

Perceived Sensory Dimensions

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Perceived Sensory Dimensions (PSDs) is a tool that defines eight different cultural ecosystem services. They correspond to different human needs (rest, exercise, socialising, pleasure, or security) resulting in rehabilitation and health and well-being promotion. An experiment was conducted to study the potential of PSDs to restore people who experienced stressful accidents. One hundred and fifty-seven participants were recruited and asked first to watch a film clip of serious accidents, then to look at the pictures, depicting one particular type of PSDs, while listening to its respective audio recording. Their stress levels were measured before exposure to the stressor (baseline), after exposure to the stressor (pre-test), and after exposure to a particular type of PSDs (post-test). The results show that all eight PSDs effectively provide mental recovery, but there are statistical differences in their potentials. As such, it is proposed that the combined potential of the PSDs is needed, and should be used to increase the capacity and supply of health-promoting urban green areas

Keywords: evidence-based health design ; perceived sensory dimensions ; cultural ecosystem services ; social sustainability ; restorative state ; public health ; mental health ; stress reduction

1. Introduction

One problem with the focus on human preferences and needs for different qualities in natural environments and urban green areas is that it risks being directed at only one part of the area about which researchers seek knowledge. However, beginning in the mid-1980s, studies not based on any theoretical model, but completely bottom-up, began to consider how people experience and value natural and green areas ^[1]. Over the years, four comprehensive questionnaire studies have been conducted, each directed to several thousand people ^{[2][3][4][5]}. By means of several factor analyses, the number of qualities has been defined as eight. These quantitative studies have been supplemented by a number of qualitative studies and three full scale experimental case sites: Alnarp Rehabilitation Garden ^[6], Nacardia health garden ^[7], and Octovia Park ^[8]. In these parks and gardens, all PSDs have been used in the design, where some PSDs are more prominent in the design of specific parts. The eight PSDs are intended to meet different therapeutic needs, leading to all types of restorative experiences.

A number of translational studies have also been conducted ^[9], bringing research results from basic research and experimental case sites to everyday practice, including at the Public Health Agency of Sweden ^[10] and the Stockholm county council ^[11].

The eight qualities are experienced, situated, and embodied, and consist of visual, audial, and spatial qualities. They are, therefore, termed Perceived Sensory Dimensions, or PSDs ^{[4][12]}. They include qualities that are emphasised as restorative according to the Stress Reduction Theory ^[13]; Attention Restoration Theory ^[14]; biodiversity theories (e.g., ^[15]); theories of social qualities (e.g., ^[16]); and naturalness (e.g., ^[17]). They, thus, cover a wide area.

Each of the PSDs is distinct, and can either occur alone in a green area or together with one or more other PSDs. Combinations of different PSDs can look different ^{[18][19]}. However, a comprehensive review of all PSD studies conducted since the 1980s showed that PSDs usually behave in a particular way, especially if one takes into account their clearest expressions. The names of the various PSDs in this article are from this extensive review ^[12]: Natural (a wild and pristine environment that does not seem to be created by humans, but on the contrary is perceived as spontaneously developed, on its own terms, over an extended period of time); Diverse (a sense of complexity and species richness in the environment, including spatial variations such as undulating ground, multilayer variation, and elements such as rocks and water features); Cohesive (the sense of spatial unity having the potential to contain and surround the individual, to provide an extended, cohesive space, possible to explore and wander around within, spacious); Open (a potentially mix-use open area, with grass surfaces, scattered trees and vistas); Sheltered (a safe haven, a sanctuary, relatively enclosed space, secluded, providing the ambience to relax or play); Social (presence of people, place for social activities including

entertainment equipment and restaurants); Serene (a safe peaceful and calm place, with no disturbances like litter, graffiti or noise; offering tranquil natural sounds); and Cultural (cultivated and man-made surroundings combined with cultural elements such as fountains, flowers, and statues).

