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The Research on the Relation between PSD of Park Green Space and Attention Restoration in Dense Urban Areas

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Abstract

Research shows that stress, a common problem in dense cities, can be relieved in the natural environment. As great significance has been attached to the urban environment and public health in the society, this paper aims to study the relation and interaction between the perceived sensory dimension of urban park green space, attention restoration and state empathy. Therefore, we conducted an on-site questionnaire survey in four typical parks in Chengdu in terms of age, sex, daily stress, frequency of access in parks and other basic information of the respondents. The main part consists of perceived dimension, state empathy and attention restoration. The software SPSS24.0 is applied to the test of the validity and reliability of the PSD Scale, and then the important correlation between the perceived sensory dimensions in the parks and visitors' attention restoration is analyzed through multiple linear regression. Finally, the moderation effect of state empathy is tested by PROCESS. The findings show that (1) only seven dimensions in the PSD Scale are effective; (2) Serene and Refuge in the perceived sensory dimensions have significant effect on the restorative components of attention. (3) Except the dimensions of Rich in Species and Refuge, empathy enhanced the moderation effect in the interaction between the other five dimensions the Perceived Restorative Scale(PRS), especially in the interaction between the dimension Social and PRS. However, this study needs to be further explored to provide scientific basis and design strategy guidance for the research on the restoration potential of urban park green space in high-density urban areas.

Key words: Dense urban area; Park green space; Perceived sensory dimension; Attention restoration; moderator

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1. Introduction

1.1 Needs of Attention Restoration for Residents in Dense Urban Areas

1.1.1 Social Stress Induced by Rapid Urbanization

Cities, carrier of human life, provide for not only better living conditions for the human beings, but also regional economic development. Urbanization has become a worldwide trend, a focus for development of each country. Whatever attitude one holds about urbanization, it exerts an increasingly subtle influence on us. As a greater density is the very symbol of urbanization[1], some scholars stated that high-density is the direction of urbanization, which would change our state of life[10]. From the worldwide perspective, there is an increasing trend of high density in the accelerating process of urbanization[2]. It is expected that in the next decade that urban population will rise sharply in both developed and developing countries, which may respectively account 85 % and 56% of the total population[3]. The development of urbanization has increasingly placed stress on the inhabitants. Studies have found that the psychological stress of the inhabitants is related to their negative feelings caused by crowdedness. The interpersonal proximity leads to more social interaction, a significant factor generating psychological stress. Lack of privacy caused by close distance causes psychological anxieties. The competition between space and social resources can also induce the psychological stress of the inhabitants [4].

1.1.2 The Close Relationship between Stress and Attention Restoration

The Kaplans stated in their study that stress falls into two categories. One is the direct or perceived injury. The other is the lack of resources caused by intuition, chronic exhaustion and the rise of autonomic arousal. The resources include external resources (such as money and social relation), physiological resources (such as physical strength and function) and psychological resources (such as attention and emotion) [5]. It can be seen that stress and attention restoration can be interactive and inter-transformational and attention restoration can be a prevention against stress.

Hence our brain needs restoration to prevent stress[6]. Many scholars have similar discoveries that the natural environment has such feature that it can produce an innate affection from human beings who would positively respond to the combination of such as plants, water, stones and animals. The Attention Restoration Theory (ART) proposed by the Kaplans defines the four components of the restorative environment[7]. Being away(an environment that physically and psychologically detaches an individual from the daily concerns and thoughts); Extent(an immersion in the environment that is rich and coherent enough to constitute another

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world for exploration); Fascination(an environment that can hold one's attention effortlessly); compatibility (an environment matching the personal inclination and purposes). The green environment with these components can bring a gradual four-stage process of cognitive recovery from fatigue. The first stage is a clearing of mind, restoration to a peace of mind. The second stage is the voluntary attention to fatigue recovery. The third stage allows the individual to be gently distracted and engaged in a low-stimulation activity, which reduces the internal noise and provides a quiet internal space to relax. The fourth stage, also the deepest stage, is the reflection on important personal matters, such as priorities, actions or goals.

1.2 Related Concepts of Park Green Space in Dense Urban Areas

1.2.1 Park Green Space

At home and abroad, different scholars and institutions may differ in definition of park green space (PGS). In his process of definition of park green space, Olmsted, architect of New York's Central Park, focuses on its own green and public attributes, and the functions it serves, i.e. the functional public green space except the gray area(mainly referring to those man-made such as buildings, roads, squares, and facilities). Blom, Swedish architect, however, defines PGS as a natural and cultural complex reconstructed on the basis of the existing natural environment. The latter lays stress on its ecological and cultural elements. Taiwan's scholar Lin Lejian defines PGS in his book Landscaping as a green space where the public can enjoy the activities for joy, leisure, relaxation and recreation in order to keep themselves healthy and raise their cultural awareness, where the public can have free access to the its supporting facilities, where the public may find refuge against natural disasters. Recent years, China has issued several standards related to park green space(PGS), which mainly involves: (1) Standard of Basic Terms for Urban Planning (GB/T 50280-98), in which the green space is defined as a designated green space for ecological improvement, environmental protection, recreation of the residents, and function of landscaping. The Standard classifies the green space into five categories: park green space, production green space, protection green space, supporting green space and other green space. Park green space refers to the public green space open to the public for recreation, with certain area, good reasonable greening and service facilities. (2) Standard of Classification of Urban Green Space (CJJ85-2002T) and Standard of Urban Land Classification and Construction Land Planning (GB50137-2011) both define the park green space as the public green space open to public for recreation with the function of ecology, beautification and emergency. This paper takes Standard of Urban Land Classification and Construction Land Planning (GB50137-2011) as the definition for park green space for research and classification.

