Preference for Chinese Vernacular Windows: Combined Effects of Shape and View

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Abstract. This study presents a psychological survey of the preferences for Chinese vernacular windows among young adults. The experiment participants were young Chinese students who were studying the programmes of architecture, urban planning, interior design and engineering in a public university in Beijing. Eighteen window shapes combined with three types of view were investigated using a subjective questionnaire. Several statistical models were applied to expose some design implications based on the feedback: 1) There are differences of preference between various window shapes. 2) The view will significantly affect the preference; while the natural view can reduce the differences of preference between various windows. 3) Male and female participants have few differences of preference for most of the window types.

Keywords: Preference · Chinese Vernacular Window · Window Shape · View · Psychological Survey · University Students

1 Introduction

Since 1980s, a trend of 'recalling Chinese vernacular spirit' has occurred in the area of design practices and academy of architecture in China [1, 2, 3]. The applications of Chinese vernacular architectural elements have been increasingly found in the contemporary buildings and relevant design works [1, 4]. As one of typical building components, the Chinese vernacular window has attracted higher attentions. In the field of arts design, typical shapes, patterns and configurations of Chinese traditional windows have been studied in the historic and cultural context [2, 5, 6]. On the other hand, the impact of such vernacular windows on indoor environmental performances (lighting, thermal, etc.) has recently become a research focus [7, 8], due to the increasing requirements of sustainable passive solutions in Chinese building industry. With a key function of delivering daylight and view, window systems can significantly affect occupants' health and well-being in a built environment [9]. The psychologi-

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cal satisfactions of window applications have been developed into one of crucial topics studied in the area of modern environmental design / psychology [10]. A number of modern façade systems have been investigated [11]. However, few studies were conducted in terms of the acceptances of Chinese vernacular windows, even though it could not be difficult to find them broadly applied in current modern public / commercial buildings (e.g. museums, offices, hotels) [4]. Thus, an investigation into this topic could be required for Chinese architectural researchers and practitioners in order to deliver an effective human-centered design solution in buildings.

The 'Preference' for façade systems / windows has been studied in the built environment. As discussed in an early study [12], windows are generally preferred while larger windows are preferred over smaller ones. It could be also found that the amount of windows desired in a space can be reliably predicted based on the occupants' requirements (e.g., having a view or good ventilation) [12]. Another literature pointed out that architectural facades are among the most widely regulated design features and that it is interesting and useful to investigate how different modifications to architectural facades influence preferences [13]. In offices, window preferences can be significantly linked with its type, gender of occupants, quality of office job and quality of view [14]. However, in houses, 'Mystery' would deliver an apparent impact on the preference of façade configurations [15]. Façade configurations with various void-to-solid ratios can influence on preferences more practically [11]. This preference has been proved as the direct effect of view [12]. In addition, this view from windows would help deliver effective psychological restoration in an urban context [16].

In this article, a psychological survey was conducted to explore the preference for Chinese vernacular windows among young adults. The participants were young Chinese students who were studying the programmes of architecture, urban planning, interior design and engineering in a public university in Beijing. The windows studied here varied in shapes and views. The hypotheses of this study have been presented as follows: H1. There are differences of preference for window shapes based on the traditional design styles. H2. The view content takes significant effects on the preference for these window shapes.

2 Methods and Materials

This section includes four parts: visual stimuli and measures, participants' background, survey procedures, and statistical models used in this study.

2.1 Visual Stimuli and Measures

On the ground of literatures [2, 3, 6], eighteen typical types of Chinese vernacular window were defined in terms of shapes and configurations (see Fig. 1). Named as W1-18 (Fig. 1), these windows have the same area of void part. W1, the square window, is a common type that is generally applied, and was used as the base case in this study. All window types were studied through the combination of three views: blank (no content, white background), urban (street view, with buildings in a highly dense urban area), nature (natural view from a city park, no buildings). The images of windows and views were produced into slides in Microsoft PowerPoint 2016, which can

be displayed in a monitor as the visual stimuli. Each slide has only one window on it. Thus, three various human psychological experiments were implemented as follows: Study1: 18 window shapes × blank view; Study2: 18 window shapes × urban view; Study3: 18 window shapes × nature view.

