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Design intensities in relation to visual aesthetic preference

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ABSTRACT

Design intensity is defined as the amount of the original landscape changed and the degree of artificiality of added elements to the landscape by design. In spite of the significance for landscape design, it has been neglected for a long time by academic research. How does a designer choose an appropriate level of design intensity for a specific landscape to satisfy the users' aesthetic preference? The answer is still unknown and important to research. This study explored the effects of three levels (low, moderate and high) of design intensity on visual aesthetic quality of two landscape types: natural and restored, using visual images as stimuli. The results indicated that, compared to the low or high level of design intensity, the moderate level not only led to a higher landscape quality, but also had a better marginal effect on promoting aesthetic preference. However the marginal effect was dependent on the landscape types: for the natural landscape, low design intensity had the highest marginal effect, with the original pictures' quality having a non-significantly negative association to design intensity's influence on visual aesthetic quality. The Intermediate Disturbance Hypothesis which suggests a moderate level of disturbance leading to maximized biodiversity is used to explain the results. In design practice high design intensity should be abandoned.

1. Introduction

In the last few decades, the importance of visual aesthetic quality (VAQ) has been widely recognized for maintaining human mental health (Velarde et al., 2007; Kurdoglu and Kurdoglu, 2010), protecting cultural heritage (Jessel, 2006), promoting recreational activities such as fishing and hunting (Rolloff, 1998), attracting tourists in many regions (Lothian, 1999) and evoking strong emotions and inferences about social status and friendliness (Nasar, 1990). Furthermore, VAQ is also linked with the ecological quality (Zhao et al., 2017a). Therefore, VAQ is considered as an important natural resource similar to water, soil, mines and fossil fuels (Kane, 1981). Some experts even suggest that protection and improvement of VAQ are the central issue for sustainable development (Wang et al., 2016) because ecological project proposals in a city may fail due to lack of the public's support (Junker and Buchecker, 2008). As a result, many scholars have devoted their talents to such research and devoted their efforts to determining the role of design in improving VAQ (e.g., Arriaza et al., 2004; Bulut and Yilmaz, 2008; Chen et al., 2016; Hauru et al., 2014; Molnarova et al., 2012; Yao et al., 2012; Zhao et al., 2013; Wang et al., 2016).

Natural environments are usually evaluated with a high rate of aesthetic quality over built environments (van den Berg et al., 2003; Kaplan et al., 1972; Ulrich, 1993), and even, built settings with natural elements are more preferred than settings without natural elements (Herzog, 1989; Sheets and Manzer, 1991). The naturalness of landscape has proven to be a strong factor in the landscape preference of people (Kaplan and Kaplan, 1989; Purcell and Lamb, 1984, 1998; Ode et al., 2009; Hull et al., 2001), and the significance has also been demonstrated across a number of regions and cultures (Balling and Falk, 1982). However, some researchers suggest that some kinds of nature would make people feel fear, for instance, the dense dark forest may appear to be a hiding place for potential attackers Burgess (1995), and Zhao et al. (2013) conclude that when the ratio of natural elements is more than 70% in sight, natural elements have a very weak influence on landscape preference. On the other hand, Nassauer (1995) indicates that neatness is a significant predictor of landscape preference because it implies care or stewardship. These contradictory findings can confuse landscape architects: when they work with a natural landscape how should they proceed? Options may include doing nothing to let nature adapt and change without human intervention, doing something to build the connection between nature and human activity, or creating a groomed, highly maintained, artificial landscape. Existing literature fails to provide reliable evidence for the decision maker. In this paper, we propose a new concept: design intensity which is defined as the

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amount of the original landscape changed and the degree of artificiality of added elements to the landscape by design.

The paper explores the effects of three design intensities (low, moderate and high) on the aesthetic quality of two landscape types: natural and restored. In this paper, the natural landscape is defined as an environment developing freely without human interference or traces thereof, and the restored landscape as a heavily disturbed or destroyed environment that goes through a natural succession and recovers to an early or moderate stage of the local ecosystem. We expect to answer the question: which level of design intensity is better as a means to improve people's aesthetic preference? The possibility of relating individuals' landscape preferences to design intensity allows planners and decision-makers to incorporate public perception explicitly into the policy-making process in a more proactive and innovative way.