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1.2.2 Dense Urban Area

Dense urban area generally refers to a limited urban area with high floor-area ratio, high population density, high building coverage, highly concentrated high-rise buildings, and low space openness. It serves the function of a city, complex and compatible, compact and intensive. Academically, there has not been an academic quantitative criterion as to what a dense urban area is. It is generally agreed that it involves both building density and population density. A city or urban area with number of population 15,000 and over p/ km2 and a 2.0 and over floor-area ratio can be regarded as dense urban area [8-9]. It can be seen park green space in dense urban area has the following distinctive characteristics: limited area, varieties of function, high usage, wider openness, compatibility with the surroundings and varieties of users.

1.2.3 Park Green Space in Dense Urban Areas

Based on the two concepts above, parks in dense urban areas have to strike a balance between limited land resources and its functions, integrate the public space and the natural environment to meet the public needs of recreation and health.

Chengdu is a highly developed city in Sichuan Province, China, with a high population density. Till 2017, Chengdu has a population of 6.57 million in 371km² urban area, exceeding the criterion 15000 people/km2, while in the central urban area (about 60km2, within the 2nd Ring Road), the population density has gone far beyond the criterion. As a result of the circle-layer spatial structure during the process of the urbanization, the park green spaces in this area are mainly distributed in spots and belts. Based on what has been mentioned above, the central urban area of Chengdu is an ideal area for research on functions of the park green space in a dense urban area. This study chooses the dense urban area--- central urban area within the 2nd Ring Road as the area for research, where four representative free public parks are selected as the sample plots for experiment, which involves Wangjiang Tower Park, Southern Suburban Park, Huanhuaxi Park and People's Park.

1.3 Moderation Effect of Empathy on Environment Perception and psychology

Perception involves both simple senses and complicated awareness[10]. In practice, senses and awareness are virtually inseparable, for they are in a continuous process, in which awareness reflects the sensory stimuli and convert them into organized experience[11]. Awareness has further processed the information deriving from the senses. If you watch in an autumn park the leaves falling from the trees, it belongs to the sensory information. However, if you feel lonely and melancholy at the sight of the falling leaves, it is the awareness that works. Rudolf Arnheim believes that vision is a mechanical perception of the

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objects, while visual awareness is the perception of the expressivity of the objects, a particular aesthetic awareness[12]. The perception of the landscapes can be regarded as a process in which senses and awareness interweave each other. The experiencers have similar senses about the same object, but they may differ greatly in awareness. Generally, senses fall into the scope of the psychological study while the awareness into the scope of the philosophical study. Merleau-Ponty, based on phenomenology, believes that the continuous movement of one's body in a space integrates the subjective world and the objective world. In this process, awareness associates symbols with meanings, form with content. Hence, the perception of the landscapes derives from both physical and psychological cognition and the awareness of the landscapes synthesizes all the senses and converts them into a complicated and continuous experience of landscape perception.

Of all the perception experience, vision plays a leading role. People rely more on vision than the other senses, for 87% of the external information comes through it[13]. Sensory stimuli, to a great extent, governs one's perception of the environment.

Sobel Believes that empathy is the basis for the study of the perceived behaviors related to environment[14]. Researchers have found that empathy is a neural representation[15] and the ultimate goal of the reactivation of the neural presentation is to help an individual perceive the environment and the connotations and spirit it carries, and produce the similar or the same behaviors and emotions. Preston and de Waal presented their Perception-Action Model (PAM), believing that shared representation is the basis of empathy. When an individual perceives the emotions of others, shared representation will be activated and one will experience the similar emotions of the others[16]. Cognitive empathy is more related to psychological theories.

The brain imaging has shown that psychological theories about empathy mainly involve such brain areas such as sulcus temporalis superior(STS), temporoparietal junction(TPJ), temporal pole(TP) and medial prefrontal cortex(MPFC), which form a neural network that can represent other people and self. Among them, MPFC plays a significant role in the process of understanding the psychology of other people and the cognition of the surrounding environment. Some scholars have demonstrated to the respondents pictures related to psychological theories and empathy. Their findings have shown that MPFC and TPJ are activated in the processing of emotional information and speculation of the psychological inference of other people[17]. Both activation would to a certain extent relieve one's sense of anxiety and fear, and psychological stress[18]. In this process, the brain has been enhanced and drilled through deliberate exercises. The efforts of the subjective will bring the psychological change, i.e. neuroplasticity. By "planting" certain sentiments, and deliberately adjusting one's cognition, perception and behaviors, one can improve his/her related brain areas and psychological state. Empathy at exposure to external environment will generate greater sensitivity of the cerebral activities, which represents an adaptive advantage[18]. It suggests that has certain , not absolute effect

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between empathy and psychology. Other correlations still remains to be researched.

It can be seen that empathy exerts certain moderating effect between environment perception and psychology. The correlations of the three can be established on the basis of moderation analysis in statistics, which can be found the following chapters.

