
34. This place awakens respect for nature in me.
35. There is something sublime and noble in this place.

36. I like this place.

2.3 Data collection

The data for the green roof was collected in 2015. During two days of a housing fare in July, from 10 a.m. to 6 p.m., all visitors to the roof were asked to participate. Data for the bay-park was generated in summer 2016, during one day in June and another in July, from 12 noon to 3.30 p.m. The visitors to the site were stopped at a frequently used walking and cycling route and asked to participate. For the urban forest, data was collected during three days in August 2016, between 2 and 9 p.m. To control for the effect of weather on our results, we conducted fieldwork only during comfortable weather (no rain or windiness).

2.4 The respondents

The final sample was composed of 331 participants: 173 visitors to green roof, 88 at bay-park and 70 at urban forest. 61% of the respondents were women, 34% were men and 5% did not answer to this question. The respondent's ages varied between 20 and 70 years, they had a variety of professions, and 88% of them lived in a big city (see more detailed information in supplementary material, Electronic Appendix D).

2.5 Data analyses

We ran an Exploratory Factor Analysis (EFA) using generalized least squares extraction and oblique rotation (Promax). We chose EFA as there was no previous testing of this set of statements. As all the statements of the scale refer to the psychological experience of being in a place, we expected the statements and the factors to correlate and thus, selected an oblique rotation allowing for correlations between factors. The factor solution of the EFA was first scanned to remove statements showing low factor loadings (< 0.30) and communalities, and multiple factor loadings. Thereafter, the shortened scale´s reliability (internal consistency, measured by Cronbach's alfa) and convergent validity, i.e., agreement with related concepts, were assessed (Trochim, 2000). For assessing convergent validity, an "overall PEAQS score", i.e. the mean value of all the statements of the scale, was used to predict preference (statement

36) in Linear Regression Analysis. Likewise, linear regression analyses were run to predict preference with the emerging sub-scales (i.e. factors) individually. For the regressions, the introduction method was "Enter". Finally, Analyses of Variance (ANOVA) were run to check whether there were statistically significant differences among the overall PEAQS score and the sub-scales' scores between the three study sites indicating discriminant validity of the scale. When finding differences, Cohen's d statistic was calculated to obtain the effect size of such differences, and interpreted with the following guidelines: $d = .20$, small; $d = .50$, moderate and $d = .80$, large (Cohen, 1988). All the statistical analyses were performed using IBM SPSS Statistics v. 24.

3. Results

3.1 Exploratory Factor Analysis suggested five factors

The Exploratory Factor Analysis (n = 331) revealed five factors that we named *Harmony* (8 statements), *Mystery* (5), *Multisensority & Nature* (4), *Visual Spaciousness & Visual Diversity* (3), and *Sublimity* (3 statements) (Table 2). The eigenvalues of the five factors were greater than 1, and together they explained 63.49% of the total variance in the dataset (KMO =.97; Bartlett's test = 7974.5; p < 0.001). Pre-extraction communalities of single statements ranged from 0.37 to 0.74. Factor solutions were quite similar for green roof and bay-park but less easy to interpret as items loaded less coherently and not in the same order as in the full sample solution. Furthermore, the factor solution for the urban forest tried to form 5 or 6 factors but the solution remained unreliable. Thus, we concentrate only on the full sample solution.

For the sub-scales, we selected statements with loadings > 0.30, *and* with clear conceptual relationships with the rest of the statements in each factor. Of the items loading > 0.30, we also excluded those redundant to the contents of the factor, e.g. items 4 and 9 referring to the ground surface and colours loading on the first factor as they might just represent concrete expressions of harmony and beauty (items 16 and 1) already present on factor 1. In addition to statements

13

with only low loadings, we also excluded those with high loadings on multiple factors. However,

statements 11, 22, 25 and 35 with moderate or large loadings on more than one factor were

retained because they made a relevant contribution to the conceptualisation of the solution.

Allowing double loadings is in line with our assumption that the factors reflecting the experience

of being in a place may not be completely independent of each other. For example, statement 11

reflects nature (Factor 3) while it also seems logical that it may simultaneously reflect harmony

(factor 1). Another example is statement 22 that loads on factors 1 and 2, and is conceptually

tightly connected to the notion of mystery and the items on factor 2. Subsequently, the

condensed version of the scale consisted of 23 statements and showed a high internal consistency

(for the full scale Cronbach´s $\alpha = 0.96$; for the sub-scales, see Table 2).

Table 2

The exploratory factor analysis solution with Promax rotation for the 35 statements of the scale. The highest loadings are bolded. Excluded statements are shown in the lower section of the table.

