Urban Forestry & Urban Greening 15 (2016) 103–111

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Perception and preference of trees: A psychological contribution to tree species selection in urban areas

Tina Gerstenberg[a,*], Mathias Hofmann[a,b]

[a] TU Dresden, Centre for Interdisciplinary Research in Technological Development, 01062 Dresden, Germany
[b] Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland

ARTICLE INFO

Article history:
Received 9 January 2015
Received in revised form
11 December 2015
Accepted 14 December 2015
Available online 17 December 2015

Keywords:
Landscape architecture
Green space planning
Urban forestry
Tree perception
Aesthetics
Environmental psychology

ABSTRACT

Trees can enhance human mental and physical well-being in urban environments. However, the tree benefits in urban planning are insufficiently recognised, and there is little knowledge on the tree characteristics that are relevant to humans and how they are evaluated. This paper presents perceptual tree parameters and their relation to human preferences. In study 1, participants sorted 24 tree images by perceived similarity. Hierarchical cluster analysis and multidimensional scaling (MDS) revealed the distinction between conifers and deciduous trees, crown shape, the two-dimensional crown size to trunk height ratio and the crown density as important to humans. In study 2, participants rated the trees based on their preferences. Multiple linear regression analyses showed that a high two-dimensional crown size to trunk height ratio and a high crown density predicted deciduous tree preferences. These findings are discussed in light of the savannah hypothesis and the Gestalt grouping principle of closure. In the task of tree selection and placement for urban areas, the identified perceptual tree parameters may allow for achieving a coherent overall picture with a simultaneous increase of tree species richness. Thus, urban landscape planning can apply the presented findings for increasing ecosystem health and residential satisfaction.

1. Introduction

1.1. The impact of trees on human health and well-being

Urban trees deliver measurable benefits to urban environmental quality and residential quality of life. They reduce urban heat stress (Potchter et al., 2006; Bowler et al., 2010; Shashua-Bar et al., 2010), building energy use (Akbari et al., 2001; Nowak and Dwyer, 2007; Escobedo et al., 2011), atmospheric carbon dioxide (CO_2, Nowak and Dwyer, 2007; Escobedo et al., 2011), rainfall runoff, flooding, noise levels, and wind speed (Tyrväinen et al., 2005; Nowak and Dwyer, 2007), and remove air pollutants (Nowak and Dwyer, 2007; Escobedo et al., 2011; Nowak et al., 2014). Trees' cooling effects in urban areas will become more important given the impact of climate change (McCarthy et al., 2010).

In addition to increasing environmental quality, trees contribute to urban neighbourhoods' aesthetic quality and enhance human mental and physical health and well-being (Tyrväinen et al., 2005; Nilsson et al., 2011). People living in greener environments report a better health (De Vries et al., 2003; Maas et al., 2006; Mitchell and Popham, 2007) and have a lower actual prevalence rate of specific diseases, such as depression and anxiety disorder, than people living in less green environments (Maas et al., 2009). A greater tree density in neighbourhoods is associated with a lower smoking prevalence, fewer antidepressant prescriptions (Taylor et al., 2015), greater physiological stress recovery (Jiang et al., 2014a) and self-reported stress-recovery (Jiang et al., 2014b; Van den Berg et al., 2014), a reduced number of small for gestational age births (Donovan et al., 2011), and social cohesion (Holtan et al., 2014). Visiting urban nature decreases suffering from headaches and stress and increases feeling well-balanced (Hansmann et al., 2007), emotional well-being (Korpela et al., 2014), feelings of restoration, creativity, and vitality, and positive mood (Tyrväinen et al., 2014). Furthermore, walking in natural environments has greater positive effects on subsequent attention test performance than walking in built environments (Berman et al., 2008). In their recent review article, Keniger et al. (2013) provide an overview of human benefits of interacting with nature. These findings are important to urban green space planning, specifically because the world is experiencing an increasing population and progressive urbanisation (United Nations, 2014). Consequently, living conditions in cities are becoming increasingly important (Hägerhäll et al., 2010).

* Corresponding author.
E-mail address: tina.gerstenberg@tu-dresden.de (T. Gerstenberg).

http://dx.doi.org/10.1016/j.ufug.2015.12.004
1618-8667/

In urban landscape design, tree placement is a key element (Wu et al., 2008). The selection of tree species for urban sites should consider the adaptability to the environmental site conditions, functions of the tree, and low costs of propagation, production, establishment, and management (Sæbø et al., 2005; Miller et al., 2015). Functions of the tree include benefits to people and aesthetic quality of the site (Sæbø et al., 2005; Miller et al., 2015). To ensure empirically founded urban tree management that considers human health and well-being, a comprehensive picture on tree perception and acceptance is essential (Tyrväinen et al., 2005). However, little is known about which tree characteristics are relevant to perception and how they are associated with tree's aesthetics. Furthermore, within tree species composition in urban sites, there is a troubling conflict between the aesthetic preference for visual uniformity and the ecological need for species diversity (Trowbridge and Bassuk, 2004). For visual attractiveness and high tolerance to urban stresses of specific species, urban tree planting often results in uniform rows of a single species (Trowbridge and Bassuk, 2004). From an ecological point of view, this gives cause for concern, as species diversity is important for the resilience of an urban tree population to pests and diseases (Pauleit et al., 2002; Sjöman et al., 2012b). In the face of climate change, the importance of species diversity is even growing, as higher temperatures and longer periods of drought increase the vulnerability of urban trees to pests and diseases (Sjöman et al., 2012a). Furthermore, species diversity is increasingly threatened by continuing urbanisation (McKinney, 2002, 2006; Alvey, 2006).