2. Materials and methods

2.1. Photographic images

Photographic images were used as surrogates for real landscapes. This method has been widely used by previous researchers (e.g., Arriaza et al., 2004; Zhao et al., 2013, 2016; Wang et al., 2016), and its reliability has been demonstrated (Kaplan and Kaplan, 1989; Nassauer, 1983; Palmer and Hoffman, 2001). Eight photographs were collected, which included four restored landscapes and four natural landscapes. All photographs were taken in landscape format in similar light conditions (on clear or mostly clear days) by the second author at eye level (about 162 cm above the ground) in the summer 2016. These photographs are selected to represent the scenes which a visitor experiences in situ. Based on these pictures, three gradients of deign intensity (low, moderate and high) were applied for each picture using the photomontage simulation. The photomontage method allows the researcher to create different images by adding, deleting and composing elements to form a well-integrated image (Waldheim et al., 2014). Thirty-two images were created in total. The low level of design intensity focused on adding a path to the picture for accessibility with some elements slightly changed to fit the path; the moderate level, based on the image with low design intensity, added a few ornamental plants and man-made facilities; and the high level added more ornamental plants and paved areas to the moderate level images. Fig. 1 shows the examples of four scenes with three gradients of design intensity and the original photographs.

2.2. Aesthetic preference assessment

2.2.1. Participants

Internet surveys were used to collect the data. This method, comparatively, is useful in reducing the higher costs of on-site surveys and often reduces the difficulties in participant accessibility. The reliability of an internet survey has been evidenced by previous researchers (Roth, 2006). To avoid the respondents' perception of the images being manipulated by photomontage, the 32 images were divided into four groups: original, low level of design, moderate level and high level, with each group including eight images. Each group was evaluated by different respondents. Online surveys included four questionnaires conducted by four postgraduates, respectively, using the snowball sampling method to invite respondents to participate. To avoid one respondent evaluating two questionnaires or more, the four postgraduate students were told not to invite the respondents in their common circle of friends. 893 personal evaluations were received: 183 for the original pictures, 249 for the images with low design intensity, 221 for moderate design intensity, and 240 for high design intensity.

2.2.2. Procedure

The online survey was conducted from October to November 2017. When the participants opened the web page, found a title "Imagine you were in the scenery representing by the picture, please choose the degree of beauty based on your perception." The aesthetic preference was assessed using a seven-point Likert-type scale ranging from "1 = not at all" to "7 = very beautiful". Before the submission, the participants could change their rating for any images freely. It took an average of one and a half minutes to complete the questionnaire.

2.3. Data analysis

Statistical analysis was carried out with SPSS 17.0 software. The interclass reliability of preference scores was tested first. Then the one-way ANOVA and correlation analysis were employed to analyze the data for researching the design intensity's effect on the aesthetic preference of respondents and further exploring the influence of the aesthetic quality of the original photograph and the landscape type on design intensity's effect. The preference score of each image was determined by the average score of all participants' judgment.

3. Results

3.1. Reliability

The interclass reliability of the preference scores of four surveys was calculated, respectively. Cronbach's Alpha for the preference scores of the original pictures was 0.916; for the images with low level of design 0.882; for the images with moderate design intensity 0.893; for the images with high design intensity 0.887. If the Cronbach's Alpha is more than 0.801, it is almost perfect (Landis and Koch, 1977). Thus, the results showed a good internal reliability of the preference scores.

