The impact of Biophilic Built Environment on Psychological Restoration within student hostels

Farhan Asim[1], Venu Shree[2]

[1] Department of Architecture and Planning, Indian Institute of Technology Roorkee, India.

[2] Department of Architecture, National Institute of Technology Hamirpur, India.

Abstract.
The focus of this paper is on how students of technical educational streams may be exposed to various aspects of stress and anxiety which burden their psychological persona and put them in a state of mental fatigue. Although it is not entirely possible to eliminate the sources of stress and anxiety in the life of students, several attempts can be made to introduce students to certain natural environments which help recover their depleted mental resources and improve fatigued cognitive functions. Our proposal is to link Attention Restoration Theory (ART) and the Biophilia Hypothesis as a way of exploring Biophilic Design in order to research this aspect of human psychology and its relationship to Nature. Individual researches have presented some evidence in favour of these propositions and this paper examines the impact and the significance of a number of Biophilic Environment Variables as regards the Psychological Restoration of students within the built environment of hostels. In order to investigate this, student hostel rooms at two institutes (105 km apart) situated in the foothills of the Himalayas, both designated as of national importance in India, were surveyed using the following variables: *Nature in the Space*, *Natural Analogues* and *Human Nature Relationship*. These were correlated with the resident students' response to Plutchik's emotional stability wheel and some specific aspects of Perceived Restorativeness: *Being Away*, *Fascination*, *Extent* and *Compatibility*. The results indicate that the students in hostel rooms which have higher qualitative and quantitative scores in terms of biophilic environment variables (connection with nature) report greater Perceived Restorativeness and also possess better self-reported emotional stability.

Key words. Biophilia; biophilic design; sustainability; sustainable architecture; psychological restoration; well-being; restorative environment.

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Corresponding Author: Farhan Asim, India.

E.mail: fasim@ar.iitr.ac.in

Introduction

Academic stress and anxiety related to mental disorders are significant among school and college students throughout the world (Deb et al, 2015). According to a study conducted on college students of Indian medical, dental and engineering streams, stress was recorded in about 24.42% of them, out of which 19.7 % engineering stream students showed stress related symptoms (Waghachavare et al., 2013). The factors contributing to stress and anxiety are academic pressure, health consciousness, environmental disturbances and social imbalance. The extreme amalgamation of these factors often leads to depression and suicides, which is the 3rd leading cause of death among young age groups. The National Crime Records Bureau (NCRB) (2014) states that India has a suicide rate of 10.6 per lakh (100.000) of the population whereas Himachal Pradesh, which is a relatively small hilly state in the Western Himalayas, has 9.2 per lakh of the population with a 45% increase since 2012. In contrast to the NCRB report, the WHO (2016) states that India has suicide rate of 16.5 per lakh of the population, taking the annual count to 2.57 lakh Indians. This discrepancy could be due to the fact that the NCRB draws data from First Information Reports (FIR) which are often under-reported in Indi, whereas the WHO draws its data from sample registration surveys and medically certified causes of death which are mandatory in the country for legal claims and procedures. Out of the entire Indian population involved in this scenario 6.7% are students of age group 18 - 30 years, with 60% being male and 40% of them being female (NCRB, 2015). A study conducted exclusively for Himachal Pradesh by the Regional Forensic Science Laboratory of Dharamshala concluded that out of all the cases of suicide in Himachal Pradesh, 68.85% are males and 31.15% are females with 66.38% exposure on 21 – 40 years age group, out of which 13.11% are students and around 74.59% of the total population who committed suicide (all sub-groups covered in the forensic study for Dharamshala) preferred indoor closed locations (Pal et al, 2016).