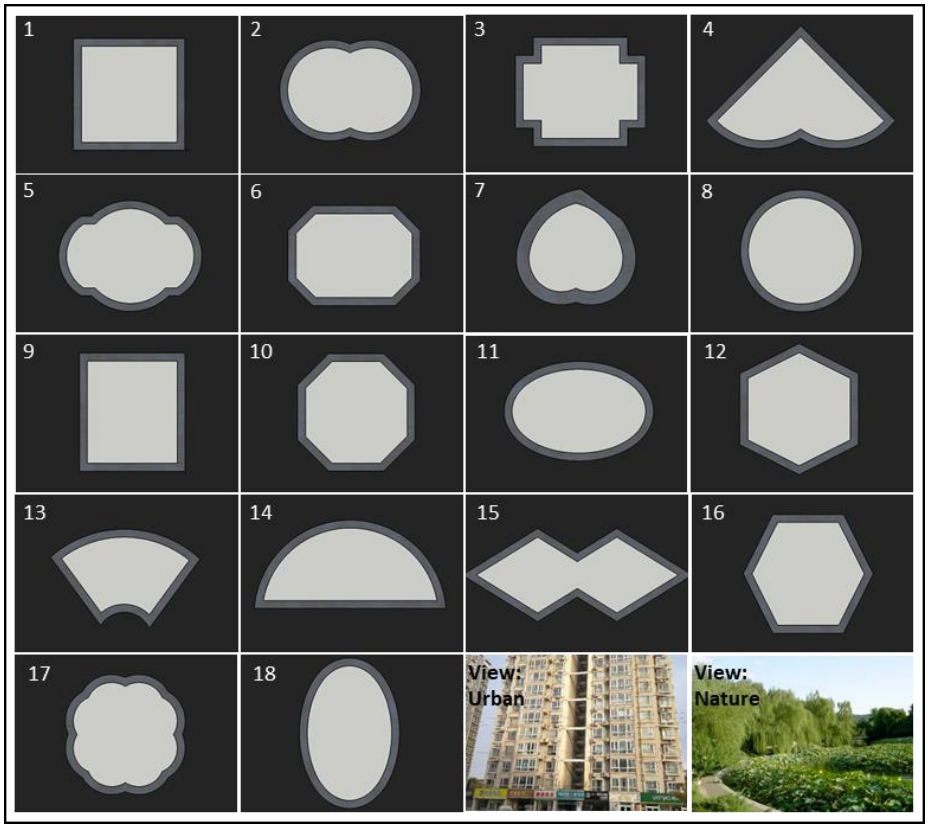

Fig. 1. Eighteen types of Chinese vernacular window [2, 3, 6]: No. 1-16 at the top four rows; No. 17 & 18 at the left side of the bottom row. For the two pictures at the right bottom, the picture 'View: Urban' and the picture 'View: Nature' were used as the background (view) of window void area during the psychological survey.

Preferences for the windows were measured through a paper-based questionnaire. Only one task was required to complete for each window type as: 'please rank the window type according to your preferences'. The questionnaire was produced using a VAS (visual analog scale [17]) scale of 0-10. '0' and '10' mean the lowest and the highest levels of preference respectively, while '5' stands for the medium level. VAS is generally applied as a continuous rating scale, which the decimal scoring can be accepted.

2.2 Participants

University students were recruited to attend three psychological experiments. The academic programmes they were studying on included architecture, urban planning, interior design, and engineering. The participants' numbers were: Study1, n=122 (male: 50; female: 72) (mean age: 18.92 years, SD: ±2.18); Study2, n=59 (male: 20; female: 39) (mean age: 18.46 years, SD: ±1.02); Study3, n=60 (male: 26; female: 34) (mean age: 18.43 years, SD: ±0.98). The students with a design background (architecture, urban planning and interior design) have received some knowledge of Chinese architectural history; whist engineering students have not studied courses relating to architectural history.