3.2. Comparison of visual aesthetic quality among design intensities

The preference scores of 32 images were shown in Fig. 2. The mean preference score of original pictures, the images with low, moderate and high level of design were 4.57, 4.80, 5.13, 4.90, respectively, on a seven-point scale. All images with moderate level of design possess higher preference scores than their three counterparts except for the natural landscape 3. It is very clear that the images with a moderate level of design were much more preferred by the respondents. The one-way ANOVA showed that there was a significant difference in preference scores among four design intensities ($df = 3$, $F = 3.435$, $p = 0.030$) (the original pictures were treated as zero design intensity), but all the pairwise comparisons indicated no significant difference except for the original pictures vs. the images with moderate design intensity, which means that moderate level of design is a reliable method to improve the VAQ of a landscape. When the eight scenes were divided into two landscape types, some changes happened. For the natural landscape, the one-way ANOVA suggested no significant difference in preference scores among design intensities ($df = 3$, $F = 0.665$, $p = 0.590$) and no significant difference among all the pairwise comparisons; for the restored landscape, there was a more significant difference among design intensities ($df = 3$, $F = 6.659$, $p = 0.007$) and significant differences of three out of six pairwise comparisons were found. These results seem to indicate that the design intensity's effect on visual quality is linked to landscape type.

3.3. Marginal effects of design intensities on visual aesthetic quality

The marginal effects of the three design intensities on landscape preference of original eight pictures were calculated (Fig. 3). Based on the average values of eight scenes, the marginal effect of moderate deign intensity (0.33) was higher than those of low intensity (0.23) and high intensity (−0.23). These results suggested that moderate design intensity had much more power to improve the landscape quality, but it was dependent on the landscape type. The restored landscape had a similar pattern with the combination of two landscape types (eight

Fig. 1. Samples of original pictures and images with three levels of design intensity for two landscape types, respectively. (top two rows for natural landscapes, bottom two rows for restored landscapes. A, original photograph; B, picture with low design intensity; C, picture with moderate design intensity; D, picture with high design intensity).

scenes in total), but for the natural landscape, low intensity had the most power. In addition, Fig. 3 also showed that the marginal effect of low design intensity was positive and concentrated (SD = 0.113), the marginal effects of moderate design intensity had a much bigger wave (SD = 0.442), and the effects of high design intensity were also concentrated but negatively (SD = 0.165), which implied that aesthetic effect of moderate design intensity was much more dependent on the design quality than low or high design intensity.

3.4. Effects of original picture's beauty on design intensities' effects on visual aesthetic quality

The design intensities' effect on VAQ was defined as the preference score of an image with a level of design intensity minus the preference score of the correspondingly original picture. Correspondingly the correlation analyses indicated that the preference scores of original pictures have a non-significantly negative relation to three design intensities' effect on visual aesthetic quality (Table 1). Concerning landscape type, the natural landscape showed a similar relation with the combination of the natural landscape and the restored landscape. However, for the restored landscape, there was a non-significantly positive relation between the preference scores of original pictures and high design intensities' effect on VAQ. In spite of the non-significant correlation we could tentatively say that the relation between the original picture's aesthetic quality and the design intensities' effect was more or less linked to the landscape type.

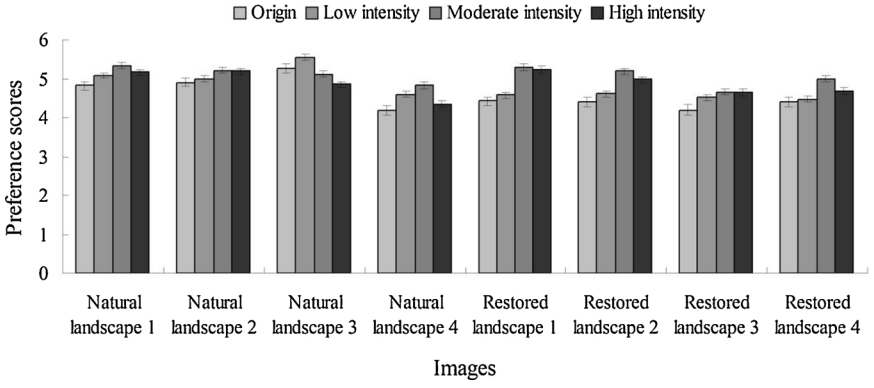

Fig. 2. Mean preference scores (± standard error) within respondents for 32 images.