1.2. Tree perception and preference

Humans are aesthetically attracted to natural elements and to particular landscape compositions (Joye, 2007). Within urban landscape design that considers residential satisfaction, preferences and health-promoting effects of tree populations should be taken into account. Research on forest preference has generated knowledge that applies to both, single trees and their composition. A recent Delphi survey with experts in forest preference research revealed that the recreational value of a forest increases with the size of trees within stand, and the variation between forest stands (along a 5 km trail) according to stand age, management regime, and/or tree species composition (Edwards et al., 2012). Large clear-cuts and residue from thinning and harvesting are negatively associated with forest's recreational value (Edwards et al., 2012). Similarly, obvious traces from forest operations (Gundersen and Frivold, 2008) and human artefacts in recreational forests (Nielsen et al., 2012) are disliked. Furthermore, the recreational value of a forest is influenced by visual penetration through a stand with medium levels of penetrability providing the highest recreational value (Edwards et al., 2012). Consistent with this, it was found that parks that are accessible and provide a view are perceived as being safer than parks that have a mass abundance of understorey and trees which are grouped tightly in masses (Yang et al., 2013). However, for residential streets a positive relationship was found between tree cover density and preference (Jiang et al., 2015). Similarly, it was found that trees, especially the portion of trees covering buildings, significantly mitigate perceived oppressiveness of urban streetscapes (Asgarzadeh et al., 2012).

Research on self-reported acceptance of trees in urban environments has shown that opinions on nearby street trees are generally positive (Schroeder et al., 2006) and that people prefer scenes that have trees more than scenes that have inanimate objects (Lohr and Pearson-Mims, 2006). Furthermore, respondents have more positive emotions when viewing trees compared to inanimate objects (Lohr and Pearson-Mims, 2006). More specifically, a survey conducted in Morelia, Mexico, revealed that people have a preference for tall, leafy, and shady trees and consider trees as being beneficial for them personally and for the city, as they provide oxygen and shade, beautify the cityscape, and improve environmental quality (Camacho-Cervantes et al., 2014). A disliked trait of trees is garbage generation due to leaf shedding and the most mentioned damages caused by trees are infrastructure damages and accidents (Camacho-Cervantes et al., 2014). However, the majority of respondents agree that there should be more trees in the city (Camacho-Cervantes et al., 2014).

Research investigating the effects of tree shapes on preference has consistently shown that trees that have broad canopies, including spreading and globular canopies, are preferred over those that are narrow (Sommer and Summit, 1996; Sommer, 1997; Lohr and Pearson-Mims, 2006). Furthermore, people have a preference for trees with large canopies and short trunks (Sommer and Summit, 1995; Summit and Sommer, 1999). Thus, preferred canopy size is positively related to trunk thickness but not to trunk height (Sommer and Summit, 1995). These findings are consistent with Orians's savannah hypothesis (Orians, 1980, 1986, 2001; Heerwagen and Orians, 1993) which implicates that humans have a preference for landscape features and tree shapes that are characteristic of African savannahs. Trees that are typical in the African savannahs' fertile habitats have broad canopies, trunks that bifurcate close to the ground, and layered canopies (Orians, 2001).

Nelson et al. (2001) applied the Gestalt grouping principle of closure to predict tree's attractiveness. According to the principles of Gestalt psychology, our visual system favours seeing closed or complete forms (Schiffman, 2001). It was confirmed that trees that have the most complete canopies are the most attractive (Nelson et al., 2001). Similarly, trees with dense canopies are preferred more frequently than trees that have open canopies (Lohr and Pearson-Mims, 2006).

All of the previously mentioned studies presented trees that varied in characteristics that were selected by researchers. To hold other attributes constant, the researchers used stimulus material that was mainly black and white and consisted of drawings, computer-generated drawings or photo compositions. The presented images were generic tree shapes (e.g., Sommer and Summit, 1995; Nelson et al., 2001), species varying in tree shape (e.g., Lohr and Pearson-Mims, 2006) or both (e.g., Sommer and Summit, 1996; Sommer, 1997; Summit and Sommer, 1999). This increase in internal validity comes at the price of decreased external validity, i.e., less realistic-looking images.

1.3. Objectives

The present paper aims to identify tree parameters that are relevant to tree perception and tree differentiation (study 1) and to examine the degree to which these parameters predict tree preference (study 2). Within urban landscape design, the knowledge on tree parameters relevant to human perception enables the selection of different species which look similar. Thus, this knowledge enables the creation of a coherent overall picture with a simultaneous increase of species diversity in urban areas. Furthermore, the selection of trees that have preferred characteristics may contribute to residential satisfaction. The studies presented in this paper aimed at generating such knowledge.

2. Study 1

2.1. Methods

2.1.1. Stimulus material

Twenty-four photorealistic colour tree images were generated using *Xfrog* plant models (Xfrog Inc., 2006) and *Terragen 2* software (Planetside Software, 2009, version 2.4). Using computer-rendered