The study ^[12] was conducted as a comprehensive quantitative and qualitative review of research on PSDs since the 1980s. Several of the studies examined were performed using factor analysis. They showed that factors with high scores for wilderness and naturalness had low scores for cultural artefacts such as sculptures or landscaped flowerbeds. Similarly, there were factors with high scores for peace and quiet and clear negative scores for environments full of people, with outdoor cafes and music. Several factor analyses had oblique rotation, which for example showed that factors for naturalness correlated with factors for serenity. These quantitative studies are supported by qualitative studies of PSDs. The research shows that the eight PSDs are associated with each other according to Figure 1, and can be interpreted to represent different cultural ecosystem services. There are four axes of opposing qualities: (1) a Natural–Cultural axis, (2) a Cohesive–Diverse axis, (3) a Sheltered–Open axis, and (4) a Serene–Social axis. The right-hand PSDs in the figure are usually linked to the most urban parts, and can work well in small parks and green areas, while the left-hand PSDs in the figure are more often linked to the larger parks and nature reserves. The PSDs on the left side are also significantly more sensitive to various types of disturbances. Social refers to green areas that, for example, contain cafés or other meeting points; Cultural is about cultural artefacts such as flowerbeds, fountains, sculptures, etc. These two PSDs are often tied to the smallest areas, and the two qualities also support each other. On the opposite side is Natural, which refers to natural, spontaneously grown vegetation, while Serene refers to silence and serenity. These qualities are often associated with large areas, and the two PSDs also support each other. Cultural is close to Open, which refers to open spaces, often urban lawns. This openness, and exposure, can also be experienced in natural areas such as meadows or beaches. These open natural areas can be supported by, and correspond to Cohesive. This quality is about perceptions of coherence and unity. On the opposite side is Shelter, referring to a safe place where you can be at peace, undisturbed. This lack of exposure differs from its opposite, Open. Next to Shelter is Diverse, which refers to variety, species richness, and hilly areas, preferably next to watercourses. Each PSD above is supported by the two closest qualities. Social is supported, for example, by both cultural artefacts in Cultural, and by variety, species richness and garden ponds in Diverse.

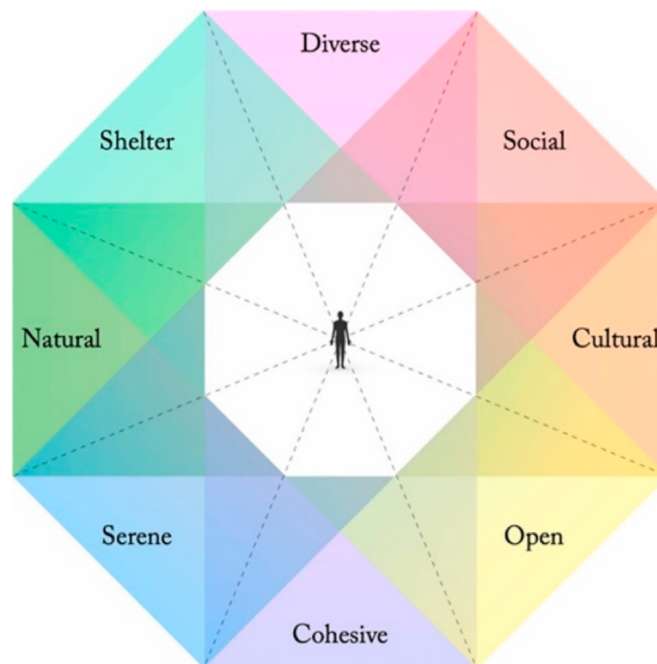


Figure 1. Perceived Sensory Dimensions (PSDs): eight complementary qualities in urban green areas in support of basic human needs. These PSDs can be interpreted to represent cultural ecosystem services ^[12].

Approximately one hundred studies with PSDs have been conducted in different parts of the world since 2010: for example, in China ^[20], Estonia ^[21], Canada ^[22], Denmark ^[23], Scandinavia ^[24], Iran ^[25], Malaysia ^[26], and Serbia ^[27]. These studies show that the PSDs are experienced similarly regardless of cultural context. The classification of the eight PSDs has been confirmed through Multiple Group Method ^[25], and the potential for using the PSDs as guidelines for designing health-promoting natural environments has been validated ^{[19][28]}.