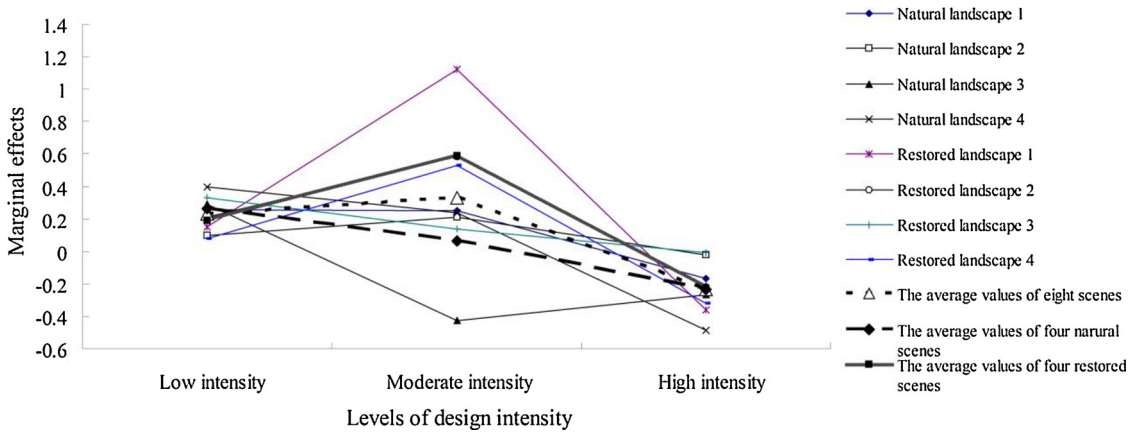

Fig. 3. Marginal effects of three design intensities on landscape preference of eight scenes among three design intensities, and the average values of marginal effects.

Table 1
Correlations of landscape preferences of original picture and design intensities' effects on visual aesthetic quality (Pearson).

		Original picture' preference score		Effect of low design intensity		Effect of moderate design intensity	
		Coefficient	Sig. (2-tailed)	Coefficient	Sig. (2-tailed)	Coefficient	Sig. (2-tailed)
Low design intensity's effect	Combination	−0.323	0.435				
	Natural	−0.529	0.471				
	Restored	−0.838	0.162				
Moderate design intensity's effect	Combination	−0.467	0.243	−0.143	0.736		
	Natural	−0.886	0.114	0.256	0.744		
	Restored	−0.227	0.773	0.700	0.300		
High design intensity's effect	Combination	−0.217	0.606	−0.252	0.548	0.635	0.091
	Natural	−0.525	0.475	−0.302	0.698	0.835	0.165
	Restored	0.330	0.670	0.089	0.911	0.734	0.266

3.5. Landscape type in relation to design intensities' effects on visual aesthetic quality

For the average value of low design intensity's effect on aesthetic quality, the natural landscape was higher than the restored landscape; for the average value of moderate or high design intensity's effect, the restored landscape was higher than the natural landscape (Table 2). However, the one-way ANOVA showed that there was no significant difference between the two landscape types with low or moderate design intensity: $F = 0.737$, $p = 0.423$ (low); $F = 3.475$, $p = 0.112$ (moderate), with a significant difference between the natural and restored landscape with high design intensity ($F = 6.568$, $p = 0.043$). These results implied that high design intensity created less damage to the visual attractiveness of the restored landscape than that of the natural landscape.

4. Discussion

4.1. Design intensity and landscape preference

Human habitat selection is an ancestral trait (Balling and Falk, 1982), and appropriate habitat selection is vital for human survival and development. Habitat selection may be considered an evolutionary module which is still relevant today in determining landscape preference. This study concludes that people prefer moderate design intensity for both natural and restored landscapes. From a landscape ecology perspective, design can be seen as a special disturbance imposed by human activity. According to the Intermediate Disturbance Hypothesis developed by Connell (1978), moderate disturbance will lead to maximized biodiversity. We can postulate that moderate design intensity, just like the intermediate disturbance, will also produce a higher biodiversity which has been demonstrated a promoter for landscape preference of people (Gobster et al., 2007; Quijas et al., 2012; Junge et al., 2015; Lindemann-Matthies et al., 2010; Jiang et al., 2015; Southon et al., 2017). Similarly biodiversity will result in a higher diversity of landscape compositions or complexity, which has also been preferred by people (Chen and Xu, 2016; Rechtman, 2013). Biodiversity is the basis of ecosystem services, which play an important role in regulating climate, water source protection, ensuring the durability of the soil nutrient supply and maintaining normal ecological processes (Zhao et al., 2017b). Habitat theory suggests that human beings prefer an environment which provides rich food, clean water and safety to benefit their survival and reproduction (Appleton, 1975). Thus, people's preference for the environment possessing biodiversity is genetically determined. This characteristic implies that people can find food and survive easily (Adevia and Grahna, 2012). Under the condition of over disturbance or over design such as the high design intensity in this study, the habitat will be homogeneous, in which most plants lose the proper living conditions causing severe damage to community structure and biodiversity. Researchers have also criticized the performance of over designing: "Designers excessively emphasize the artificial factors in a landscape to pursue formal beauty of a landscape and the so-called cultural connotation. Furthermore, they use man-made elements to stress the novelty of experience for space" (Bao, 2006).

