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Mapping environmental properties through image processing for an environmental perception study

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Abstract:

Characteristics of the environment affects our psychological and general well-being (Kaplan and Kaplan 2011, Jiang et al. 2014, Fong et al. 2018). Natural elements in the environment, for example, promote stress reduction and lower the risk of stress-related diseases (Ulrich et al. 1991, Kobayashi et al. 2017, Hunter et al. 2019). Nature therapy, green prescriptions, and green infrastructure design have been applied widely to promote health in sustainable urban communities (Kotera et al. 2020, Russo and Holzer 2021, Nguyen et al. 2023). The mechanisms of environment's psychological impacts on humans have been long studied (Ulrich 1983, Kaplan 1996, Kuo 2015, Markevych et al. 2017, Van den Berg et al. 2019), but many questions remain unanswered. For example, not enough is known about the roles that specific characteristics of the environment play in promoting health benefits and how such relationships are moderated by factors such as sociocultural backgrounds, individuals' dispositions, and ways of relating to emotional experiences. We conducted two experiments to investigate the objective characteristics of environmental settings and subjective perceptions of such settings among individuals with different identities and stances toward their emotional experiences. The first experiment used Google Street View (GSV) images to represent environments people encounter in urbanized communities in New Jersey, USA. The images were used for immersive visualization by participants who then answered questions about their perceptions of the environment and related psychological status. The GSV images were analysed through semantic image segmentation (Liu et al. 2019) to derive quantitative measures of the environmental characteristics such as environmental complexity, green index, etc. The second experiment used a geo-enabled survey tool, the ArcGIS Survey123, to collect data on people's perceptions of their surrounding environment. The collected data points were mapped on an aerial imagery. The imagery was classified and similar environmental properties as in the first experiment, environmental complexity, green index, etc., were calculated.

We recognize three different types (layers) of environmental attributes in our environmental perception study. The first is the original holistic environment that contains various environmental stimuli. The second consists of a set of visual environmental attributes derived from the aerial and eye-level images. The third is about the subjective environmental properties perceived by humans such as environmental complexity, existence and dominance of certain environmental stimuli. In other words, this is the interpretation of the objective environmental attributes, which can be subjective and selective. It is based on these interpreted environmental attributes that humans develop psychological and behavioural responses such as emotion, attitude, behaviour, etc. Previous research has examined quantitative relationships between the derived environmental attributes (type 2) with psychological measures (Barton and Pretty 2010, Van den Berg et al. 2014, Larkin and Hystad 2018). Our data collection instruments allowed for the collection of interpreted environmental attributes (type 3). We are thus able to investigate how the environmental attributes derived from data sources such as aerial or eye-level images represent or correlate with the subjective interpreted environmental attributes.

It has been noted that gender and sociocultural factors affect environmental perception and the relationships between environmental attributes and people's psychological responses (Jiang et al. 2014, Kobayashi et al. 2017, Larkin and Hystad 2018). Our study also examines if such effect exists during the interpretation stage, that is whether gender, sociocultural backgrounds, and individuals' dispositions make a difference in the correlation between the derived (type

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2) and the interpreted environmental attributes (type 3). Our hypothesis is that different people can have distinct interpretations of the same environment. Selectivity should be observed among individual participants as vision is already a selective process and in addition each perceiver perceives reality based on their own interests and preferences. With data collected in our two experiments, we report preliminary results on the correlation between environmental attributes derived from available data sources (i.e. aerial and eye-level imageries) and people's interpreted environmental attributes and how such correlation may vary among individuals with factors such as gender and sociocultural backgrounds.

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