2. The Supportive Environment Theory as a Framework for PSDs

There seems to be a fundamental need for green areas that convey an impression of safety and security, values linked to Serene and Shelter. With regard to the other PSDs, as reported in the introduction, studies disagree regarding which PSDs are most restorative. In general, regarding sufferers from long-term or severe stress, such as those with stress-related mental illness, Natural, Shelter, Serene, and Cohesive appear to be restorative while Cultural, Open, and Social are not regarded as restorative, and Social in some studies even is assumed to have a negative impact on stress [4][25][29][30]. If, on the other hand, the studies are aimed at the general population or at young people, Social and Cultural are proposed to be restorative, with some studies also highlighting these PSDs as the most restorative [27][31]. This study involved healthy young people acutely exposed to a stressful event, and many PSDs appear to have worked restoratively.

The Supportive Environment Theory (SET) states that specific qualities of green environments are supportive of psychological restoration [18][6]. These qualities correspond to different human needs for support, including the needs for rest, exercise, socialising, or pleasure. SET explains the relationships among the individual's mental strength, the need for supportive environments, and the PSDs [6]. This theoretical framework has been suggested as a cornerstone for the evaluation and design of green areas [19][29].

The relationship between the need for support and mental strength is usually illustrated as a hierarchy of needs (see Figure 2). The X-axis illustrates the need for support, while the Y-axis illustrates the person's mental strength. The figure also includes four levels, which reflect the needs for support the person experiences [18]. This model has been tested and developed in several studies, for example, at the Alnarp rehabilitation garden, in which participants were severely stressed or ill [30][32].

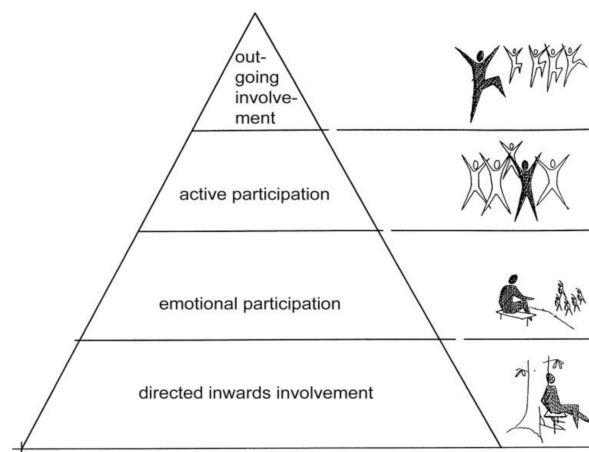


Figure 2. The model of supportive environments (SET): It explains the relationships among the individual's mental Scheme [29]. In this tool, the Y-axis, in addition to indicating the participants' mental strength, also describes the degree of challenges that participants can cope with or need. The Y-axis is then called the "Gradient of challenge". The lowest level of the hierarchy of needs, directed inwards involvement, was proposed to reflect the needs of Serene, Natural, and Shelter. The next level, emotional participation, was proposed to reflect the needs of Cohesive and Diverse. The third level was proposed to reflect the needs of Open and Cultural, while the top level, outgoing involvement, was proposed to reflect the needs of Social. The more sensitive the user group, the greater the impact the environment has on its health and well-being. Depending on the user group's characteristics related to gender, age, disability, mood, interests, etc., different PSDs along the challenge gradient will be most crucial.

After a review of studies with different types of users, Bengtsson [33] found that the need for green areas with Social, Cultural, and Open could sometimes be great in nursing homes. This applied to users who may have a physical disability, but remain mentally alert. They often felt isolated and desired social contact, attractive natural scenery, and cultural-historical experiences. Ulrich [34] also describes the sensitivity, stress, and needs of long-term and short-term patients. Ulrich claims that stress in short-term patients emanates from anxiety related to acute illness. They suffer from too much social contact, are overstimulated, and need to feel seclusion as well as peace and quiet. This contrasts to the tedium and lack of stimulation and social interaction that cause stress and depression in people with chronic illnesses who undergo long-term hospital stays, e.g., in nursing homes [34]. Bengtsson [33], therefore, suggested that the pyramid of needs in such cases should be reversed. However, a study in the Alnarp rehabilitation garden, where participants suffered from long-term stress-related illness, showed that some participants, even at the beginning of the rehabilitation, sometimes looked for environments with the PSDs Social and Cultural. They sought out these social environments to de-stress following difficult and stressful conversations with a psychotherapist [35].