The landscape preference of human beings is not only genetically

Table 2
The average value of three design intensities' effects on aesthetic quality of two landscape types.

	Low design intensity's effect	Moderate design intensity's effect	High design intensity's effect
Natural landscape	0.263	0.330	0.093
Restored landscape	0.193	0.785	0.558

determined, but also influenced by cultures (Adevia and Grahna, 2012). In this study, respondents' preference for moderate design intensity is in line with the ideas of traditional Chinese philosophies. Their core concept is "harmony", which stresses on the ideas of "integrating man and nature" and "coexistence of man and nature". These ideas deeply influence Chinese people's thinking. The moderate design intensity is coincidental with these ideas. Thus, this possibly leads to the results of this research only in China. However, the concept of "harmony" is similar to "coherence" which has been evidenced positively to increase the preference of people living in western cultures Nasar (1990), and Kaplan et al. (1975) indicates that humans are predisposed to favor coherence because it has fostered the survival of the species. Harmony means a balance between human and nature, in which the natural environment provides the basic resources for human survival; the artificial elements imply a well-kept environment that may be less potential danger than the wild (Zheng et al., 2011). Therefore, it is proposed that our results can work across a variety of cultures.

4.2. Aesthetic quality of the existing landscape, landscape type and the choice of design intensity

The present study suggests that the design's effect on VAQ is linked to the aesthetic quality of the existing landscape: in general, the higher the preference scores of the existing landscape, the lower the design's effect. These results inspire us to note that it is necessary to assess the aesthetic quality of the original landscape before engaging in design. Armed with information about popular preferences and landscape quality of the site, we will easily identify what affects them, and how they change and develop, which in turn can provide valuable guidelines for designers (Nasar, 1990). If the existing landscape possesses a high preference rate, the work of design will produce a low output-to-input ratio. Thus, designers should focus their work on the landscape with low aesthetic quality to increase the efficiency. However, due to the non-significantly correlation, this issue should be examined by more studies.

The landscape type is another factor influencing the design's effect on VAQ. Undoubtedly, the preference scores of originally natural landscapes were generally higher than those of originally restored landscapes (see Fig. 2). Thus we hypothesize that the landscape type interlocks with the aesthetic quality of the existing landscape to influence design intensities' effect. However, the data collected by this study can not verify the hypothesis, but as it is a very compelling and practical topic, such research is strongly recommended.

4.3. The values of design

For seven of the eight landscape scenes (natural landscape 3 being an exception), the VAQ of original photographs were improved by all design intensities, especially for the photographs with low aesthetic quality (Fig. 2). These results demonstrate that design will promote aesthetic preference. Human beings origins demonstrate that nature provides the basic resources for human survival. But nature also contains some negative factors restricting human development, such as natural disasters, deficient resources, dangerous species and harmful bacteria. Therefore nature is a contradiction of being both friendly and hostile to human. Landscape design, directly or indirectly, promotes human benefit. It focuses on isolating the adverse effects of the nature and strengthening the positive aspects, such as creating a safe place, providing access to a broad range of ecological services, and building a sense of belonging for users. Although some researchers suggest the importance of naturalness for improving the VAQ (Ode et al., 2009; Hull et al., 2001), this can not deny the importance of design which can keep the landscape in a natural appearance while benefiting human well-being. Based on our results, landscape design is indispensable contributing to an increase in human aesthetic experience and landscape value.