2.3 Procedure

A quite room in the university campus was used for implementing all psychological experiments (Fig. 2). During each experiment, only the experimenter and one participant were allowed to stay in the room. The experimenter controlled the testing procedures. Before starting the experiment, each participant was required to read and sign the document of agreement, and fill in a short form of relevant background information (gender, age and academic programme). Then, the experimenter will randomly display the 18 slides and give 5 seconds for the participant to score on each window type using a paper sheet. The indoor environment (e.g. thermal and lighting) was kept at a comfortable level to avoid unnecessary interference during the experiment.

Fig. 2. The testing room and a view of on-going psychological experiment.

2.4 Statistical Analysis

Given experimental conditions and collected data, three statistical models were applied in this study, including 2-tailed t-test, two-way repeated measures of variance (ANOVA), and *Post Hoc* analysis (Scheffe). The t-test was used for comparisons of

means between W1 and other window types, and between male and female participants. The main effects of view and gender and the paired comparisons of the means were assessed through the ANOVA and *Post Hoc* analysis respectively. The significance can be achieved with $p \leq 0.05$ for all statistical analysis methods. IBM-SPSS (v25) was the tool to carry out all analysis.

3 Results

3.1 Mean Scores of Preference for Window Shapes

For Study1, Fig. 3 shows mean scores (±sem) of preference for 18 window types with the blank view among 122 participants. The highest score is found for W13 (shape: fan; 7.13). W5-6, W8 and W10 can achieve relatively higher scores (> 6.0), while W3, W9, W11-12, and W15-17 would see medium scores between 5.0 and 6.0. However, other window types have relatively lower scores (< 5.0).

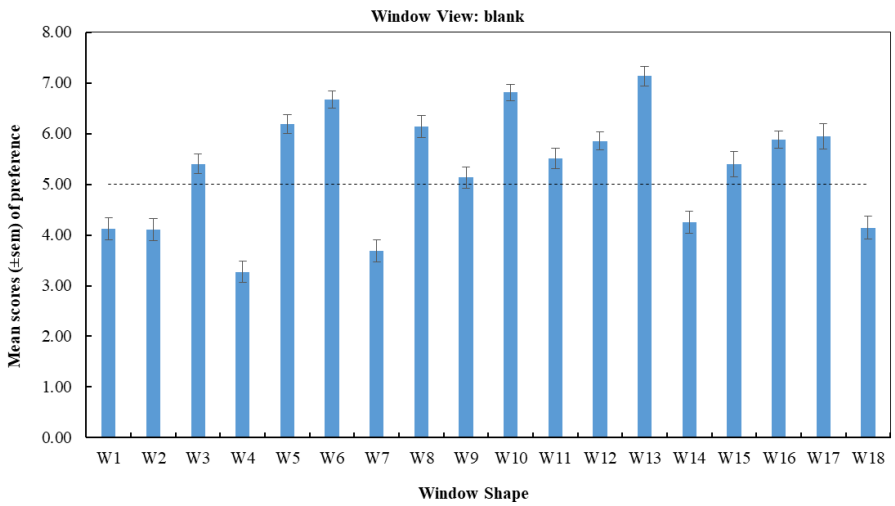

Fig. 3. Mean scores (±sem) of preference for 18 window types (Study1: blank view, n=122).

According to the feedback of Study1, compared with W1 (shape: square), Table 1 presents the differences of preference scores of other 17 window types. The 2-tailed t-test reveals that there are no significant differences between W2/7/14/18 and W1 ($p > 0.05$) in terms of the preference. Apparently, preferences for other 13 types have significant differences from that of W1 ($p < 0.05$). Except for W4, W1 receives the significantly lower preference scores than other 12 type.

Table 1. Study1 (blank view): differences of mean scores of preference between W1 and other window shapes (2-tailed t-test; sig. $p < 0.05$).