1.4 Research Design

As is shown in Chart 1, by introducing control variables, the paper researches the mechanism of the effect of independent variables and moderator variable on dependent variables [19]. In another word, based on the analysis of existing relevant literature, the research mainly focuses on the effect of perceived sensory dimensions(PSDs) on the attention restoration, and moderation effect of the perceived sensory dimensions on attention restoration. The paper proposes the following hypothesis:

(1) The Perceived Sensory Dimension (PSD) Scale has certain degree of reliability and validity;

(2) Eight perceived dimensions have different effects on components of attention restoration;

(3) The relationship between eight perceived sensory dimensions and attention restoration can be moderated by empathy.

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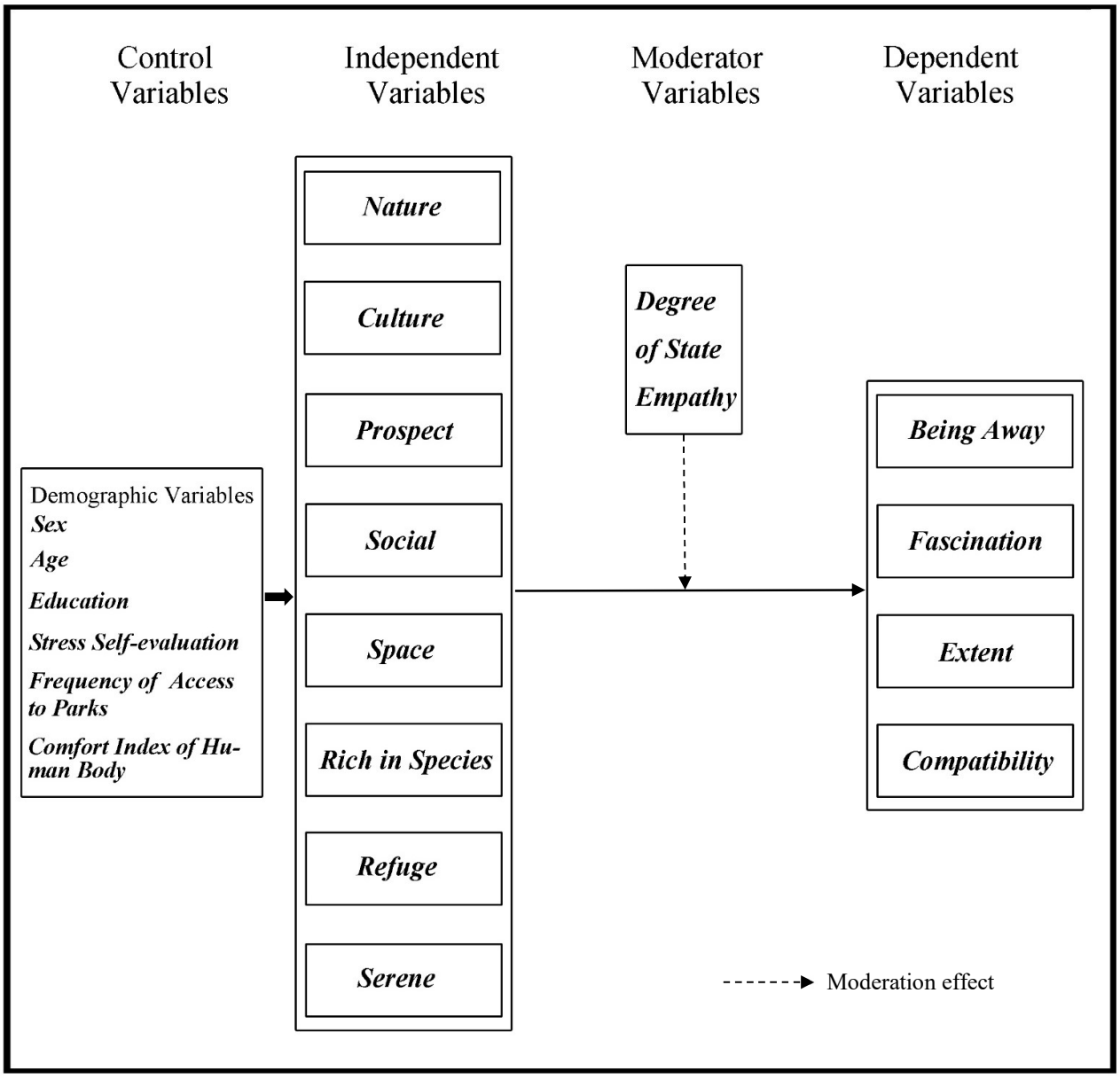
Chart 1. Theoretical Model for Perceived Sensory Dimensions and Attention Restoration in Urban Park Green Space



2. Materials and Methodology

The experiment was conducted on sunny April. Questionnaires(PSD Scale) were distributed to the visitors in the four parks on mornings, afternoons and evenings of the week days, and all weekends. This is to guarantee the immediate experience of the visitors [20]. The Scale consists of three parts. The first part includes personal data. Such as age, sex, occupation , stress self-assessment and frequency of access to parks，Comfort index of human body(Comfort index of human body involves three environmental indexes, including air temperature, humidity and wind velocity. Its calculation method is based on the following formula: SSD = (1.818t+18.18)(0.88 + 0.002f)+(t-32)/(45-t)-3.2v+18.2. In the above equation: SSD represents comfort index