4.4. Practical application

The moderate design intensity not only creates the most beautiful scenery, but also produces the highest marginal effect when the eight scenes were treated as a whole (Fig. 3). Although the low intensity has a higher marginal effect for the natural landscape, the marginal effect of moderate intensity is still positive. Thus, comparatively speaking, the moderate design intensity is the best choice for both the natural and restored landscapes aiming to improve the visual quality of a landscape. However, when we select a level of design intensity, it is necessary to consider other factors, such as consumption of natural resources, costs and disturbances on the ecological sustainability of the existing landscape. For the natural landscape, the present paper suggests that although the moderate intensity can further improve the aesthetic quality, it has a lower cost-effective benefit than the low intensity level (Fig. 3). Therefore, for practical design purposes, we should first identify the landscape type, accurately understand the status quo of the site, and then assess the visual aesthetic quality of the site before proceeding to design. Based on these data and considering socio-economic costs, the designers can choose an appropriate level of design intensity and pursue the formal design process.

Compared to the low or moderate design intensity, the high design intensity undoubtedly will result in the use of more natural and social resources. What is possibly worse, according to our research results, it can seriously damage the visual beauty of a landscape. The high design intensity can be seen as over design which always applies more man-made elements to a landscape aiming to gain short-term visual impact at first glance, while ignoring the aesthetic preference of human beings formed over many thousands of years. This preference represents the idea that an ecologically sound landscape is also an attractive landscape and vice versa (Gobster, 1999). Thus, in practical design, the luxurious, noble and convenient human-centered design style should be abandoned (Zhang and Wang, 2010). It is necessary to leave some space for the nature to work, while design is just a subsidiary measure to form the beautiful scenery, especially for the landscape with originally high aesthetic quality.

In practical design, however, most projects have a functional requirement which may drive the level of design intensity from particular vantage points. Following the concept of design intensity built by this study, the functional requirement can be considered as a design intensity which has to be evaluated to determine whether or not it meets the optimal intensity. If the functional design intensity is higher than the optimal level, a balance between the functional requirement and aesthetic quality may be a better choice, in which, if possible, we would cut down the functional requirement to achieve the aesthetic goal.

5. Conclusion

The findings of our study demonstrate for the first time that the moderate level of design intensity is a better way to improve the landscape quality of the natural or restored landscape than low or high level, but for natural landscape, the low level of design intensity is highly cost-effective. Furthermore, in general, the preference scores of the existing landscapes have a non-significantly negative relation to design levels' effects on the VAQ; the high level of design intensity will damage the aesthetic quality of both landscape types. The moderate design intensity is strongly recommended for the practice of landscape architecture. And high design intensity should be abandoned. These results will provide a set of guidelines for landscape designers to create the landscapes to be more beautiful, cost-efficient and livable.

6. Limitations

An important limitation in this study is the lack of quantitative criteria to define moderate design intensity, which is similar to the difficulty of accurately describing and/or quantifying the intermediate

disturbance in Intermediate Disturbance Hypothesis (Sheil and Burslem, 2013). In this study, the definitions of the three levels of design intensities are based on the authors' experience using a progressive approach to create distinct differences among them. However, it is still difficult to precisely define low, moderate or high design intensity, which can weaken the practical application of our results.

Landscape preference research suggests that respondents' variabilities (e.g., gender, age, education level, occupation, and/or living environment) have a considerable influence on aesthetic preference judgment (Howley, 2011; Howley et al., 2012; Lindemann-Matthies et al., 2010; Svobodova et al., 2012; van den Berg and Koole, 2006; Yu, 1995). Therefore, Strumse (1996) emphasizes that demographic group differences in landscape evaluation should not be neglected. However, the demographic components of participants in our study are not identified, which perhaps might weaken the findings and decrease their generalizability. Thus, related research covering a wider demographic range of respondents and exploring demographic variables' influence on the relationship between aesthetic quality and design intensities will be needed in the future.

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