Pairs		Mean differences	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
I	J	(I-J)				Lower	Upper
W1	W2	0.016	0.069	121	0.945	-0.457	0.490
W1	W3	-1.279	-5.224	121	0.000	-1.763	-0.794
W1	W4	0.852	3.085	121	0.003	0.305	1.400
W1	W5	-2.066	-7.822	121	0.000	-2.588	-1.543
W1	W6	-2.549	-9.985	121	0.000	-3.055	-2.044
W1	W7	0.434	1.563	121	0.121	-0.116	0.985
W1	W8	-2.016	-7.755	121	0.000	-2.531	-1.502
W1	W9	-1.008	-5.296	121	0.000	-1.385	-0.631
W1	W10	-2.689	-10.509	121	0.000	-3.195	-2.182
W1	W11	-1.385	-5.073	121	0.000	-1.926	-0.845
W1	W12	-1.730	-6.412	121	0.000	-2.264	-1.195
W1	W13	-3.008	-9.434	121	0.000	-3.639	-2.377
W1	W14	-0.123	-0.426	121	0.671	-0.694	0.448
W1	W15	-1.279	-3.643	121	0.000	-1.974	-0.584
W1	W16	-1.762	-6.805	121	0.000	-2.275	-1.250
W1	W17	-1.820	-4.917	121	0.000	-2.552	-1.087
W1	W18	-0.016	-0.053	121	0.958	-0.629	0.596

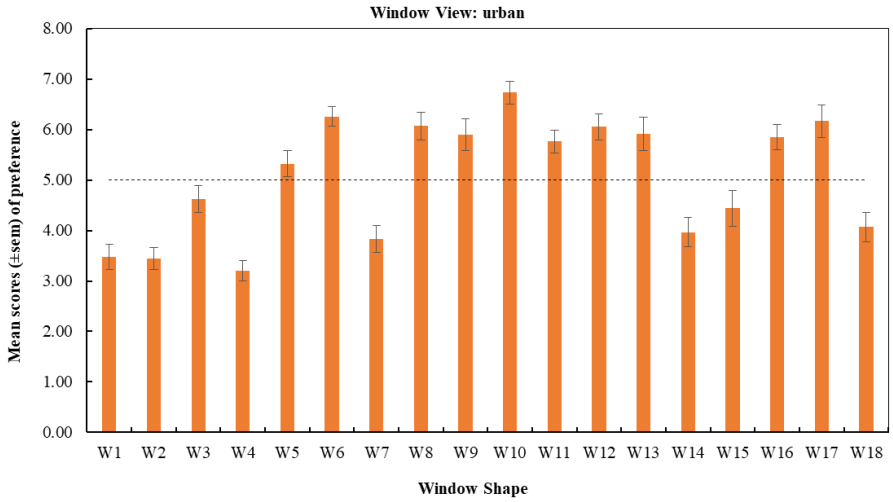

Fig. 4. Mean scores (±sem) of preference for 18 window types (Study2: urban view, n=59).

For Study2, mean scores (±sem) of preference for 18 window types with the urban view among 59 participants are given in Fig. 4. The relatively higher scores are achieved by W6, W8, W10, W12 and W17 (> 6.0). W5, W9, W11, W13 and W16

have medium scores (> 5.0 and < 6.0), while relatively lower scores can be found for others (< 5.0).

In comparison with W1 (shape: square), the 2-tailed t-test exposes differences of preference of other 17 window types (Table 2). Similar to Study1, Study2 shows that no significant differences can be found between W2/7/14/18 and W1 in terms of the preference ($p > 0.05$). In addition, W4 has no significant difference of preference from W1 in Study2 ($p > 0.05$). On the other hand, preferences for other 12 types have achieved significantly higher scores than W1 ($p < 0.05$).

Table 2. Study2 (urban view): differences of mean scores of preference between W1 and other window shapes (2-tailed t-test; sig. $p < 0.05$).