Statement	Harmony	Mystery	Multisensority & Nature	Visual spaciousness & Visual diversity	Sublimity
15. This place fits well with its surroundings.	**.828**	-.067	-.016	.031	-.077
14. It is easy to understand this place.	**.809**	-.010	-.037	.062	-.028
17. The scale of this place is pleasing for me.	**.786**	.014	-.064	.117	.035
12. Things here seem to be right in place.	**.738**	-.104	-.009	-.021	.188
16. This is a harmonious environment.	**.721**	-.144	.100	-.044	.180
13. The different parts of this place form a coherent whole.	**.644**	-.084	.115	-.026	.080
1. It's beautiful here.	**.619**	.028	.054	-.095	.205
25. This is an interesting place.	**.613**	.419	-.280	.060	.071
26. This is an exciting environment	-.015	**.693**	.027	.170	.010
23. This place is mysterious.	-.054	**.601**	.114	-.115	.262
22. I feel like exploring this place.	.524	**.542**	.011	-.142	-.051
10. The manifold materials here attract to touch and feel.	.298	**.497**	.011	.020	-.119
24. This environment could provide me with surprises.	.232	**.480**	.093	-.040	.056
33. In places like this a person can perceive his/her smallness (in relation to all being).	-.099	.239	**.640**	.009	.071
8. There are many scents in the air.	.254	.097	**.499**	-.013	-.056
11. Nature is diverse here.	.446	-.008	**.487**	.045	-.046
3. The soundscape here is pleasant.	.299	-.034	**.479**	-.083	.163
21. Visibility here is good.	-.033	-.041	.069	**.789**	-.077
18. This place is spacious.	.013	-.042	-.177	**.787**	.182
6. The view here is diverse.	.023	.122	.225	**.599**	-.065
28. This place is striking.	.119	-.010	-.014	.033	**.834**
35. There is something sublime and noble in this place.	.307	.105	.016	-.126	**.603**
30. This place is unspeakably spectacular.	.050	.163	.102	.087	**.595**
Cronbach's α	.92	.846	.830	.767	.893
Factor's eigenvalue (pre-rotation)	16.84	1.81	1.48	1.08	1.02
Explained variance by factor (%, post-rotation)	14.89	9.30	11.04	8.24	11.63

Excluded statements

2. The view here is picturesque.	.322	-.164	.149	.169	.379
4. The surface underneath my feet feels comfortable.	.598	.140	.079	-.042	-.099
5. There is a nice/good smell here.	.512	.046	.374	-.118	-.108
7. The soundscape here is varying.	.181	.176	.294	.147	-.099
9. There are many colors in this place.	.313	.117	.116	.161	-.043
19. The horizon here seems to be somewhere far away.	-.118	.100	.357	.118	.176
20. There is enough room here.	.386	-.030	.141	.362	-.034
27. This place is unique.	.169	.219	.052	.223	.255
29. Here I can clearly sense the presence of nature.	.579	-.095	.389	.014	.026
31. This place exudes a deep (sense of) peace.	.222	.001	.379	-.019	.309
32. This place is scary in a fascinating way.	-.583	.630	.227	-.049	.017
34. This place awakens respect for nature in me.	.484	.024	.380	-.037	.075

Overall the PEAQS mean score was strongly correlated with preference ($r = .78$; $p < .001$), indicating that the scale explained a relevant amount of the variance in preference (61%). Pearson correlation coefficients between the sub-scales and preference ranged from 0.52 to 0.84, with $p < .001$ (see Electronic Appendix D). The multivariate regression that tested their predictive power also gave statistically significant results for preference $F(5,324) = 159.86$, $p < .001$ (Fig. 4).

Here we would like to place Figure 4.

3.2 Differences in perceived aesthetic qualities between the study sites

The overall PEAQS score varied statistically significantly between the sites: *Post Hoc* testing showed that visitors on green roof reported lower levels than those at bay-park or in urban forest (Tukey´s HSD, Table 3). A main effect of the sites was also found for the five sub-scales (Table 3). Cohen's d varied from 0.61 (moderate) to 1.49 (large; Cohen, 1998). Visitors of green roof reported lower levels of *Harmony* and *Sublimity* than participants in bay-park and urban forest. *Mystery* and *Multisensority & Nature* were highest in urban-forest while *Visual Spaciousness & Visual Diversity* was highest in bay-park.

Table 3

ANOVA results with the means (M) and standard deviations (SD) of the overall perceived aesthetic score and each sub-scale per study site. Tukey's HSD results show the pairwise comparisons of the means of the study sites, with statistically significant differences (p < .05) given with < or > to show which site had the higher mean score.   d = effect size. GR = green roof, BP = bay-park, UF = urban forest

Sub-scale		ANOVA				Tukey 's HSD Comparisons		
		Score (1-7)		F (2, 327)	p	Tukey HSD	p	d
	Site	M	SD					
PEAQS (overall score)	GR	4.01	0.99			GR<BP	< .001	1
	BP	4.94	0.87	42.83	< .001	GR<UF	< .001	1.13
	UF	5.13	0.99			BP UF	.137	-
Harmony	GR	4.36	1.09			GR<BP	< .001	1.24
	BP	5.56	0.83	72.63	< .001	GR<UF	< .001	1.42
	UF	5.81	0.95			BP UF	.271	-
Mystery	GR	4.01	1.16			GR BP	.318	-
	BP	4.23	1.26	19.30	< .001	GR<UF	< .001	0.94
	UF	5.02	0.98			BP<UF	< .001	0.70
Multisensority & Nature	GR	3.51	1.16			GR<BP	< .001	0.96
	BP	4.56	1.02	65.31	< .001	GR<UF	< .001	1.49
	UF	5.21	1.12			BP<UF	.001	0.61
Visual Spaciousness & Visual Diversity	GR	4.86	1.17			GR<BP	< .001	0.70
	BP	5.60	0.93	15.17	< .001	GR UF	.764	-
	UF	4.75	1.22			BP>UF	< .001	0.78
Sublimity	GR	3.32	1.26	56.93	< .001	GR<BP	< .001	1.19

18

BP	4.83	1.27	GR<UF	< .001	1.15
UF	4.87	1.42	BP UF	.984	-

0

4. Discussion

Below, we discuss the results of the Factor analysis and the free-form answers jointly, reflecting where the free-form answers provided support to the results based on the statements, or offered ideas for further development of the PEAQS.