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of human body; T the average temperature (℃); F relative humidity (%); V wind velocity (m/s)). The second part is concerned with a qualitative analysis of the characteristics of the urban park green space based on PSDs, which is based on the 1000 randomly selected questionnaires, defining the following eight dimensions: Serene, Space, Nature, Rich in Species, Refuge, Culture, Prospect and Social. And， a measure on degrees of empathy based on Batson's Emotional Response Scale(ERS), which is to measure the immediate emotional response to a specific context, the degrees of empathy through state empathy and effective control of state empathy. The third part is about the degrees assessment of the attention restoration of the respondents through Perceived Restorative Scale(PRS). PRS was first introduced in by Hartig，Korpela，Evansvand Gärling(1996) [21], which was based on the four components of the restorative environment. Now there are several versions. The Perceived Restorative Scale (PRS) in this paper is the Chinese version introduced by Ye Liuhong and Wu Jianping in 2010. It includes 22 items, a 7-point scale(1=not at all, 7= completely). The PRS is significantly reliable and valid, including four components: Being Away, Fascination, Compatibility and Extent, which can interpret 57.05% of the population variance. The correlation coefficient of the four sub-scales and the total scale is between 0.724-0.943, that coefficient between the subscales 0.478-0.684. Cronbach Alpha coefficient of the total scale and four subscales is between0.769-0.936 and their split-half reliability is between 0.695-0.903. It took the visitors about 6 minutes to finish the questionnaire. Finally, 87 validated questionnaires were collected in Group Wangjiang Tower Park, with a 96.67% validation rate, 90 questionnaires in Group Southern Suburban Park, with a 100% validation rate, 85 questionnaires in Group Huanhuaxi Park, with a 94.44% validation rate, and 86 questionnaires in Group People's Park, with a 95.56% validation rate. The total number is 348. The experiment includes some of the questionnaires (Pic.1).

Picture 1. On-the-spot Experiment

3. Results

3.1 Assessment of Reliability and Validity of PSD Scale

The reliability and validity of the PSD Scale were tested before the research analysis. The reliability was

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tested through Cronbach's α coefficient and Composite Reliability while validity was tested through Factor Analysis and Average Variance Extracted(AVE).

3.1.1 Assessment of reliability

The test of reliability is to describe the expression level of the observed variables to potential variables, to assess consistency of the PSD Scale and its reliability. It has been academically agreed that a Cronbach's α coefficient over 0.8 is relatively reliable [22]. We tested the statistical reliability of the PSD Scales. Their Cronbach's α coefficients are all over 0.8, indicating a high internal consistency and reliability(Fig. 1).

Figure 1. Reliability Test of PSD Scale in Four Parks

Group	Cronbach's α	Standardized Cronbach's α	Items
Group Wangjiang Tower Park	0.951	0.952	35
Group Southern Suburban Park	0.964	0.967	35
Group Huanhuaxi Park	0.969	0.978	35
Group People's Park	0.944	0.970	35

3.1.2 Assessment of Validity

This paper conducted the Confirmatory Factor Analysis(CFA) on the basis of Exploratory Factor Analysis(EFA) to determine the structural relation between the factors and each dimension .The validity of the Scale was conducted with the combination of the Composite Reliability(CR) and the Average Variance Extracted (AVE).

(1) Analysis of EFA

35 statements in the PSD Scale went through Kaiser-Meyer-Olkin(KMO) test and Bartlett test to test their suitability as factors. According to the academic requirement, A KMO value over 0.7 indicates the adequacy of sample data for factor analysis [22]. As is shown in Figure 2, the values of two groups are both over 0.7 while the statistical p-value of Bartlett X2 test is 0.000, ＜0.01，indicating that data of the samples are correlated and concentrated, suitable for factor analysis(Fig. 2).

Figure 2. KMO and Bartlett Test of PSD Scale in Four Parks

Group	KMO Sampling Adequacy	Bartlett's Test of Sphericity		
		Approx. Chi-Square	df	Sig.
Group Wangjiang Tower Park	0.823	2072.317	595	0.000
Group Southern Suburban Park	0.903	2719.975	595	0.000
Group Huanhuaxi Park	0.891	3652.128	595	0.000
Group People's Park	0.882	2956.959	595	0.000

(2) Confirmatory Factor Analysis(CFA)

CFA includes both convergent and discriminant validity assessment. Convergent validity assessment

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involves calculation of factor loadings, AVE (Average Variance Extracted),and CR(Composite Reliability). The CR values are desirable when the data are greater than the threshold values 0.5， 0.45 and 0.7 respectively while the discriminant validity value assessment mainly depends on √AVE value. If it is greater than the correlation coefficients between each dimensions, it meets the requirement of the discriminant validity. (1) In terms of factor loadings, Estimate values of all items in the four parks are greater than 0.5, indicating their high representation in all the parks. (2) AVE and CR values show that AVE values, with the exception to that of 0.363 in Wangjiang Tower Group in the dimension Nature, are all greater than the threshold value 0.45, indicating that the convergent validity of the PSD in all parks except the dimension Nature in Wangjiang Tower Park is desirable. (3) In the assessment of discriminant validity, √AVE values of eight dimensions in each park are all greater than the correlation coefficients between each dimension, indicating a desirable discriminant validity in PSD(data unmentioned in the paper).

