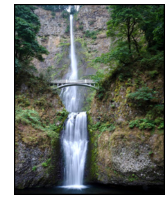
Journal of Environmental Psychology 58 (2018) 93–100

Contents lists available at ScienceDirect

Journal of Environmental Psychology

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



Demonstrating the effect of exposure to nature on happy facial expressions via Flickr data: Advantages of non-intrusive social network data analyses and geoinformatics methodologies

Tal Svoray[a,b,*], Michael Dorman[a], Golan Shahar[b], Itai Kloog[a]

[a] *Department of Geography and Environmental Development, Ben-Gurion University of the Negev, Israel*
[b] *Department of Psychology, Ben-Gurion University of the Negev, Israel*

ARTICLE INFO

Handling Editor: Jeff Joireman

ABSTRACT

Although the role of exposure to nature (ETN) in improving well-being was previously demonstrated, most of the existing research is derived from self-report measures. Conversely, geoinformatics methodologies are seldom used. To address this gap, we examined the prevalence of happy facial expressions (HFE) in natural settings such as water bodies, green vegetation, and undeveloped areas. We applied a novel, spatio-temporal analysis of photos taken in the Boston area and posted on Flickr – a location-based social network – during 2012–2015 (N = 60,013). Photos were analyzed using Microsoft Emotion API to detect facial expressions. ETN, measured either as a composite score, or based on the three aforementioned aspects, was significantly associated with HFEs, even after controlling for temporal patterns. An exploratory visualization of spatial clusters characterized by high HFE proportion was in agreement with the statistical results. This method can be used to explore human-environment interactions more explicitly in a non-intrusive manner.

1. Introduction

Exposure to nature (ETN) appears to be associated with improved mental health and well-being. During an era in which most of the human population lives in cities, research on the effect of ETN on mental health and well-being is chiefly sought and, indeed, studies such as Carrus et al. (2015) have shown that urban green spaces rich in biodiversity are associated with enhanced well-being. Similarly, White, Alcock, Wheeler, and Depledge (2013) reported that individuals have both lower mental distress and higher well-being when living in urban areas with more green space. Furthermore, Berman et al. (2012) showed that interacting with nature improves cognition also for individuals with depression. To advance knowledge on the subject, data science tools, new and modern devices such as mobile phones, geoinformatics, and social network data can provide accurate, detailed, and temporal data on human emotions, as well as on built and natural environments. Here, we present a study that examines the role of ETN in yielding happy facial expressions (HFE), using non-intrusive, social network data linked with high-resolution, geoinformatics data.

1.1. Geography of happiness

Working from a geopsychological and environmental-psychological perspective (Jokela, Bleidorn, Lamb, Gosling, & Rentfrow, 2015; Rentfrow & Jokela, 2016), numerous studies demonstrated the positive effect of ETN on health and well-being (Bowler, Buyung-Ali, Knight, & Pullin, 2010; Capaldi, Dopko, & Zelenski, 2014; Kabisch, Qureshi, & Haase, 2015). The *Attention Restoration Theory* (*ART*; Kaplan, 1995) posits that ETN – being relatively undemanding for attentional resources – renews cognitive capacity to focus attention. Similarly, the *Stress Reduction Theory* (*SRT*; Ulrich et al., 1991) postulates that ETN enhances psychophysiological stress recovery, resulting in reduced blood pressure and lower levels of stress hormones. Consistent with both theories, experimental research provides compelling evidence for the beneficial effect of ETN on cognition (Berman, Jonides, & Kaplan, 2008), improved memory, directed attention abilities, and task performance (Bratman, Hamilton, & Daily, 2012), adaptation to stress (Thompson et al., 2012), reduction of depressive symptoms (Berman et al., 2012), and improved general life satisfaction and well-being (Marselle, Irvine, Lorenzo-Arribas, & Warber, 2016).

* Corresponding author. Dept. of Geography and Environmental Development, Dept. of Psychology (Adjunct Prof.), Ben-Gurion University of the Negev, Building 72 Room 229, Beer-Sheva, Israel.
E-mail address: tsvoray@bgu.ac.il (T. Svoray).
URL: https://tsvoray.wixsite.com/mysite (T. Svoray).

https://doi.org/10.1016/j.jenvp.2018.07.006
Received 18 December 2017; Received in revised form 24 July 2018; Accepted 24 July 2018
Available online 26 July 2018
0272-4944/

Several studies have targeted the effect of ETN on happiness (e.g., Berman et al., 2012; Capaldi et al., 2014; Herzog & Strevey, 2008; Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009). While these studies indicate that ETN is indeed associated with happiness, they also reveal some variability among studies in terms of definition of ETN, e.g., subjective "nature connectedness" (Howell, Dopko, Passmore, & Buro, 2011) and "love of nature" (Perkins, 2010) vs. physical proximity to *various* natural sites (Wheeler, White, Stahl-Timmins, & Depledge, 2012).

Our focus herein is on the study of spatial distribution of HFEs. In general, HFEs are considered an evolutionary-based, principal way of conveying mental states and of communicating with others (Adolphs, 2003; Van't Wout & Sanfey, 2008). In an interpersonal context, emotional facial expressions appear to signal to individuals how other people feel and, consequently, how they might behave, thereby "gluing" interpersonal exchanges (Adolphs, 2003; Haxby, Hoffman, & Gobbini, 2002). HFEs, in particular, reflect individuals' sense of elevated self-worth and self-efficacy (Tanzer, Avidan, & Shahar, 2013). Deficits in identifying HFEs have been documented in various psychopatholgies (Yiend, 2010).