References

1. Haig, B.D. Detecting psychological phenomena: Taking bottom-up research seriously. *Am. J. Psychol.* 2013, 126, 135–153.
2. Gyllin, M.; Grahn, P. A semantic model for assessing the experience of urban biodiversity. *Urban. For. Urban. Green.* 2005, 3, 149–161.
3. Grahn, P. Landscapes in our minds: People's choice of recreative places in towns. *Landsc. Res.* 1991, 16, 11–19.
4. Grahn, P.; Stigsdotter, U.K. The relation between perceived sensory dimensions of urban green space and stress restoration. *Landsc. Urban. Plan.* 2010, 94, 264–275.
5. Adevi, A.A.; Grahn, P. Preferences for landscapes: A matter of cultural determinants or innate reflexes that point to our evolutionary background? *Landsc. Res.* 2012, 37, 27–49.
6. Grahn, P.; Ivarsson, C.T.; Stigsdotter, U.K.; Bengtsson, I.-L. Using affordances as a health-promoting tool in a therapeutic garden. *Innov. Approaches Res. Landsc. Health* 2010, 1, 116–154.
7. Stigsdotter, U.K. Nature, health and design. *Alam Cipta* 2015, 8, 89–96.
8. Stigsdotter, U.K.; Corazon, S.S.; Sidenius, U.; Refshauge, A.D.; Grahn, P. Forest design for mental health promotion—Using perceived sensory dimensions to elicit restorative responses. *Landsc. Urban. Plan.* 2017, 160, 1–15.
9. Ogilvie, D.; Craig, P.; Griffin, S.; Macintyre, S.; Wareham, N.J. A translational framework for public health research. *BMC Public Health* 2009, 9, 1–10.
10. Johansson, A.-K.; Kollberg, S.; Bergström, K. Grönområden för Fler: En Vägledning för Bedömning av Närhet och Attraktivitet för Bättre Hälsa [Green Areas for More people: A Guide for Assessing Proximity and Attractiveness for Better Health]; Public Health Agency of Sweden: Solna, Sweden, 2009.
11. Bernergård, K.; Lundh-Malmros, B.; Tönnerfors, E. Upplevelsevärden—Sociala kvaliteter i den regionala grönstrukturen [Experienced values: Social qualities in the regional green structure]. *Stock. Cty. Counc.* 2001, 4, 2001.
12. Stoltz, J.; Grahn, P. Perceived sensory dimensions: An evidence-based approach to greenspace aesthetics. *Urban. For. Urban. Green.* 2021, 59, 126989.
13. Ulrich, R.S. Biophilia, biophobia, and natural landscapes. *Biophilia Hypothesis* 1993, 7, 73–137.
14. Pasini, M.; Berto, R.; Brondino, M.; Hall, R.; Ortner, C. How to measure the restorative quality of environments: The PRS-11. *Procedia-Social Behav. Sci.* 2014, 159, 293–297.
15. Dallimer, M.; Irvine, K.N.; Skinner, A.M.; Davies, Z.G.; Rouquette, J.R.; Maltby, L.L.; Warren, P.H.; Armsworth, P.R.; Gaston, K.J. Biodiversity and the feel-good factor: Understanding associations between self-reported human well-being and species richness. *Bioscience* 2012, 62, 47–55.
16. Giles-Corti, B.; Broomhall, M.H.; Knuiaman, M.; Collins, C.; Douglas, K.; Ng, K.; Lange, A.; Donovan, R.J. Increasing walking: How important is distance to, attractiveness, and size of public open space? *Am. J. Prev. Med.* 2005, 28, 169–176.
17. Carrus, G.; Laforzezza, R.; Colangelo, G.; Dentamaro, I.; Scopelliti, M.; Sanesi, G. Relations between naturalness and perceived restorativeness of different urban green spaces. *Psychology* 2013, 4, 227–244.
18. Van den Bosch, M.; Ward-Thompson, C.; Grahn, P. Preventing Stress and Promoting Mental Health. In *Oxford Textbook of Nature and Public Health: The Role of Nature in Improving the Health of a Population*; Oxford University Press: Oxford, UK, 2017; pp. 108–115.
19. Stigsdotter, U.K.; Sidenius, U.; Grahn, P. From research to practice: Operationalisation of the eight perceived sensory dimensions into a health-promoting design tool. *Alam Cipta* 2020, 13, 57–70.
20. Chen, H.; Qiu, L.; Gao, T. Application of the eight perceived sensory dimensions as a tool for urban green space assessment and planning in China. *Urban. For. Urban. Green.* 2019, 40, 224–235.
21. Maikov, K. Landscape characteristics in Tartu city parks: User influences through design. *WIT Trans. Ecol. Environ.* 2013, 179, 353–364.
22. Lockwood, A. Balancing Perceived Sensory Dimensions and Biotopes in Urban Green Space design. Ph.D. Thesis, The University of Guelph, Guelph, ON, Canada, 2017.
23. Plambech, T.; Van Den Bosch, C.C.K. The impact of nature on creativity—A study among Danish creative professionals. *Urban. For. Urban. Green.* 2015, 14, 255–263.
24. Lindholst, A.C.; Caspersen, O.H.; Van den Bosch, C.C.K. Methods for mapping recreational and social values in urban green spaces in the nordic countries and their comparative merits for urban planning. *J. Outdoor Recreat. Tour.* 2015,

