



Using AI to Extract Biophilic Design Elements and Predict Health Benefits and Tradition Environmental Qi

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ABSTRACT

People release stress in urban environments by experiencing green areas, such as parks, grasslands, and areas with trees and hedges. For over 30 years, increasing studies have depicted the psychological and physiological health benefits of experiencing nature. However, recently, people have been staying in concrete environments without green spaces in their daily lives, especially during the COVID-19 pandemic, not only causing social isolation but also contributing to health problems. Biophilic attributes in built environments might improve people's connection to nature and provide health benefits and influence landscape design applications. To confirm this, the present study took photos in urban green spaces and imported them into Google Vision AI to label their biophilic attributes and to predict the tradition environmental Qi in the space. The study found that natural labels, such as "tree, plant, grass, and park" significantly influenced people's preference for a space, its tradition environmental qi, and people's experiences of recovery and reflection. However, urban labels, such as "building, architecture, city, and house" were significantly negatively related to the same psychological outcomes. Using AI to define biophilic labels could optimize the psychological benefits of designed spaces and provide a new view for related landscape design work.

Keywords: *Biophilic Elements, Tradition Environmental Qi, Google Vision AI, Environmental Information Labels, Urban Green Space*

INTRODUCTION

Human health is influenced by the environment in which people live, which is an important issue for work and living spaces, especially now, during the COVID-19 pandemic, when people are staying at home more than usual. Connecting to nature could have a great impact on such people. Many studies have shown that connecting with the natural environment is important for body-mind-spirit health benefits. Environmental psychology has shown that interventions involving direct and indirect connection to nature often support health outcomes by restoring attention, increasing positive emotions, reducing stress, and decreasing blood pressure, as well as having numerous physical benefits (Hartig, Mang, & Evans, 1991; Kaplan & Kaplan, 1989; Ulrich, 1981). Compared to urban

environments, nature is more restorative on a physiological and psychological level (Cox et al., 2017; Keniger, Gaston, Irvine, & Fuller, 2013). Nature can facilitate positive emotional experiences and increase voluntary sustained attention, especially for people who are fatigued (Berto, 2005; Korpela, Ylén, Tyrväinen, & Silvennoinen, 2010). Decades of study discuss the “nature and health” were related to Attention Restoration Theory and Stress Reduction Theory, however, the biophilic design and Qi field could influence our health. Therefore, in this article, we used the concept of Environmental Psychology and biophilic design from the Western and the Qi field in the Eastern—the vague substances in the environment that interact with one's mind, body, and spirit—to predict health benefits.

Attention restoration theory asserts that people can release mental fatigue and concentrate better after spending time in nature or even after looking at scenes of nature (Kaplan & Kaplan, 1989; Kaplan, 1995). An environment that aids the recovery of one's voluntary attention, called a restorative environment, has the following four characteristics: (1) *being away*, which allows people to escape from daily life physically or psychologically; (2) *fascination*, which effortlessly attracts people's attention; (3) *extent*, which means that the environment is rich and coherent enough to constitute a whole other world; and (4) *compatibility*, which means that the environment supports people who belong in the space. Moreover, Kaplan & Kaplan (1989) proposed that restorative environmental features not only restore voluntary attention but also provide a deeper experience, including recovery and reflection. One study asked people to develop their ability to concentrate and think about their life goals while viewing urban landscapes, sports games, and natural landscapes. Results showed that natural landscapes provided *recovery* and *reflection* experiences (Herzog, Black, Fountaine, & Knotts, 1997). Staats et al. (2003) argued that compared with urban landscapes (cities, streets, urban parks, and so on), natural landscapes (forests, paths, a lack of other people, and so on) provide greater experiences of recovery and reflection, which were related to people's preferences. In other words, people may prefer environments that help them recover their attention and to engage in reflection.

Wilson (1984) stated that humans have a deep affiliation with nature called *biophilia*. The biophilia hypothesis aims to explain why people prefer to engage in natural rather than built environments, why people seek to connect to nature in interior environments, and why people like to perform outdoor activities in places with pleasant views. Tang, Sullivan, and Chang's (2015) study showed that an individual's deep connection with nature (for example, rural forest settings) may predict a sense of safety, legibility, mystery, and attentional restoration, and this may enhance one's perceptual experiences of natural landscapes. Biophilic designs could emerge in everyday life, such as on campuses, in the community, or in individual working or living spaces, which may directly or indirectly influence human psychological and physiological health (Kellert, Heerwagen, & Mador, 2008). Kellert et al. (2008) mentioned that biophilic design is composed of two major aspects. First, there is an organic or naturalistic dimension, including direct or indirect contact with a natural environment in person or via photos. Second, there is a place-based or vernacular dimension defined as buildings and landscapes that connect to the culture and ecology of a locality or geographic area. In other words, it is said that people exist in a holistic environment and have a sense of place attachment.