In conclusion, the assessment of the reliability and validity of PSD finds that the convergent validity assessment and the critical values in the dimension Nature are not desirable(There is not significant difference in the other dimensions). It will be omitted in dimension Nature of PSD to guarantee its rigor and scientificity. To avoid the complexity, the other seven perception dimensions will be integrated into a unit of seven groups of perception dimensions in the convenience to integrally analyze them with other variables. it guarantees the efficiency in analysis and the expansion of the samples also improves the accuracy of the analysis.

3.2 Regression Analysis of Interaction between Each PSD and the Restorative Components

3.2.1 Assessment of Collinearity

As multiple regression analysis involves collinearity, it is necessary to test the collinearity of the independent variables. If the independent variables are highly correlated, the regression equation is unlikely to be stable. Tolerance and VIF(Variance Inflation Factor) are usually applied to the multiple statistical regression analysis between the independent variables. VIF is defined as the reciprocal of tolerance. When both VIF and tolerance are close to 1.00, there will not be a serious collinearity between the independent variables. Generally, A VIF<10 is acceptable in multiple regression analysis[23].

In this paper, VIF values of the constants as sex, age, education are all around 1.000. VIF values in seven perceived sensory dimensions(PSDs), Culture, Prospect, Social, Space, Rich in Species, Serene are respectively 2.253、2.615、2.238、3.747、3.753、5.037、2.463 indicating a regular collinearity and it is feasible to conduct a regression analysis of the interaction between the PSDs and physiological and psychological indexes.

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3.2.2 Regression Analysis

Based on the regression analysis of each perceived sensory dimension on Being Away , Fascination, Extent and Compatibility, their R-squared is above 10%, and in component Being Away and Fascination is above 30%, indicating that eight PSDs can interpret the 10% variance of the attention restoration, each dimension contributing uniquely to attention restoration [23]. F-test also shows that explanatory variables have significant effect on dependent variables. Furthermore, Durbin-Watson(DW) statistic shows a value close to 2 in the four components [23]. It can be concluded from above that the regression analysis of the interaction between the eight dimensions and the four components of attention restoration is effective(Fig. 3).

Figure 3. Multiple Regression: Effect of PSDs on Components of Attention Restoration（N=348）

	B	Standard Error	Standardized Beta Coefficient	Sig.	R-squared variation	F-test variation	DW Test
Being Away					0.393	**30.286****	1.890
Culture	0.069	0.149	-0.031	0.642			
Prospect	0.009	0.107	-0.006	0.935			
Social	0.136	0.098	-0.086	0.165			
Space	0.166	0.083	0.158	**0.046***			
Rich in Species	0.131	0.076	0.136	0.087			
Refuge	0.169	0.066	0.235	**0.011***			
Serene	0.663	0.095	0.448	**0.000****			
Fascination					0.404	**29.974****	2.000
Culture	0.290	0.159	0.123	0.068			
Prospect	0.078	0.114	0.047	0.493			
Social	0.014	0.104	0.008	0.894			
Space	0.043	0.089	0.039	0.630			
Rich in Species	0.275	0.081	0.272	**0.001****			
Refuge	0.275	0.070	0.367	**0.000****			
Serene	0.336	0.101	0.217	**0.001****			
Extent					0.131	**6.622****	1.817
Culture	0.468	0.335	0.114	0.163			
Prospect	0.050	0.241	-0.017	0.837			
Social	0.664	0.219	-0.231	**0.003****			
Space	0.130	0.187	-0.068	0.488			
Rich in Species	0.304	0.172	-0.173	0.077			
Refuge	0.385	0.147	-0.295	**0.009****			
Serene	0.306	0.213	0.113	0.151			
Compatibility					0.293	**19.573****	1.892
Culture	0.334	0.179	0.132	0.063			
Prospect	0.240	0.129	0.135	0.064			
Social	0.090	0.117	0.051	0.444			
Space	0.006	0.100	-0.005	0.955			
Rich in Species	0.137	0.092	0.127	0.136			
Refuge	0.130	0.079	0.162	0.099			
Serene	0.299	0.114	0.180	**0.009****			

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3.3 Test of Moderation Effect of State Empathy on the Interaction between the PSDs and Attention Restoration

Due to the multi-dimensions between independent variables and dependent variables, to reduce the complicated analysis process, we introduce the moderator variables to sum up the four dependent variables, so that we can focus on the exploration of the moderation effect of the state empathy on the interaction between the eight PSDs and attention restoration(Fig.4).

Figure 4. Hierarchical Regression: Test of Moderation Effect of State Empathy on the Interaction between the PSDs and Attention Restoration

	Attention Restoration		**Attention Restoration**	
Culture	0.159	2.632	0.218	3.434
Empathy	0.451	7.553	0.469	7.896
Interaction			0.140	2.799
R-squared	0.353		0.368**	
F	26.499		24.632**	
Prospect	0.281	5.276	0.286	5.438
Empathy	0.390	7.246	0.429	7.830
Interaction			0.132	2.979
R-squared	0.390		0.405**	
F	31.023		28.883**	
Social	0.280	5.223	0.253	4.802
Empathy	0.387	7.117	0.477	8.375
Interaction			0.196	4.316
R-squared	0.389		0.421**	
F	30.904		30.771**	
Space	0.336	5.307	0.36	5.875
Empathy	0.308	4.844	0.378	5.996
Interaction			0.224	5.022
R-squared	0.390		0.433**	
F	31.094		32.298**	
Rich in Species	-0.066	-1.413	-0.087	-1.780
Empathy	0.573	11.959	0.595	11.846
Interaction			0.069	1.446
R-squared	0.344		0.348	
F	25.432		22.586**	
Refuge	0.254	5.614	0.218	4.698
Empathy	0.459	9.773	0.503	10.315
Interaction			0.133	2.960
R-squared	0.396		0.411**	
F	31.819		29.572**	
Serene	0.259	4.042	0.311	4.785
Empathy	0.367	5.720	0.390	6.132
Interaction			0.159	3.351
R-squared	0.370		0.390**	
F	28.535		27.123**	