Pairs		Mean differences	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
I	J	(I-J)				Lower	Upper
W1	W2	0.034	0.150	58	0.881	-0.417	0.485
W1	W3	-1.153	-3.882	58	0.000	-1.747	-0.558
W1	W4	0.271	1.000	58	0.321	-0.272	0.814
W1	W5	-1.847	-5.379	58	0.000	-2.535	-1.160
W1	W6	-2.780	-9.750	58	0.000	-3.350	-2.209
W1	W7	-0.356	-1.140	58	0.259	-0.981	0.269
W1	W8	-2.593	-7.602	58	0.000	-3.276	-1.910
W1	W9	-2.424	-7.730	58	0.000	-3.051	-1.796
W1	W10	-3.254	-10.757	58	0.000	-3.860	-2.649
W1	W11	-2.288	-7.969	58	0.000	-2.863	-1.713
W1	W12	-2.576	-7.350	58	0.000	-3.278	-1.875
W1	W13	-2.441	-5.425	58	0.000	-3.341	-1.540
W1	W14	-0.492	-1.320	58	0.192	-1.237	0.254
W1	W15	-0.966	-2.207	58	0.031	-1.842	-0.090
W1	W16	-2.373	-6.791	58	0.000	-3.072	-1.673
W1	W17	-2.695	-7.089	58	0.000	-3.456	-1.934
W1	W18	-0.593	-1.775	58	0.081	-1.262	0.076

As regards Study3, Fig. 5 gives the mean scores (±sem) of preference for 18 window types with the nature view among 60 participants. The highest score is found for W10 (shape: octagon; 7.02). Compared with Study1 and Study2, Study3 sees that more window types can receive relatively higher scores (> 6.0), such as W1, W5-6, W8-9, and W12-13. W2-3, W11, and W16-17 have medium scores (> 5.0 and < 6.0), while relatively lower scores (< 5.0) can be found for other types including W4, W7, W14-15, and W18.

Taking the W1 (shape: square) as a base case, the analysis using 2-tailed t-test shows differences of preference for other 17 window types (Table 3). Study3 sees that less window types have significant differences of preference from W1 than Study1 & 2. These window types include W2, W6-7, W10, W14-15, and W18 ($p < 0.05$). W1 receives significantly higher preference scores than W2, W7, W14-15, and W18 ($p < 0.05$), while the scores of W6 and W10 are significantly higher than W1 ($p < 0.05$). However, other 10 window types do not achieve significant differences of preference from W1 ($p > 0.05$).

Fig. 5. Mean scores (±sem) of preference for 18 window types (Study3: nature view, n=60).

Table 3. Study3 (nature view): differences of mean scores of preference between W1 and other window shapes (2-tailed t-test; sig. $p < 0.05$).

Pairs		Mean differences	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
I	J	(I-J)				Lower	Upper
W1	W2	0.700	2.843	59	0.006	0.207	1.193
W1	W3	0.200	0.739	59	0.463	-0.342	0.742
W1	W4	1.767	1.937	59	0.058	-0.058	3.592
W1	W5	0.000	0.000	59	1.000	-0.764	0.764
W1	W6	-0.750	-2.228	59	0.030	-1.424	-0.076
W1	W7	1.817	4.682	59	0.000	1.040	2.593
W1	W8	-0.400	-1.198	59	0.236	-1.068	0.268
W1	W9	0.000	0.000	59	1.000	-0.459	0.459
W1	W10	-0.983	-3.664	59	0.001	-1.520	-0.446
W1	W11	0.067	0.220	59	0.827	-0.540	0.674
W1	W12	-0.267	-0.866	59	0.390	-0.883	0.350
W1	W13	-0.333	-0.843	59	0.403	-1.124	0.458
W1	W14	1.567	4.234	59	0.000	0.826	2.307
W1	W15	1.400	3.366	59	0.001	0.568	2.232
W1	W16	0.050	0.169	59	0.867	-0.543	0.643
W1	W17	0.117	0.281	59	0.779	-0.713	0.946
W1	W18	1.717	4.971	59	0.000	1.026	2.408

3.2 Effects of View and Gender

In all studies, a two-way ANOVA analysis of all feedback exposes the significant main effects of view and gender on the preferences for window types (Table 4 and 5). The significant effects of view can be found for seven window types, including W1-3, W5, W9, W13 and W15 ($p < 0.05$). However, only four window types (W5, W11-12, W17) can receive the significant main effects of gender ($p < 0.05$). For the interaction of view and gender, only W15 sees the significant effect ($p < 0.05$).