4.1 A Perceived Environmental Aesthetic Qualities Scale

Based on our approach that drew from diverse theoretical and empirical literature, the 23-statement PEAQS revealed five perceived aesthetic qualities - *Harmony, Mystery, Multisensority & Nature, Visual Spaciousness & Visual Diversity*, and *Sublimity*. The scale showed good internal consistency and a factor structure accounting for a large proportion of the variance. Most of the qualities met our *a priori* expectations (see Table 1), however, the combinations of statements within some qualities deviated from what we had expected. This means that even though we carefully considered each statement with experts, and based them on a large set of literature, the sub-scales' contents (i.e. the set of necessary and sufficient statements and their exact formulation) should be refined for the next versions of the scale.

PEAQS succeeded in predicting preference, indicating convergent validity. The emerging factors were positively correlated to preference scores ($r = .52$-$.84$) and altogether explained a considerable share of the variance (61%). The size of these associations is similar to the ones obtained in other studies using informative variables (Stamps, 2004) and environmental affective responses (Galindo & Corraliza, 2012) but greater than those reported in studies using place attachment (Jaskiewicz, 2015) and familiarity (Hernández, Hidalgo, Berto, & Peron, 2001) as predictors. Furthermore, it showed discriminant validity by distinguishing between three different green spaces (one including also blue space). With PEAQS, we were able to sensibly characterize the aesthetic qualities of each environment: the green roof offered lower levels of *Harmony* and *Sublimity* than urban forest and bay-park, the urban forest scored highest in

25 *Mystery* and *Multisensority & Nature,* and *Visual Spaciousness & Visual Diversity* were highest

26 in bay-park. The differences were remarkable in size ($d = 0.70 – 1.49$).

27 All statements that we hypothesized to load on coherence did indeed load on the one factor, but

28 also statements reflecting beauty and interestedness loaded on the same one. This factor

29 entangles scale, unity and balance between the different parts of the perceived environment,

30 beauty and understandability, and also interest towards the place. We suggest that this

31 combination of items represents *Harmony* and propose an explanation for it based on

32 psychological processes: as beauty is experienced both cognitively and emotionally, beauty and

33 interest towards the observed environment combine together. Interest might be a predecessor as

34 well as a consequence of experiencing beauty (Leder, Belke, Oeberst, & Augustin, 2004). A

35 further reason for this combination can be found in the Stress Reduction Theory (Ulrich, 1983),

36 which states that environmental preferenda that are analyzed very rapidly include complexity,

37 focality, depth and ground surface texture. As a conclusion, we think that *Harmony* portrays a

38 space more specifically than the multifaceted concept "coherence" that has frequently been used

39 in landscape preference studies: as reviewed in section 1.2, coherence has been characterized in

40 multiple ways, and operationalizing it definitely needs more stringent conceptualization.

41 All statements that we hypothesized to load on *Mystery* did so, except the place being interesting

42 that loaded on *Harmony*. In addition, the statement "The manifold materials here attract to touch

43 and feel" (a priori hypothesized as a multisensory item) also loaded on *Mystery* and actually fits

44 well with its content, reflecting the multisensory side of this perceived aesthetic quality. *Mystery*

45 reflects excitement, desire for exploration and the place being tempting, and it has been shown to

46 be an important quality affecting preferences for natural environments also in many previous

47 studies (Kaplan & Kaplan, 1989 and studies thereafter; e.g. Gobster & Westphal, 2004;

48 Pazhouhanfar & Kamal, 2014). Also, the free-form answers reflected mystery and the place

49 being inviting for exploration. Thus, we suggest mystery to be an essential perceived aesthetic

50 quality of green and blue spaces.

51 The *Multisensority & Nature* was an unexpected quality, combining statements measuring

52 soundscape and scents (hypothesized to load on multisensory beauty), as well as diversity of

53 nature (hypothesized to load on diversity), and perception of oneself being small in relation to all

54 being (hypothesized to load on sublimity). It is an interesting combination but makes sense

55 intuitively: nature can feed all senses and evoke a feeling of humbleness or relativeness

56 (Olafsdottir, Cloke, & Vögele, 2017; Schroeder, 2007). This interpretation is supported by the

57 free-form answers: both bay-park and urban forest gathered equally high numbers of mentions of

58 nature, but yet the greatest proportion of mentions regarding senses other than visual was

59 gathered in the forest, the most natural-like one of the study sites.

60 It may also be that multisensorial perception is "intrinsic" to all aesthetic qualities assessed *in*

61 *situ*, as a person usually experiences an environment with all senses, not only by vision (see e.g.

62 Brady, 2003, p. 123–128; Chen et al., 2009; Hauru et al., 2014), and therefore a "multisensory

63 beauty" quality did not occur in our analysis. We suggest that the future versions of PEAQS

64 should try to capture multisensorial aspects even better, by incorporating statements reflecting

65 multiple senses into each quality.