Observation of R-squared from Fig.4 finds that state empathy has some moderation effect on the interaction between all PSDs and attention restoration except dimension Rich in Species. In addition, F-test

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shows that moderation effect is statistically significant, which statistically support the moderation effect on the interaction between the perceived dimensions and attention restoration.

4. Discussion

4.1 The relation between each perceived sensory dimension and components of attention restoration

The previous researches has emphasized that the green environment has restorative function [24]. Scholars such as Cooper-Marcus(1998)[25], St Leger(2003)[26], Grahn P(2010)[27] have found that immersion in the nature can effectively relieve the emotion of fatigue, anger and worries. A continuous attention and interest can promote the concentration of the attention and increase the sense of joy. These findings have supported the statement that the PSDs have some effect on the attention restoration. It can been seen from Fig.3 that some of the dimensions and the attention restoration are significantly correlated. (1)As to the restorative component Being Away, the dimension with most predictive effect is Serene, with significance P-values 0.000, all less than 0.01, followed by dimension Refuge and Space, with respective significance P-values 0.011 and 0.046, all less than 0.05. indicating that Serene can better help people get rid of the daily stress and obligations, which has also been reflected in other studies of the relation between PSDs of small urban green space and attention restoration[20]. Besides, dimension Refuge and Space can also help one temporarily forget the reality. (2) As for the restorative component Fascination, three dimensions, Rich in species, Refuge and Serene have greater predictive effects, with respective significance P-values 0.001, 0.00 and 0.001, all less than 0.01, indicating that these three dimensions can hold one's attention and stimulate one's curiosity.(3) As for the restorative component Extent, the dimensions Social and Refuge have most predictive effect, with respective significance P-values 0.003, 0.009, both less than 0.01, indicating that the two dimensions help improve people's cognition of the environmental varieties.(4) As for Compatibility, the dimension Serene is only dimension with most predictive effect, with P-value 0.009, less than 0.01,indicating that the dimension Serene can generate a sense of belonging, reaching a state of harmony between human and nature.

It can be concluded that the dimension Serene is significantly related with the three restorative components Being Away, Fascination, Compatibility, Refuge related with Being Away, Fascination and Extent, indicating that the Serene and Refuge are the key perceived sensory dimensions that influence the attention restoration. The previous findings, however, shows that Serene and Nature share the similar predicting effect [20], a little different from our study. It may be that the dense urban park green spaces have high frequency of access, different from other green spaces. People may not feel Nature that requires Serene to match in an environment is no longer an important way to relieve stress while safety, inclusivity, recreation, and capacity

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of an environment are the major influential factors for attention restoration. Besides, Space, Rich in Species and Social are also important influential dimensions for attention restoration, but with single and limited influential level. For example, dimension Space is just related to component Being Away, Rich in Species just to Fascination, and Social just to Extent.

4.2 Moderation Effect of State Empathy on the Interaction between Each PSD and Attention Restoration

It can be concluded from Fig.4 R-squared in Rich in Species is not significant, indicating empathy cannot moderate effectively between Rich Species and psychological health. With a simple slope analysis as in Chart 2 below, in all the dimensions except Rich in Species, (1) Respondents with higher empathy degree (M+1SD) show significant predictive effect between dimension Culture and attention restoration, simple slope=3.956, t=3.787，p<0.01, while respondents with lower empathy degree（M-1SD) also show significant predictive effect, simple slope=3.607, t=2.137，p<0.05. Besides, simple slope=3.956>3.607. This suggests that those with higher empathy degree show a bit greater moderating effect than those with lower empathy degree between dimension Culture and attention restoration. but without great significant difference. (2) Respondents with higher empathy degree (M+1SD) show significant predictive effect between dimension Prospect and attention restoration , simple slope=3.600, t=6.157，p<0.01, while respondents with lower empathy degree (M-1SD) show significant predictive effect, simple slope=3.327, t=3.264, p<0.01. Besides, simple slope=3.600>3.327. This suggests that those with higher empathy degree show a bit greater moderating effect than those with lower empathy degree between dimension Prospect and attention restoration but without great significant difference.(3) Respondents with higher empathy degree (M+1SD) show significant predictive effect between dimension Social and attention restoration, simple slope=3.321，t=7.164，p<0.01, while respondents with lower empathy degree（M-1SD) also show significant predictive effect, simple slope=2.819，t=2.121，p<0.05，p<0.05. Besides, simple slope=3.321>2.819. This suggests that those with higher empathy degree show a bit greater moderating effect than those with lower empathy degree between dimension Social and attention restoration. but without great significant difference. (4) Respondents with higher empathy degree (M+1SD) show significant predictive effect between dimension Space and attention restoration , simple slope=3.055，t=7.5146，p<0.01, while respondents with lower empathy degree (M-1SD) also show significant predictive effect, simple slope=2.785，t=3.749，p<0.01. Besides, simple slope=3.055>2.785. This suggests that those with higher empathy degree show a bit greater moderating effect than those with lower empathy degree between dimension Space and attention restoration but without great significant difference.(5) Respondents with higher empathy degree (M+1SD) show significant predictive effect between dimension Refuge and attention restoration, simple slope=1.307，t=6.210，p<0.01 while respondents with lower