These two major aspects can be related to six biophilic design aspects. Environments may also be composed of various aspects, which are as follows. *Environmental features* include water, plants, views and vistas, façade greening, geology, landscape, and so on. *Natural shapes and forms* may refer to botanical motifs, shapes resisting straight lines and right angles, biomorphy, geomorphology, and so on. *Natural patterns and processes* may refer to sensory variability, information richness, patterned wholes, transitional spaces, and so on. *Light and space* refers to natural light, light and shadow, spatial

variability, spatial harmony, and so on. *Place-based relationship* refers to a geographic connection to a place, landscape orientation, landscape ecology, spirit of place, and so on. Finally, the *Evolved human-nature relationship* aspects refer to prospect and refuge, order and complexity, attraction and beauty, curiosity and enticement, and so on. Overall, there are more than 70 biophilic design attributes present in built environments. Through the description in biophilic design, it could lead a chance to approach landscape and urban design to link humans and nature, which are related to *Goal 3: Good Health with Wellbeing*, *Goal 11: Sustainable Cities and Communities*, and *Goal 15: Life on the Land*.

Central holistic concepts in Chinese history, such as Daoism, Confucianism, and Feng Shui theories, believe that humanity and the environment are integrated and that the harmonious relationship between people and the environment is important and affects the health of our body, mind, and spirit. Tradition environmental qi (TEQ) is a vague substance present around geographical features, but it is difficult to measure. Water, grass, and trees are important biophilic elements that produce restorative experiences, which people prefer. The TEQ questionnaire uses people as a sensor to feel the Qi field in an environment and capture holistic environmental aspects during people-environment interactions, which include seven healthy landscape dimensions as follows: (1) landscape structure, (2) vegetation characteristics, (3) landscape visual quality, (4) brightness, (5) microclimate, (6) disturbances, and (7) healthy feelings (Chou, Hung, & Chang, 2020). Landscape structure is related to the composition and configuration of the coordination, integrity, and appropriateness of a space. Vegetation characteristics refer to the pattern of planting and the color, cleanliness, and tidiness of a landscape. Landscape visual quality is the view from a space. Brightness describes the level of light in a space. Air flow, air quality, wind, and temperature are related to the microclimate. Uncomfortable feelings, such as noise, could create disturbances, which affect a space's TEQ. Healthy feelings include a sense of inner thought, refreshment of the body, a felt sense of physical comfort, an ability to breathing smoothly, and a sense of psychological relaxation. Mind-body exercises, such as qigong, can help people experience TEQ dimensions through experiencing Qi in an outdoor environment.

A broad natural environment includes plenty of elements that might influence health. One study has shown that there are no significant differences between parkland, tended woodland, and wild woods in terms of the effect of greening and trees on mood and restorative experience, though this effect was significant compare to urban streets and those greenings. (Van den Berg et al., 2014). The Western view in environmental psychology suggests that a restorative environment restores attention and that people prefer natural environments to those that are urban. Most of the 72 biophilic design attributes that may influence people's health include water, plants, color, air, landscape ecology, sunlight, natural materials, façade greening, geology and landscape, and so on. The layout of the environment, including the type, composition, and configuration of these attributes may affect attention restoration, emotions, preferences, cognition, stress, and so on (Gillis & Gatersleben, 2015). Moreover, Velarde, Fry, and Tveit (2007) suggested that it is important to identify the key elements in landscapes that provide the most health benefits.

However, most research uses the main visual scope of a landscape to classify it into landscape type and to categorize elements. In this study, we asked whether various elements in an environment could be labeled by AI as the elements of biophilic design for predicting human perception of TEQ and psychological outcomes. While there could be a strong assumption of a link between landscape elements and psychological experience, little empirical evidence has been found that has established a direct relationship between these variables. Researchers have asked whether and to what extent the sense of connection with nature provided by the biophilic design and the healthy quality of the environment (Qi field) in urban green spaces could influence health benefits. The scope of this study is to answer the urban green space that could contribute to human health through AI. By doing so, we used image recognition in Google Vision AI to understand selected elements in an urban green space (1) to determine the relationship between biophilic elements and TEQ and (2) to predict the health experiences, such as preference, recovery, and reflection provides in urban green space. In so doing it seeks to our growing understanding of how and to what extent the updated technology—AI machine learning—predicts the human perception of psychological outcomes in urban green space. Besides,

the results of this study could have a considerable impact on relevant SDGs goals, especially the application of greenery the nearby nature for the human being.