25. Memari, S.; Pazhouhanfar, M.; Nourtaghani, A. Relationship between perceived sensory dimensions and stress restoration in care settings. *Urban. For. Urban. Green.* 2017, 26, 104–113.
26. Mansor, M.; Ghani, N.; Harun, N.Z.; Zakariya, K. Conceptual models of greenspace and health. *Adv. Sci. Lett.* 2017, 23, 6326–6330.
27. Vujcic, M.; Tomicevic-Dubljevic, J. Urban forest benefits to the younger population: The case study of the city of Belgrade, Serbia. *For. Policy Econ.* 2018, 96, 54–62.
28. Qiu, L.; Nielsen, A.B. Are perceived sensory dimensions a reliable tool for urban green space assessment and planning? *Landsc. Res.* 2015, 40, 834–854.
29. Bengtsson, A.; Grahn, P. Outdoor environments in healthcare settings: A quality evaluation tool for use in designing healthcare gardens. *Urban. For. Urban. Green.* 2014, 13, 878–891.
30. Pálsdóttir, A.M.; Stigsdotter, U.K.; Persson, D.; Thorpert, P.; Grahn, P. The qualities of natural environments that support the rehabilitation process of individuals with stress-related mental disorder in nature-based rehabilitation. *Urban. For. Urban. Green.* 2018, 29, 312–321.
31. Peschardt, K.K.; Stigsdotter, U.K. Associations between park characteristics and perceived restorativeness of small public urban green spaces. *Landsc. Urban. Plan.* 2013, 112, 26–39.
32. Pálsdóttir, A.M. The Role of Nature in Rehabilitation for Individuals with Stress-Related Mental Disorders. Ph.D. Thesis, Department of Work Science, Business Economics and Environmental Psychology, Swedish University of Agricultural Sciences, Alnarp, Sweden, 2014.
33. Bengtsson, A. From Experiences of the Outdoors to the Design of Healthcare Environments. Ph.D. Thesis, Department of Work Science, Business Economics and Environmental Psychology, Swedish University of Agricultural Sciences, Alnarp, Sweden, 2015.
34. Ulrich, R.S. Effects of Gardens on Health Outcomes: Theory and Research. In *Healing Gardens: Therapeutic Benefits and Design Recommendations*; Marcus, C.C., Barnes, M., Eds.; John Wiley & Sons: New York, NY, USA, 1999.
35. Adevi, A.A.; Uvnäs-Moberg, K.; Grahn, P. Therapeutic interventions in a rehabilitation garden may induce temporary extrovert and/or introvert behavioural changes in patients, suffering from stress-related disorders. *Urban. For. Urban. Green.* 2018, 30, 182–193.