Table 4. Significant main effects of view on the preferences for window types ($p < 0.05$).

Window Type	df	F	η^2	Sig.
W1	(2, 235)	20.018	0.146	0.000
W2	(2, 235)	11.568	0.090	0.000
W3	(2, 235)	4.326	0.036	0.014
W5	(2, 235)	4.789	0.039	0.009
W9	(2, 235)	4.155	0.034	0.017
W13	(2, 235)	6.605	0.053	0.002
W15	(2, 235)	4.705	0.039	0.010

Table 5. Significant main effects of gender on the preferences of window types ($p < 0.05$).

Window Type	df	F	η^2	Sig.
W5	(1, 235)	7.054	0.029	0.008
W11	(1, 235)	4.936	0.021	0.027
W12	(1, 235)	4.922	0.021	0.027
W17	(1, 235)	4.168	0.017	0.042

Following the ANOVA analysis, pairwise comparisons of preference scores between three types of window view were conducted (Post-hoc: Scheffe). Table 6 shows the significant differences ($p < 0.05$). For W1, W2, W3, and W9, the nature view will give rise to significantly higher preference scores than the urban view and/or blank view ($p < 0.05$). W5 and W13 have significantly higher preference scores for blank view than those of urban view ($p < 0.05$). With the blank view, W15 can approximately achieve significantly higher scores than the urban view ($p = 0.076$).

Given the comparisons between male and female participants, a 2-tailed t-test reveals that there are significant differences of preference scores found for W5, W11 and W17 ($p \leq 0.05$) (see Table 7). W5 and W17 see that female participants scored significantly higher on the two window types than male participants ($p \leq 0.05$). Interestingly, female participants have given significantly lower scores for W11 than male participants ($p < 0.05$). However, the t-test analysis is not able to support a significant difference of preference between male and female participants for W12 ($p > 0.05$).

Table 6. Pairwise comparisons of preference scores between various types of window view (Post-Hoc: Scheffe; Sig. $p < 0.05$).

Window Type	View		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
W1	Blank	Nature	-1.91	0.359	0.000	-2.79	-1.03
	Nature	Urban	2.56	0.417	0.000	1.53	3.59
W2	Blank	Nature	-1.23	0.336	0.002	-2.05	-0.40
	Nature	Urban	1.89	0.390	0.000	0.93	2.85
W3	Nature	Urban	1.21	0.376	0.007	0.28	2.13
W5	Blank	Urban	0.87	0.314	0.024	0.09	1.64
W9	Blank	Nature	-0.90	0.357	0.043	-1.78	-0.02
W13	Blank	Urban	1.22	0.349	0.003	0.36	2.08
W15	Blank	Urban	0.96	0.421	0.076	-0.08	2.00

Table 7. Comparisons of preference scores between male and female participants (2-tailed t-test; Sig. $p < 0.05$).

Window type	Mean Difference (male-female)	t	df	Std. Error Difference	Interval of the		Sig. (2 tailed)
					Lower	Upper	
W5	-0.606	-2.298	239	0.264	-1.126	-0.087	0.022
W11	0.628	2.439	239	0.257	0.121	1.135	0.015
W17	-0.644	-1.940	239	0.332	-1.298	0.010	0.054

4 Discussions and Practical Implications

It can be found that the results above have supported the hypotheses of H1 and H2. First, there are significant differences of preference for window shapes. Generally, window shapes (W5-6, W8-13, and W16-17) could receive relatively higher levels of preference. It could be explained by the fact that they are very common configurations used in a Chinese vernacular building [2, 6]. Other window shapes (W2, W4 and W18) would not be easily accepted since they are applied in some special spaces. If one finding achieved in a modern building can be applied [14], the larger horizontal size could be regarded as another reason for a higher level of preference for some windows. Certainly, cultural factors (e.g. mystery [15]) cannot be denied as the significant impact on the window preferences. Second, the view from windows has been proved as one of critical environmental factors affecting human's psychological and

physiological performances [9, 18]. It is not surprised that with the natural view the preference differences between various window types can be significantly reduced.