METHOD

The study was designed to answer the following research question: “What biophilic attributes that arise from AI can predict psychological outcomes?” We investigated the question using Google Vision AI and questionnaires that measured the environment’s TEQ as well as people’s experiences related to health benefits—preference, recovery, and reflection. The dependent variable was the questionnaire score. Participants who volunteered to take part in the study were mind-body practitioners, such as those who practiced Qigong. Such participants were chosen because they were considered to be sensitive to the felt sense of Qi, as feeling environmental Qi is an element of practicing Qigong. We then asked those participants practicing Qigong on-site in the selected practicing sites in urban green spaces. After practicing, the participants answered the following questionnaires related to environmental psychology and TEQ. The independent variable is the photos taken at the selected practice site, and these photos are used as representative of the biophilic attributes, selected by Google Vision AI to predict these health benefits.

Google Vision AI is a product that detects the information in an image, such as facial expression, landmarks, locations, logos, image colors, image content, objects, similar images on the web, and so on. The study used images of the National Taiwan University campus as the urban green space from which image content was detected. This generated different outcome labels, which represented biophilic attributes. Figures 1–3 have shown these outcome labels.

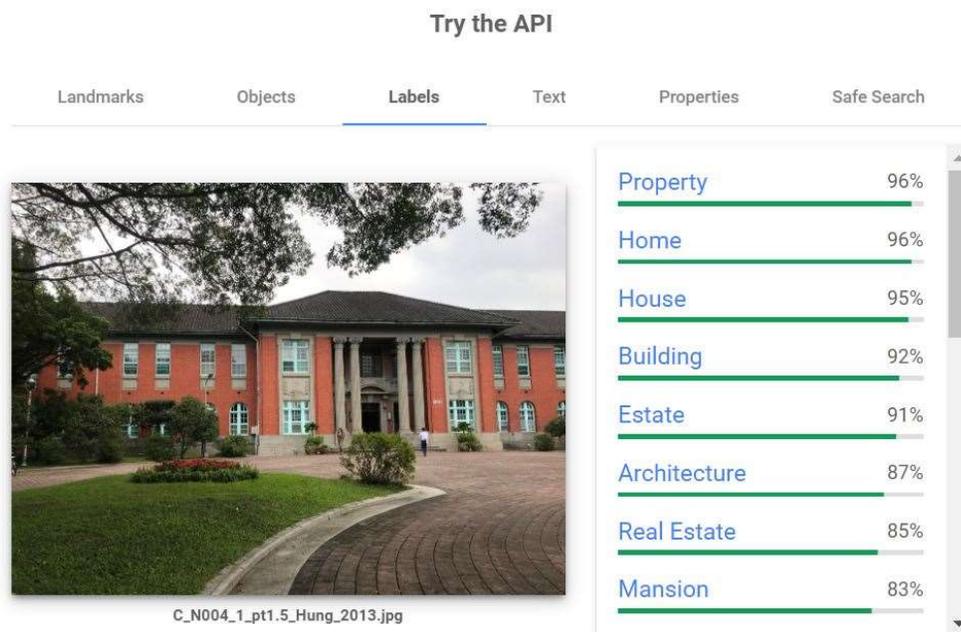


Figure 1 Using Google Vision AI, the study extracted labels from images of built environments in the urban green space that were used as independent variables. (Retrieved from <https://cloud.google.com/vision>).

RESULTS AND DISCUSSION

Over 200 labels were reported by Google Vision AI. More than 30 values in each label were selected to do factor analysis. The study used principal components analysis (PCA) to categorize labels into three groups: “Building” included the labels of “building, architecture, city, and house,” “Nature” included the labels of “tree, plant, grass, park,” and “Landscape” included the labels of “landscape and garden.” Results showed a negative relationship between “Building” and the outcomes of preference and recovery. The relationships between “Nature,” TEQ, preference, recovery, and reflection, while significant, were moderate in strength and in line with previous research. Additionally, “Nature” significantly predicted and had a positive relationship with TEQ, preference, recovery, and reflection, while “Building” significantly predicted and had a negative relationship with reflection, see Table 1.