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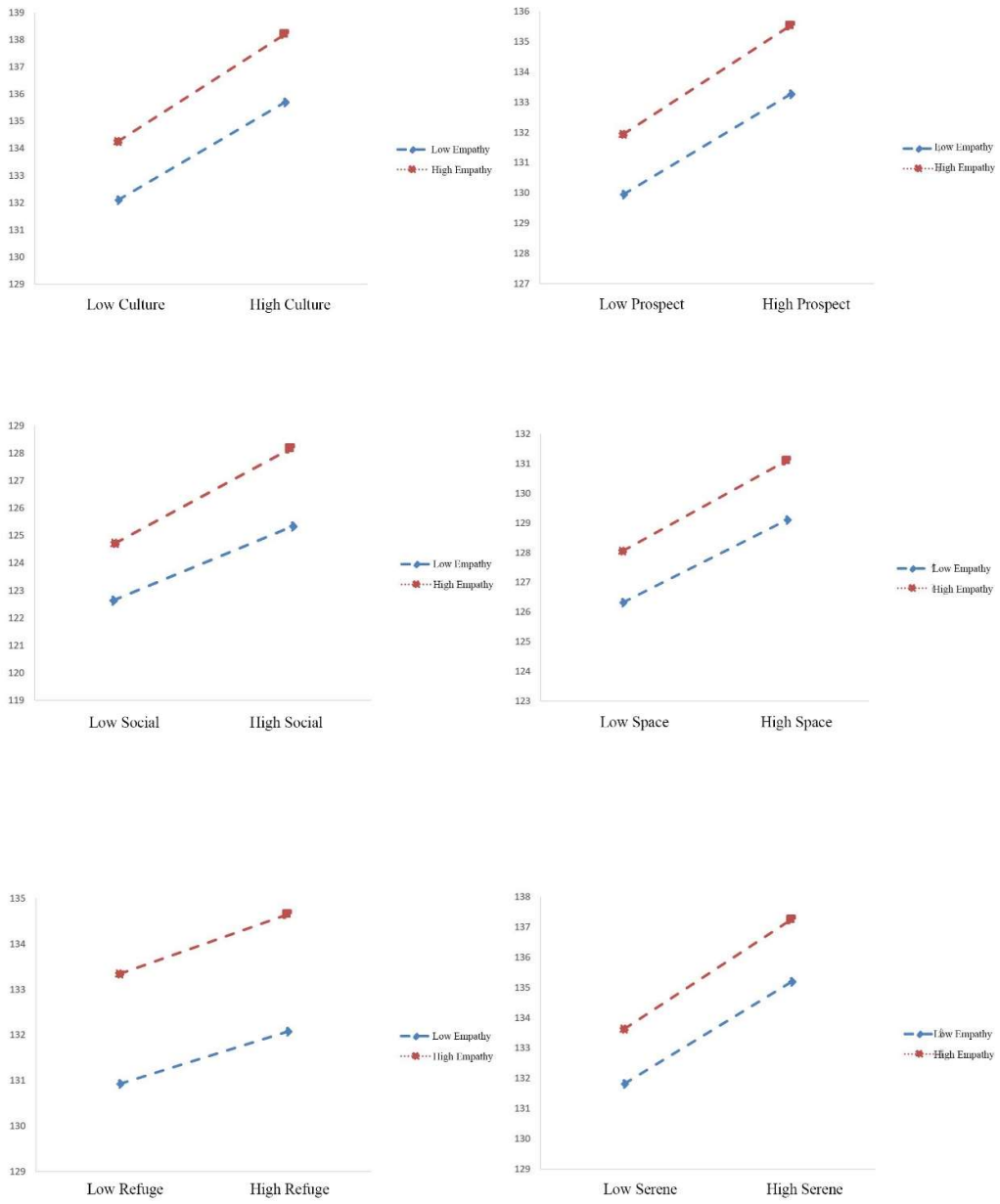
empathy degree（M-1SD) do not show predictive effect between dimension Refuge and attention restoration，simple slope=1.145，t=1.401，p>0.05.(6) Respondents with higher empathy degree (M+1SD) show significant predictive effect between dimension Serene and attention restoration , simple slope=3.626，t=5.162，p<0.01, while respondents with lower empathy degree (M-1SD) also show significant predictive effect, simple slope=3.378，t=3.325，p<0.01. Besides, simple slope=3.626>3.378. This suggests that those with higher empathy degree show a bit greater moderating effect than those with lower empathy degree between dimension Serene and attention restoration but without great significant difference.