1.2. Components of nature

We explored here three components of ETN that may elicit HFEs: green vegetation, proximity to water bodies, and undeveloped areas. The presence of green vegetation in urban areas and its surroundings is associated with improved mental and physical health (Jiang, Li, Larsen, & Sullivan, 2016; White et al., 2013), and with reduced disease-related human mortality (Maas et al., 2009). Similarly, environments containing water bodies constitute attractive landscape features for human activities, thereby increasing positive affect (White et al., 2010). Lower building density means higher availability of open areas – which appear to be restorative (Akpinar, Barbosa-Leiker, & Brooks, 2016).

1.3. Temporal factors

Different diurnal segments may be associated with differential emotional responses. Studies of diurnal and seasonal mood variance with work, sleep, and day length across diverse cultures have shown that positive affect has two peaks: relatively early in the morning and near midnight (Golder & Macy, 2011; but see; English & Carstensen, 2014). It also makes sense that weekends will encourage more happy faces than workdays, nighttime more than daytime, and warm months more than cold months, particularly during the North-East American winter. We also surmised that temporal determinants might moderate the link between ETN and well-being, such that the beneficial effect of ETN will be particularly pronounced during nighttime, weekends, and warm months.

1.4. Use of computer vision and geoinformatics techniques

Extant psychological research examines the links between ETN and well-being via self-report measures. Despite their frequent use in psychological science, these measures suffer from several disadvantages, including (Paulhus & Vazire, 2007): (1) a response set that distorts subjective experience due to social desirability, acquiescent responding, extreme responding, and other manifestations; (2) recollection biases; (3) constraints on self-knowledge; and (4) cultural biases in respondents' interpretation of items. These and other problems have inspired calls to increase the use of alternative measures, particularly behavioral ones (Baumeister, Vohs, & Funder, 2007).

A promising alternative methodological avenue is the use of location-based social network (LBSN) data analyzed by Computer Vision (CV) methods, juxtaposed against satellite data and spatial databases available from governmental or public sources. CV enables analyzing of digital images (Pulli, Baksheev, Kornyakov, & Eruhimov, 2012), such as emotional facial expressions (Kanade, Cohn, & Tian, 2000; Pantic, Valstar, Rademaker, & Maat, 2005). Specifically, CV modules allow for the automatic detection of face locations within an image and for the estimation of their most likely emotional expression (Sinha, Balas, Ostrovsky, & Russell, 2006), based on spatial arrangement of key facial feature points (Valstar, Mehu, Jiang, Pantic, & Scherer, 2012). Analyzing LBSN data using geoinformatics tools can allow exact identification and quantification of the physical environment where the individuals stay at the time of expressing their emotions, and provide us with powerful tools to analyze and map hedonic areas and the effect of ETN on HFE using hard evidence rather than self-reports.

1.5. Aim and objectives

Using the above methodologies, we tested the enhancing effect of ETN on HFE. ETN was assessed as a composite score, based on a combination of greenness, water bodies, and built area density, and its association with the probability of HFEs was examined. We also examined the interaction between ETN and temporal effects and the unique contribution of each of the components to the prediction of positive affect, either as a main-effect or by interacting with temporal determinants. Finally, we identified and mapped hedonic hot spots characterized by anomalously high or low concentrations of "happy" images.

2. Methods

2.1. Design

To facilitate clarity of presentation, we present a flowchart describing the study (Fig. 1). All photos for the research period (see below) were collected from Flickr API and filtered to include only the geo-tagged ones. Geotagged photos including human faces were used to identify facial expressions with Microsoft Emotion API. Subsequently, to be able to test the interaction of the different environmental components (greenness, distance from water bodies, and development) with temporal characteristics, we developed an index of ETN based on cutoff points of the three variables' values, as well as a classification of phase on three temporal cycles (daily, weekly, and annual). Additionally, we evaluated the effect of each ETN component on its own through fitting separate models. Finally, once the statistical relationships were established, we mapped hedonic areas in the Greater Boston Area (GBA) using hot spot analysis.

2.2. Data

Flickr data for the GBA were downloaded, focusing on the years 2012–2015. GBA was selected, as Flickr usage is particularly high in urban areas in the USA, and particularly in the GBA, which is one of the major educational and information technology (IT) hubs in the USA. This assures us that we have a large sample size for estimating spatial variation in HFEs. Geoinformatics, including GIS (Geographical Information System – software used for creating, storing, editing, analyzing, and visualizing spatial or geospatial data; Bolstad, 2016) and remote sensing data, were used to produce land-use maps. All 1,018,023 public Flickr images taken within the GBA over the duration of four years (2012–2015) were downloaded, along with their metadata, using the Flickr API (https://www.flickr.com/services/api/). Only images associated with the highest accuracy geo-tag ("street-level") were retained, resulting in a sample size of 525,405 images (Fig. S1).

Urban development land cover class was determined based on the National Land Cover Database (NLCD) for 2011 (Homer et al., 2015). The NLCD consists of a 16-class land cover classification scheme applied consistently across the United States at a spatial resolution of 30 m, based on Landsat satellite images.