Groups of Labels	Health benefits			
	TEQ	Preference	Recovery	Reflection
Building	-	There is a negative relationship between Building and Preference.	The Building negative influence Recovery.	There is a negative relationship between Building and Reflection.
Nature	There is a positive relationship between Nature and TEQ. Nature positive influence TEQ	There is a positive relationship between Nature and Preference. Nature positively influences Preference.	There is a positive relationship between Nature and Recovery. Nature positively influences Recovery.	There is a positive relationship between Nature and Reflection.
Landscape	-	-	-	-

Table1: The correlation diagram summarizes the results of labels and health benefits

A possible explanation for the results could arise from the prospect and refuge theory, savannah hypothesis, attention restoration theory, and the concept of biophilic attributes, which all explain how landscape traits, such as trees, grass, openness, and restorative elements can fulfill people’s needs and recover from mental fatigue. Our results could be explained from an ecological perspective, which shows that large, continuous, open spaces, such as woodlands, grassland, and waterscapes could provide restoration and safety, generate preference, and decrease heart rate and that large areas of buildings limit healthy outcomes (Chou, Lee, & Chang, 2016). Our results were similar to previous research showing that natural landscape types, such as streams, trees, pathways in forests, mountains, and so on improve mood, reduce stress, provide a restorative effect, and generate higher levels of preference compared to cityscapes, such as buildings, streets, residential areas, urban parks, and so on (Hartig, Evans, Jamner, Davis, & Gärling, 2003; Laumann, Gärling, & Stormark, 2003; Staats, Kieviet, & Hartig, 2003; Van den Berg, Jorgensen, & Wilson, 2014; Van den Berg, Koole, & Van der Wulp, 2003). In the book *Breathing Spaces: Qigong, Psychiatry, and Healing in China*, Chen (2003) mentioned that qigong practitioners preferred to practice breathing in grassland and treescapes. It is said that the more people perceive a landscape as natural, the more they prefer the environment, and the more they experience recovery and reflection (Staats et al., 2003).

CONCLUSION

This research has taken advantage of advances in science and technology and the rapid development of AI machine learning to use an AI image recognition system to classify landscape-related label content and predict the impact of aspects of an outdoor environment on people's psychological state. What had done in this study is (1) use AI to analyze landscape elements that representing biophilic attributes in the selected on-site Qi practicing places, and (2) to predict TEQ and related health benefits through the AI biophilic labels. The percentage on each label in Google Vision AI is the reliability that represents each element; in other words, those could have labeled through human perception and then automatically trained the system. By using AI could be more powerful than asking participants "what are the biophilic elements" and "how much could you perceived" in urban green space.

The urban green space was selected in this study represented a park-like setting with large amounts of grass, trees, plants, openness, lightness, buildings, and a few waterscapes from which labels that represented biophilic attributes were selected. Findings showed that an environment containing nature-related labels improved psychological outcomes more than those containing urban-related labels. Moreover, the groups of labels in "Nature" could positive predict human's perception in TEQ, preference, and recovery. Nature labels, including trees, plants, grass, and park are likely to explain a significant amount of the variance in predicting psychological outcomes, while buildings were likely to create disturbance to the recovery and reflection experience. People prefer to experience or do exercise in nature than in a built environment, which may be explained by the felt sense of TEQ. Besides, nature and natural environments provide more elements that provide a sense of fascination, which benefit people's health. These findings were in line with previous studies (Barton & Pretty, 2010; Hung et al., 2019; Korpela et al., 2010), although a few previous studies used an unknown type of machine learning to predict people's psychological state, especially none of the studies predict the concept of TEQ in urban green space.

In this era of COVID-19, the experimental model that explores close contact between humans and the environment has been greatly affected. Since the study relied on AI that detected the labels to represent the biophilic elements, the selected photos of the on-site practicing places could be important to generalize the results. It could be a limitation to the study. However, the results provide a new way to think about the relationship between people and the environment, which may have implications for landscape designers and policy implication. For example, the findings suggest that inputting designs into Google Vision AI could provide a percentage representing the amount of nature in an environment, which could be modulated to provide maximum benefits for users' physical and psychological health. On the other hand, we could use this approach to analyze the landscape resource assessment and aesthetic for the actuality environment that replaces the Post-occupancy evaluation. By doing so, the method could be a useful tool to evaluate the amount of "nature-related labels" from the environment and give a perception of "what positive/ negative elements are in the environment that might influence on human health", especially as the basis for environmental policy decisions. Future research is required, but this article has highlighted an exciting use of AI to predict people's psychological outcomes in response to urban green space.

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