66 Diversity did not form a distinct factor in our analysis but instead the statements hypothesized to

67 load on diversity scattered among other qualities, or did not load on any factor, and were

68 excluded. Instead, a factor that we interpreted as *Visual spaciousness & Visual diversity*

69 comprised three statements that we *a priori* had assigned to the separate qualities of *diversity* (6.,

70 diverse view) and *scale* (16., spacious place; 21., good visibility). Logically, it was highest in

71 bay-park, which was quite open, and visibly the most diverse of the study sites. Openness and

72 diversity are qualities frequently present in previous landscape perception studies (e.g. Hauru et

73 al., 2014; Kirillova et al., 2014; Ruddell & Hammitt, 1987; Ode & Fry 2002; Qiu & Nielsen,

74 2015), however, the association between these two qualities has not, to our knowledge, been

75 much emphasized before. Nevertheless, the frequent mentions of space and visual diversity in

76 the free-form answers suggest that statements operationalizing them should be included in the

77 future development of the scale. Whether the combination of diversity and spaciousness is a

78 general environmental aesthetic quality or a result due to the characteristics of our sites needs to

79 be tested with a new data generation procedure that provides a sampling design that explicitly

80 contrasts visual diversity with visual spaciousness.Moreover, related to the perception of space,

81 the free-form responses also included mentions of height and position in relation to the observed

82 environment, which should be considered in future versions of PEAQS.

83 Finally, *Sublimity* emerged as a separate quality, however, only three of the hypothesized

84 statements loaded on this factor. Even though sublime characters have mostly been related to

85 great and powerful landscapes, such as waterfalls or mountains (Shapsay 2013; Nicholson, 1963;

86 Webster, 2001), we showed that the sublime can be experienced even in everyday environments,

87 here in urban green and blue spaces. In philosophical aesthetics (e.g. Shapshay, 2013), the

88 sublime is essential in aesthetic experiencing of natural environments, but to our knowledge, it

89 has not been operationalized in empirical studies before. A reason for this might be that

90 sublimity may be symbolic and quite abstract, and contains emotional and visceral responses

91 towards the perceived (Shapsay, 2013), and is thus difficult to concretize.

92 *4.2 Further development and applied value of PEAQS*

93 While the 23-statement PEAQS extensively gathers aspects of the perceived environmental

94 aesthetic qualities, there is still room for elaboration of its content. Also, the operationalization

95 of the qualities (i.e. the statements) may need to be refined to accurately measure each quality.

96 The relevance of the statements dismissed in this study could be re-evaluated after rephrasing

97 them. One could also consider whether the factors could be measured with equal emphasis, i.e.

23

98 equal number of statements e.g. five-six, per factor, each including visual, auditory, olfactory

99 and tactile senses where relevant.

100 Apart from re-elaborating some of the initially designed and current statements, there might be a

101 need for the inclusion of further content. For instance, the sublime could include perspectives

102 from psychology and applied aesthetics regarding transcendent or prototypical aesthetic

103 emotions such as awe, being moved, and captivation (Joye & Dewitte, 2016; Keltner & Haidt,

104 2003; Shiota, Keltner, & Mossman, 2007; Schindler et al. 2017). Furthermore, the findings based

105 on the free-form answers also raised some issues to be considered, such as the experience of joy

106 and other positive feelings, frequently mentioned in our data. Aesthetic joy and delight have in

107 fact been used to conceptualize positive perceived environmental aesthetic qualities (e.g. Nohl,

108 2001; Paden at al., 2013; see also Schindler et al. 2017 who list pleasing feelings as part of the

109 aesthetic emotions evoked by art), but on the other hand, good mood and delight may also be a

110 *consequence* of positive perceptions of environmental aesthetic qualities. Hence, including

111 statements on the qualities behind the experience of joy and mood-enhancement might also

112 constitute a relevant step forward. Finally, some free-form answers dealt with negative outcomes

113 concerning other users' behaviors (e.g. fast bikers), overcrowding, or noise. The inclusion of

114 such disruptive elements might mean an improvement for PEAQS as well – however, adding

115 negative statements is not advisable, as they may impact the factor analysis, so that the solution

116 is related to the negative phrasing rather than the actual meaning of the statements (see

117 Mesimäki et al. 2019).

118 Future work with the tool should comprise its use in a greater variety of settings (e.g. designed

119 parks, blue corridors, green corridors, rain gardens and brown fields, to give a few examples).

120 Similarly, the tool should be used in different weather conditions (weather during data collection

121 in this study was dry and warm) in order to check whether it maintains its structure in different

122 moments of the year and under different climatological conditions. On the other hand, if the

123   scale does not work in a similar manner in all weather conditions, it implies that weather may

124   modify the experience so that that the composition of perceived environmental aesthetic qualities

125   is different during different weathers. In order to answer to these questions, the further

126   development and testing of the tool we recommended in previous paragraphs should be

127   complemented with these latter suggestions.

128   Obviously, no environmental experience occurs in a vacuum and thus, the perceived

129   environmental aesthetic qualities are likely linked to other psycho-environmental processes.

130   Examples of likely important and interesting associations include psychological restoration from

131   attentional fatigue (Kaplan & Kaplan, 1989, Hartig et al., 1997, Attention Restoration Theory;

132   ART), place attachment or place memories (Ratcliffe & Korpela, 2016), and evaluation of the

133   benefits and risks in the environment (Orians & Heerwagen, 1992). Clearly, besides aesthetics,

134   studies in environmental psychology and social sciences are relevant when examining perceived

135   qualities of environments. Consequently, the paired use of PEAQS with other measures

136   operationalizing the above-mentioned processes is highly recommended.

137   The need for PEAQS is evident, as the benefits that the perceived aesthetic qualities provide, are

138   important ingredients of good quality environments promoting health and well-being (Clark et

139   al., 2014; Chan et al., 2012; Hoyle, Hitchmough, & Jorgensen, 2017; Jorgensen & Gobster,

140   2010;; Mesimäki et al., 2017; Raymond et al., 2017; Velarde, Fry, & Tveit, 2007; WHO, 2005).