Chart 2. The Moderation Effect of Empathy on PSDs and Attention Restoration



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4.3 The Optimal Restorative Dimensions and their Combination in Urban Park Green Space

4.3.1 Transformation of Single Dimensions

It can be found from the interaction between perceived sensory dimensions and attention restoration that the best dimensions in the urban park green pace are Serene and Refuge. As for dimension Serene, improvement of its moderating effect lies in the control of the noise and sanitary condition in the surroundings. For example, we may make full use of the plants or landscape elements to prevent noise, improving the Serene effect. At the same time, natural sound such as that from the wind, water, animals and the cultural sound such as music and chimes of the drum and bell tower may also promote its moderating effect. As for dimension Refuge, the factors as security and comfort of the facilities and the space of the activities must be taken into first priority. A space which is likely to lead people to get lost should be avoided. The prevention of potential dangers also should be taken into consideration in the design of the railings, choice of the materials, contact with waters, and plant configuration. The number of the visitors and vehicles should be under strict control, without exceeding the capacity limit to avoid crowdedness.

4.3.2 Innovation in Combination of Different Dimensions

When empathy is taken as a variable, it has been observed that visitors with higher empathy degree can better achieve the attention restoration in dimension Culture, Prospect, Space and Serene, particularly in dimension Social. Through the analysis above, the paper proposes a possible optimal design : (Culture + Prospect + Space + Serene) × Social.

（1）Singular Interactive Mode

Singular Interactive Mode, i.e. the five modes: Culture × Social, Prospect × Social, Space × Social, and Serene× Social. In the mode Culture × Social, the cultural elements, through direct application, extension or artistic conception, especially through horizontal relevance and vertical extension of these elements, can be applied to improvement of cultural transmission, construction of multilayer, multiangle , comprehensive and compatible interactive cultural platform, so that it can be a harmoniously fusion anchor for the local residents by representation over abstraction. The mode Prospect × Social may focus on the accessibility and relevance of the accessible facilities such as the green and water system and traffic system. The maintenance service and management, control of space capacity may be other considerations. The mode Space × Social may serve as a guidance for social behaviors under different forms of spaces. For example, static activity space may guide people to reduction of activities of physical and verbal interaction, and generate greater frequency of visual, auditory and smell perception. Dynamic activity space, however, may focus on greater verbal and physical

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interaction to sustain people's emotional interaction. As for the mode Serene× Social, some advanced technology may be introduced to the soundscapes to break the conventional design, achieving the purpose of interaction and function of medium and realizing the landscape-person interaction.

（2）Integrated Interactive Mode

Integrated Interactive Mode refer to a variety of dimensions interacting with dimension Social, such as (Culture + Prospect) × Social, (Serene + Space) × Social, (Culture + Prospect) × Social,) (Culture + Prospect + Serene) × Social, ((Serene + Space + Prospect) × Social, or (Culture + Prospect + Space) × Social, or any other combinations. Their design may refer to the design of singular interactive mode.

It can be concluded that the design of the park green space in dense urban areas should meet the needs of greater varieties, and make full use of the limited green resources to achieve the optimal effect of physical and mental restoration.

5. Conclusions

The paper, for the first time, under the scope of dense urban park green space, based on the previous studies, proposes the relation model between perceived sensory dimensions (PSDs) and perceived restorative scale (PRS), introduces the empathy as moderator variable and then further explores the interaction between the three aspects. The findings show that: (1) After the test of the PSD Scale, all the dimensions except dimension Nature have a relatively high reliability and validity, which can be applied as a measuring tool for the perceived sensory dimensions in the urban park green space. (2) Through the multiple linear regression analysis, the paper explores effect of different perceived sensory dimensions on the components of attention restoration. The findings show that PSDs can to some extent interpret the attention restoration, suggesting that PSD is an important predictive variable for attention restoration. Generally, the predictive effect lies in three dimensions, Refuge, Serene and Rich in Species. In terms of components, Dimension Space, Refuge, and Serene exert stronger predictive effects on component Being Away of PRS; Dimension Rich in Species exert stronger predictive effects on component Fascination of PRS; Dimension Social, Refuge, exert stronger predictive effects on component Extent of PRS; Dimension Serene exerts stronger predictive effects on component Compatibility of PRS. (3) The hierarchical regression analysis is applied to the assessment of the moderating effects of the empathy degree between PSDs and attention restoration. The findings show that empathy degree does not show significant moderating effect between Rich in Species and attention restoration. Further simple slope analysis through PROCESS plugins finds that higher empathy degrees of state empathy show significant moderating effects between dimension Refuge and attention restoration and lower empathy degree do not show significant moderating effects. In the other five dimensions, both higher empathy degrees

and lower empathy degrees show significant moderating effects. Furthermore, empathy degrees of both exert enhanced moderating effects between Culture, Prospect, Social, Space and Serene five dimensions and attention restoration, particularly in dimension Social, both without significant difference.–

In conclusion, the proposed hypotheses in this paper have basically passed the model validation. There are, however, some limitations in the process, which is to be further explored and improved. First, although PSD Scale has been based on previous studies, with good reliability and validity, which have been tested through questionnaires, there may be some room for improvement. The PSD Scale may be designed on the basis of the characteristics of improving its validity. In addition, some part of the content in the Scale is a little complicated in understanding, so that most of the valid samples are young people, suggesting that the samples may be underrepresented. The further research will comparatively analyze the PSDs in different groups, leading to a more reliable and valid finding. Finally, the relation between PSDs and attention restoration may be influenced by more moderator variables, even intermediate variables than just empathy, which is introduced as a moderator variable in this paper. All these need improvements in further research.

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