Practical implications for supporting architectural design can be drawn as follows. In general, there are significant differences of preference between some Chinese vernacular window shapes, even though they can deliver similar environmental performances (e.g. daylighting, solar gain, etc.). Most of the window shapes have no significant differences of preference between male and female users. On the other hand, the vacant area (view) of windows will take significant effects on the preferences. The nature view generally receives higher preferences, while the blank view can be more preferable than a view with only urban buildings. When applied with the Chinese vernacular windows, the natural view can also significantly reduce the impact of window shape on the preference.

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References

1. Peng, P.: Design of Xiangshan Hotel--An Approach to Modern Chinese Architecture. Architectural Journal. 04, 1--5 (1980)
2. Xie, Y.: Chinese Vernacular Architecture: Detailed Design. China Architecture and Building Press, Beijing, China (2001)
3. Liu, D.: History of Ancient Chinese Architecture. China Architecture and Building Press, Beijing, China (2005)
4. Huang, J.M..: Recurrent Reverberations--Experiencing I.M.Pei & Pei Partnership Architects' Suzhou Museum. Time Architecture. 03, 1--5 (2007)
5. Yin, J., Zhao, S.: The Art Appreciation of Chinese Ancient Windows. Architectural Knowledge. 02, 52--56 (2007)
6. Dye, D.S.: Chinese Lattice Designs. Dover Publications, I N C, New York (1974)
7. Liu, T., Zhang, X., Du, J.: A Daylighting Simulation Study of the Form of Traditional Chinese Windows Based on a Window-to-Wall Ratio of 0.1. Xin Jianzhu: New Architecture. 05, 156--159 (2017)
8. Du, X., Bokel, R., Dobbelsteen, A.: Building Microclimate and Summer Thermal Comfort in Free-running Buildings with Diverse Spaces: A Chinese Vernacular House Case. Building and Environment. 82, 215--227 (2014)
9. Aries, M. B. C., Veitch, J. A. and Newsham, G. R.: Windows, View, and Office Characteristics Predict Physical and Psychological Discomfort. Environmental Psychology. 30, 533-41 (2010).
10. Yildirim, K., Akalin-Baskaya, A. and Celebi, M.: The Effects of Window Proximity, Partition Height, and Gender on Perceptions of Open-plan Offices. Environmental Psychology. 27, 154-165 (2007).
11. Alkhresheh, M. M.: Preference for Void-to-solid Ratio in Residential Facades. Environmental Psychology. 32, 234-245 (2012).
12. Butler, D. l., Biner, P. M.: Effects of Setting on Window Preferences and Factors Associated with Those Preferences. Environment and Behavior. 21, 17-31 (1989).
13. Stamps, A. E.: Physical Determinants of Preferences for Residential Facades. Environment and Behavior. 31, 723-751 (1999).
14. Dogrusoy, I. T., Tureyen, M.: a Field Study on Determination of Preferences for Windows in Office Environments. Building and Environment. 42, 3660-3668 (2007).

15. Ikemi, M.: The Effects of Mystery on Preference for Residential Facades. Environmental Psychology. 25, 167-173 (2005).
16. Masoudinejad, S., Hartig, T.: Window View to the Sky as a Restorative Resource for Residents in Densely Populated Cities. Environment and Behavior. 0, 1-36 (2018).
17. Hasson, D. and Arnetz, B. B.: Validation and Findings Comparing VAS vs. Likert Scales for Psychosocial Measurements. International Electronic Journal of Health Education. 8, 178-192 (2005).
18. Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M.: Stress Recovery during Exposure to Natural and Urban Environment. Environmental Psychology, 11, 201-230 (1991).