141   PEAQS will be a usable tool for city planners and green space managers, but also for scientists

142   to address the challenges of describing, assessing and evaluating aesthetic qualities of different

143   types of environments. The academic field of environmental aesthetics still lacks consistent

144   conceptualization of the perceived environmental aesthetic qualities (see section 1.1 in this

145   paper), which has hindered their effective assessment by both scientists and green space planners

146   and managers. We believe that with the help of this tool, demarcating and assessing aesthetic

147   qualities will become easier and more precise.

148   In the urbanizing world (European Commission, 2015; UNDESA, 2012), nature-based solutions

149   and ecosystem services are expected to provide livable environments, and help adapt to climate

150   change. Continuous feedback from science to practice is needed to support development of

151   cities. PEAQS can be one tool to promote user-centred planning and management, and applying

152   it to practice is important for the following reasons: First, since there are widely documented

153   discrepancies between designers' and users' tastes and preferences for environments, empirical

154   evidence of local citizens' experiences in their surroundings is necessary in order to plan liveable

155   cities for urbanites (Frank, Fürst, Koschke, Witt, & Makeschin, 2013; Hoffmann, Westermann,

156   Kowarik, & Van der Meer, 2012; Kalivoda, Vojar, Skřivanová, & Zahradník, 2014). Second, as

157   aesthetic benefits are often mentioned in the strategies and guidelines for urban green and blue

158   spaces (City of Copenhagen, 2015; European Commission, 2015), well formulated

159   operationalization of such benefits is needed for them to be meaningfully evaluated. Third,

160   PEAQS can be used to follow the changes of a particular space, to track the evolution of its

161   perceived aesthetic qualities through time and to take decisions to improve the users'

162   experiences. Finally, it could be a tool to better understand and evaluate aesthetic ecosystem

163   services and benefits (Frank et al., 2013).

164   5.   Conclusions

165   With this study we aimed at developing a comprehensive self-report tool for the assessment of

166   the aesthetic qualities of urban green and blue spaces. By integrating knowledge from different

167   disciplines concerning the aesthetics of environments, we operationalized four aesthetic

168   qualities: harmony, multisensory and perception of nature, visual spaciousness and diversity,

169   and sublimity in three different kinds of green spaces. It also captured qualities beyond visual,

170   thus we encourage future studies to incorporate multisensory into the tool more extensively.

171   **References**
172
173   Appleton, J. (1975) Landscape evaluation: the theoretical vacuum. Transactions of the Institute
174   of British Geographers, 66, pp. 120 – 123.
175   Appleton, J. (1975). *The experience of landscape* (Wiley). London.
176   Berleant, A. (1992). *The Aesthetics of the Environment*. Philadelphia: Temple University Press.
177   Berleant, A. (1995). The aesthetics of art and nature. In *Landscape, Natural Beauty and the Arts*
178   (pp. 228–243). Cambridge: Cambridge University Press.
179   Blumentrath, C., & Tveit, M. S. (2014). Visual characteristics of roads: A literature review of
180   people's perception and Norwegian design practice. *Transportation Research Part A:*
181   *Policy and Practice*, *59*(January 2014), 58–71. https://doi.org/10.1016/j.tra.2013.10.024
182   Brady, E. (2003). *The Aesthetics of the Natural Environment*. Tuscaloosa, Alabama: The
183   University of Alabama Press.
184   Carlson, A. A. (1977). On the possibility of quantifying scenic beauty - A response to Ribe.
185   *Landscape Planning*, *4*, 131–172. https://doi.org/10.1016/0304-3924(84)90017-0
186   Carlson, A., & Berleant, A. (2004). Introduction: The aesthetics of nature. In A. Carlson & A.
187   Berleant (Eds.), *The Aesthetics of natural environments* (pp. 11–42). Ontario: Broadview
188   Press.
189   Chen, B., Adimo, O. A., & Bao, Z. (2009). Assessment of aesthetic quality and multiple
190   functions of urban green space from the users' perspective: The case of Hangzhou Flower
191   Garden, China. *Landscape and Urban Planning*, *93*(1), 76–82.
192   https://doi.org/10.1016/j.landurbplan.2009.06.001
193   City of Copenhagen. (2015). *Urban Nature in Copenhagen. Strategy 2015-2025*.
194   Clark, N. E., Lovell, R., Wheeler, B. W., Higgins, S. L., Depledge, M. H., & Norris, K. (2014).
195   Biodiversity, cultural pathways, and human health: A framework. *Trends in Ecology and*
196   *Evolution*, *29*(4), 198–204. https://doi.org/10.1016/j.tree.2014.01.009
197   Coeterier, J. F. (1996). Dominant attributes in the perception and evaluation of the Dutch
198   landscape. *Landscape and Urban Planning*, *34*(1), 27–44. https://doi.org/10.1016/0169-
199   2046(95)00204-9
200   Cohen, J. (1998). *Statistical Power Analysis for the Behavioral Sciences*. New York, US:
201   Lawrence Erlbaum Associates. https://doi.org/10.1234/12345678
202   European Commission. (2015a). *Towards an EU Research and Innovation policy agenda for*
203   *Nature-Based Solutions & Re-Naturing Cities. Final Report of the Horizon 2020 expert*
204   *group on nature-based solutions and re-naturing cities (full version)*. Brussels.
205   https://doi.org/10.2777/765301
206   European Commission. (2015b). *Towards an EU Research and Innovation policy agenda for*
207   *Nature-Based Solutions & Re-Naturing Cities*. https://doi.org/10.2777/765301
208   Frank, S., Fürst, C., Koschke, L., Witt, A., & Makeschin, F. (2013). Assessment of landscape
209   aesthetics - Validation of a landscape metrics-based assessment by visual estimation of the
210   scenic beauty. *Ecological Indicators*. https://doi.org/10.1016/j.ecolind.2013.03.026
211   Galindo, M. P., & Corraliza, J. A. (2012). Estética ambiental y bienestar psicológico: algunas
212   relaciones existentes entre los juicios de preferencia por paisajes urbanos y otras respuestas
213   afectivas relevantes. *Apuntes De Psicología*, *30*(1–3), 289–303. Retrieved from
214   http://www.apuntesdepsicologia.es/index.php/revista/article/view/412
215   Gobster, P. H., Nassauer, J. I., Daniel, T. C., & Fry, G. (2007). The shared landscape: What does
216   aesthetics have to do with ecology? *Landscape Ecology*, *22*(7), 959–972.
217   https://doi.org/10.1007/s10980-007-9110-x
218   Gobster, P. H., & Westphal, L. M. (2004). The human dimensions of urban greenways: Planning
219   for recreation and related experiences. *Landscape and Urban Planning*, *68*(2–3), 147–165.
220   https://doi.org/10.1016/S0169-2046(03)00162-2
221   Grahn, P., & Stigsdotter, U. K. (2010). The relation between perceived sensory dimensions of

urban green space and stress restoration. *Landscape and Urban Planning*, *94*, 264–275. https://doi.org/10.1016/j.landurbplan.2009.10.012

Haapala, A. (2005). On the aesthetics of the everyday: familiarity, strangeness, and the meaning of place. In A. Light & J. M. Smith (Eds.), *The aesthetics of everyday life* (pp. 39–55). New York: Columbia University Press.

Han, K.-T. (2003). A reliable and valid self-rating measure of the restorative quality of natural environments. *Landscape and Urban Planning*, *64*(4), 209–232. https://doi.org/10.1016/S0169-2046(02)00241-4

Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality in environments. *Scandinavian Housing and Planning Research*. https://doi.org/10.1080/02815739708730435

Hartig, T., Lindblom, K., & Ovefelt, K. (1998). The home and near-home area offer restoration opportunities differentiated by gender. *Scandinavian Housing and Planning Research*, *15*(4), 283–296. https://doi.org/10.1080/02815739808730463

Hauru, K. (2015). *Eco-experiential quality of urban forests : Combining ecological , restorative and aesthetic perspectives*. University of Helsinki, Faculty of Biological and Environmental Sciences.

Hauru, K., Koskinen, S., Kotze, D. J., & Lehvävirta, S. (2014). The effects of decaying logs on the aesthetic experience and acceptability of urban forests - Implications for forest management. *Landscape and Urban Planning*, *123*, 114–123. https://doi.org/10.1016/j.landurbplan.2013.12.014

Hauru, K., Lehvävirta, S., Korpela, K., & Kotze, D. J. (2012). Closure of view to the urban matrix has positive effects on perceived restorativeness in urban forests in Helsinki, Finland. *Landscape and Urban Planning*, *107*(4), 361–369. https://doi.org/10.1016/j.landurbplan.2012.07.002

Hernández, B., Hidalgo, M. D. C., Berto, R., & Peron, E. (2001). The role of familiarity on the restorative value of a place, Research on a Spanish sample. *Bulletin of People-Environment Studies*, *18*, 22–24.

Herzog, T. R., & Bryce, A. G. (2007). Mystery and Preference in Within-Forest Settings. *Environment and Behavior*, *39*(6), 779–796. https://doi.org/10.1177/0013916506298796

Hofmann, M., Westermann, J. R., Kowarik, I., & Van der Meer, E. (2012). Perceptions of parks and urban derelict land by landscape planners and residents. *Urban Forestry and Urban Greening*, *11*, 303–312. https://doi.org/10.1016/j.ufug.2012.04.001

Hoyle, H., Hitchmough, J., & Jorgensen, A. (2017). All about the 'wow factor'? The relationships between aesthetics, restorative effect and perceived biodiversity in designed urban planting. *Landscape and Urban Planning*, *164*. https://doi.org/10.1016/j.landurbplan.2017.03.011

Jaskiewicz, M. (2015). Place attachment, place identity and aesthetic appraisal of urban landscape. *Polish Psychological Bulletin*, *46*(4), 573–578. https://doi.org/10.1515/ppb-2015-0063

Jorgensen, A. (2011). Beyond the view: Future directions in landscape aesthetics research. *Landscape and Urban Planning*, *100*, 353–355. https://doi.org/10.1016/j.landurbplan.2011.02.023

Jorgensen, A., & Gobster, P. H. (2010). Shades of Green: Measuring the Ecology of Urban Green Space in the Context of Human Health and Well-Being. *Nature and Culture*, *5*(3), 338–363. https://doi.org/10.3167/nc.2010.050307

Joye, Y., & Dewitte, S. (2016). Up speeds you down. Awe-evoking monumental buildings trigger behavioral and perceived freezing. *Journal of Environmental Psychology*, *47*, 112–125. https://doi.org/10.1016/j.jenvp.2016.05.001

Kalivoda, O., Vojar, J., Skřivanová, Z., & Zahradník, D. (2014). Consensus in landscape preference judgments: The effects of landscape visual aesthetic quality and respondents'

273   characteristics. *Journal of Environmental Management*, *137*, 36–44.
274   https://doi.org/10.1016/j.jenvman.2014.02.009

275 Kaplan, R., & Kaplan, S. (1989). *The Experience of Nature. A Psychological Perspective*. New
276   York: Cambridge University Press.

277 Kaplan, S., & Kaplan, R. (1982). *Cognition and environment: Functioning in an uncertain*
278   *world*. New Yprk: Praeger.

279 Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion.
280   *Cognition and Emotion*, *17*(2), 297–314. https://doi.org/10.1080/02699930244000318

281 Kirillova, K., Fu, X., Lehto, X., & Cai, L. (2014). What makes a destination beautiful?
282   Dimensions of tourist aesthetic judgment. *Tourism Management*, *42*, 282–293.
283   https://doi.org/10.1016/j.tourman.2013.12.006

284 Kirillova, K., & Lehto, X. (2015). Destination Aesthetics and Aesthetic Distance in Tourism
285   Experience. *Journal of Travel and Tourism Marketing*, *32*(8), 1051–1068.
286   https://doi.org/10.1080/10548408.2014.958608

287 Korpela, K. M., Ylén, M., Tyrväinen, L., & Silvennoinen, H. (2008). Determinants of restorative
288   experiences in everyday favorite places. *Health and Place*, *14*, 636–652.
289   https://doi.org/10.1016/j.healthplace.2007.10.008

290 Korpela, K. M., Ylén, M., Tyrväinen, L., & Silvennoinen, H. (2010). Favorite green, waterside
291   and urban environments, restorative experiences and perceived health in Finland. *Health*
292   *Promotion International*, *25*(2), 200–209. https://doi.org/10.1093/heapro/daq007

293 Koskinen, S. (2013). *Lahojen ja lahoavien maapuiden estetiikka ja hyväksyntä Helsingin*
294   *kaupunkimetsissä*. University of Helsinki.

295 Leddy, T. (2012). *The Extraordinary in the Ordinary: The Aesthetics of Everyday Life*.
296   Peterborough: Broadview Press.

297 Lee, K. E., Williams, K. J. H., Sargent, L. D., Williams, N. S. G., & Johnson, K. A. (2015). 40-
298   second green roof views sustain attention: The role of micro-breaks in attention restoration.
299   *Journal of Environmental Psychology*, *42*, 182–189.
300   https://doi.org/10.1016/j.jenvp.2015.04.003

301 Lugten, M., Kang, J., Karacaoglu, M., Steemers, K., & White, K. (2018). Improving the
302   soundscape quality of urban areas exposed to aircraft noise by adding moving water and
303   vegetation. *The Journal of the Acoustical Society of America*, *144*(5), 2906–2917.
304   https://doi.org/10.1121/1.5079310

305 Mesimäki, M., Hauru, K., Kotze, D. J., & Lehvävirta, S. (2017). Neo-spaces for urban livability?
306   Urbanites' versatile mental images of green roofs in the Helsinki metropolitan area,
307   Finland. *Land Use Policy*, *61*, 587–600. https://doi.org/10.1016/j.landusepol.2016.11.021

308 Mesimäki, M., Hauru, K., & Lehvävirta, S. (2019). Do small green roofs have the possibility to
309   offer recreational and experiential benefits in a dense urban area? A case study in Helsinki,
310   Finland. *Urban Forestry and Urban Greening*, *40*, 114–124.
311   https://doi.org/10.1016/j.ufug.2018.10.005

312 Nasar, J. L. (1988). *Environmental aesthetics – theory, research and applications*. Cambridge:
313   Cambridge University Press.

314 Nasar, J. L., Julian, D., Buchman, S., Humphreys, D., & Mrohaly, M. (1983). The emotional
315   quality of scenes and observation points: A look at prospect and refuge. *Landscape*
316   *Planning*, *10*(4), 355–361. https://doi.org/10.1016/0304-3924(83)90041-2

317 Nicholson, M. H. (1963). *Mountain Gloom and Mountain Glory: The Development of the*
318   *Aesthetics of the Infinite*. New York: W.W. Norton.

319 Ode, Å. K., & Fry, G. L. A. (2002). Visual aspects in urban woodland management. *Urban*
320   *Forestry & Urban Greening*, *1*(1), 15–24. https://doi.org/10.1078/1618-8667-00003

321 Olafsdottir, G., Cloke, P., & Vögele, C. (2017). Place, green exercise and stress: An exploration
322   of lived experience and restorative effects. *Health and Place*, *46*(March), 358–365.
323   https://doi.org/10.1016/j.healthplace.2017.02.006

Orians, G. H., & Heerwagen, J. H. (1992). Evolved responses to landscapes. In L. Barklow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind* (pp. 555–579). New York: Oxford University Press.

Paden, R., Harmon, L. K., & Milling, C. R. (2013). Philosophical Histories of the Aesthetics of Nature. *Environmental Ethics*, *35*, 57–77.

Pazhouhanfar, M., & Mustafa Kamal, M. S. (2014). Effect of predictors of visual preference as characteristics of urban natural landscapes in increasing perceived restorative potential. *Urban Forestry and Urban Greening*, *13*(1). https://doi.org/10.1016/j.ufug.2013.08.005

Peschardt, K. K., & Stigsdotter, U. K. (2013). Associations between park characteristics and perceived restorativeness of small public urban green spaces. *Landscape and Urban Planning*, *112*, 26–39. https://doi.org/10.1016/j.landurbplan.2012.12.013

Puyana Romero, V., Maffei, L., Brambilla, G., & Ciaburro, G. (2016). Acoustic, visual and spatial indicators for the description of the soundscape of water front areas with and without road traffic flow. *International Journal of Environmental Research and Public Health*, *13*(9). https://doi.org/10.3390/ijerph13090934

Qiu, L., & Nielsen, A. B. (2015). Are Perceived Sensory Dimensions a Reliable Tool for Urban Green Space Assessment and Planning? *Landscape Research*, *6397*(May), 1–21. https://doi.org/10.1080/01426397.2015.1029445

Ratcliffe, E., & Korpela, K. M. (2016). Memory and place attachment as predictors of imagined restorative perceptions of favourite places. *Journal of Environmental Psychology*, *48*, 120–130. https://doi.org/10.1016/j.jenvp.2016.09.005

Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M. R., … Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science and Policy*, *77*(June), 15–24. https://doi.org/10.1016/j.envsci.2017.07.008

Rolston, H. (1998). Aesthetic Experience in Forests. *The Journal of Aesthetics and Art Criticism*, *56*(2), 157–166.

Rudell, E. J., & Hammit, W. E. (1987). Prospect refuge theory: A psychological orientation for edge effect in recreation environments. *Journal of Leisure Research*, *19*, 249–260.

Saito, Y. (2007). *Everyday Aesthetics*. Oxford: Oxford University Press.

Schindler, I., Hosoya, G., Menninghaus, W., Beermann, U., Wagner, V., Eid, M., & Scherer, K. R. (2017). *Measuring aesthetic emotions : A review of the literature and a new assessment tool*. https://doi.org/10.17605/OSF.IO/Q8ZV5

Schroeder, H. W. (2007). Place experience, gestalt, and the human-nature relationship. *Journal of Environmental Psychology*, *27*, 293–309. https://doi.org/10.1016/j.jenvp.2007.07.001

Sevenant, M., & Antrop, M. (2009). Cognitive attributes and aesthetic preferences in assessment and differentiation of landscapes. *Journal of Environmental Management*, *90*(9), 2889–2899. https://doi.org/10.1016/j.jenvman.2007.10.016

Shapshay, S. (2013). Contemporary environmental aesthetics and the neglect of the sublime. *British Journal of Aesthetics*, *53*(2), 181–198. https://doi.org/10.1093/aesthj/ays067

Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition & Emotion*, *21*(5), 944–963. https://doi.org/10.1080/02699930600923668

Staats, H., Kieviet, A., & Hartig, T. (2003). Where to recover from attentional fatigue: An expectancy-value analysis of environmental preference. *Journal of Environmental Psychology*, *23*, 147–157. https://doi.org/10.1016/S0272-4944(02)00112-3

Stamatopoulou, D. (2004). Integrating the Philosophy and Psychology of Aesthetic Experience: Development of the Aesthetic Experience Scale. *Psychological Reports*, *95*(6), 673. https://doi.org/10.2466/PR0.95.6.673-695

Stamps, A. E. (2004). Mystery, complexity, legibility and coherence: A meta-analysis. *Journal of Environmental Psychology*, *24*(1), 1–16. https://doi.org/10.1016/S0272-4944(03)00023-9

375   Tang, I.-C., Sullivan, W. C., & Chang, C.-Y. (2015). Perceptual Evaluation of Natural
376   Landscapes: The Role of the Individual Connection to Nature. *Environment & Behavior*,
377   *47*(6), 1–23. https://doi.org/10.1177/0013916513520604
378   Tenngart Ivarsson, C., & Hagerhall, C. M. (2008). The perceived restorativeness of gardens -
379   Assessing the restorativeness of a mixed built and natural scene type. *Urban Forestry and*
380   *Urban Greening*, *7*(2), 107–118. https://doi.org/10.1016/j.ufug.2008.01.001
381   Trochim, W. (2000). *The Research Methods Knowledge Base* (2nd ed.). Cincinnati: Atomic Dog
382   Publishing.
383   Tveit, M., Ode, Å., & Fry, G. (2006). Key concepts in a framework for analysing visual
384   landscape character. *Landscape Research*, *31*(June 2015), 229–255.
385   https://doi.org/10.1080/01426390600783269
386   UNDESA. (2012). *World Urbanization Prospects: The 2011 Revision. Presenta-tion at the*
387   *Center for Strategic and …*. New York. https://doi.org/10.2307/2808041
388   van den Berg, A. E., Koole, S. L., & van der Wulp, N. Y. (2003). Environmental preference and
389   restoration: (How) are they related? *Journal of Environmental Psychology*, *23*, 135–146.
390   https://doi.org/10.1016/S0272-4944(02)00111-1
391   Van Renterghem, T. (2018). Towards explaining the positive effect of vegetation on the
392   perception of environmental noise. *Urban Forestry & Urban Greening*.
393   https://doi.org/10.1016/j.ufug.2018.03.007
394   Velarde, M. D., Fry, G., & Tveit, M. (2007). Health effects of viewing landscapes - Landscape
395   types in environmental psychology. *Urban Forestry and Urban Greening*, *6*(4), 199–212.
396   https://doi.org/10.1016/j.ufug.2007.07.001
397   Webster, D. (2001). Inside the Volcano. In *The Best American Science and Nature Writing* (pp.
398   253–254).
399   WHO. (2005). *Millenium Ecosystem Assessment. Ecosystems and human well-being-health*
400   *synthesis report*. New York, US.
401   Zinzi, M., & Agnoli, S. (2012). Cool and green roofs. An energy and comfort comparison
402   between passive cooling and mitigation urban heat island techniques for residential
403   buildings in the Mediterranean region. *Energy and Buildings*, *55*, 66–76.
404   https://doi.org/10.1016/j.enbuild.2011.09.024
405