An average human spends 90% of his time inside or around buildings (a membrane) and a plausible quantity of previous studies in this domain suggests that if these buildings are not designed in a balanced way with the human psychology then they can additionally burden the involuntary human attention and adversely affect behavioural and cognitive functions (Evans and McCoy, 1998; Takki et al. 2011; Seidman and Standring 2010; Pegas et al. 2011). Prolonged exposure to such negative environments can lead to development of several psychological ailments, which affect our mood and co-create mental disorders of severe intensities. Buildings affect mental health in direct and indirect ways. Physical contributors such as insufficient amount of ambient light, poor indoor air quality (IAQ), noise and uncomfortable thermal and ventilation conditions cause the direct effects on mental health (Chua et al., 2006; Fang et al., 2004; Kamaruzzaman and Sabrani, 2011; Seppanen, Fisk and Lei, 2006; Wargocki et al., 2006; Bakó-Biró et al., 2012). Indirect effects include the interferences in psychosocial processes like disturbing the sense of belongingness, wellbeing, self-efficacy, commitment, engagement, self-esteem, motivation and satisfaction (Evans, 2003; Carlson et al., 2012).
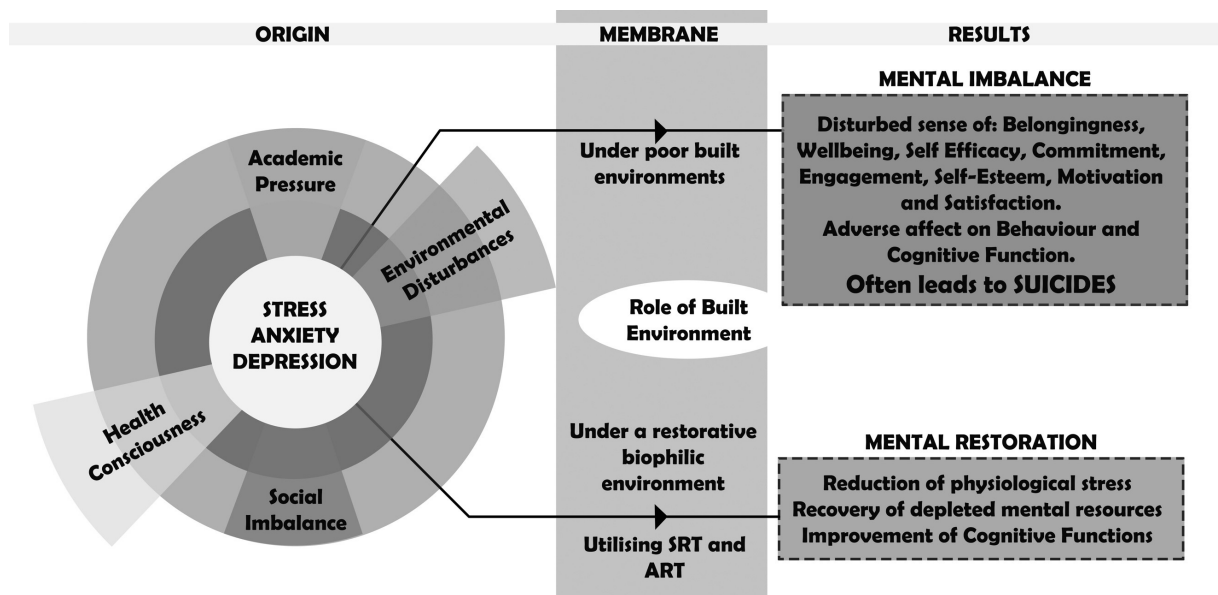

Figure 1. Role of built environment as a membrane in handling stress and anxiety.

Restorative Quality of Environment

In environmental psychology literature, the term 'restoration' has been used as a synonym for other terms such as stress recovery, mental fatigue restoration and improvement of cognitive functions and is associated with renewing or recovery of depleted mental resources through exposure to nature which diminish due to daily work or stressful situations (Ulrich et al., 1991; Kaplan and Kaplan, 1989; Hartig et al, 1996; Korpela et al., 2008). Restorative environments are certain nature rich environments (scenic views, dense and lush green vegetation, natural water bodies and imitations of nature like topiary and biomimicry) which promote and enhance the recovery process of human mental resources.

The term 'biophilia' was first introduced by Fromm (1973) as "the passionate love of life and of all that is alive" and later developed by Wilson (1984) in his 'Biophilia hypothesis', defined it as "the innate tendency to affiliate with other forms of life". Research on restorative environments has grown in quantity within the last three decades since Wilson presented his hypothesis. Since then, several theories suggesting mitigation strategies for psychological stress and anxiety were put forward by various environmental psychologists including Kaplan and Kaplan (1984, 1985 and 1989). The research within this domain developed within two distinctive theories: The Attention Restoration Theory (ART) by Kaplan and Kaplan (1989) and Stress Reduction Theory (SRT) by Ulrich (1991). Stress Reduction Theory (SRT) emphasizes how natural environments like greenery and landscapes can reduce physiological stress and negative emotions (Ulrich, 1983; Ulrich, 1991; Ulrich 1986). Attention Restoration Theory (ART) emphasizes how efficiently the natural environment can capture involuntary attention in an entirely effortless manner, thus easing the mind to recover from an exhausted directed attention system (Kaplan, 1984; Kaplan & Kaplan 1995; Kaplan, 1989).

Perceived Restorativeness: Being Away, Fascination, Extent and Compatibility

Extended and case specific researches on four theoretical restorative factors of ART - Being Away, Fascination, Scope or Extent or Coherence and Compatibility - resulted in the development of Perceived Restorativeness Scale (PRS), which is a tool developed by Hartig et al. (1997) to measure the restorative quality of the environment through evaluating the richness of these four restorative

factors. Being Away represents the experience of the user to sense distance from the source of their mental stress or cognitive burden. Fascination is a facile action of attaining involuntary attention. Extent signifies the ability to interact with the environment without reaching any stage of boredom. Compatibility represents a stage of certain comfort and understanding where the user senses no need to use the intellectual or cognitive effort in order to understand the environment (Rai et. al., 2019). Kaplan & Kaplan (1989) explained that the PRS is not restricted to any one environment and it is more than capable of handling several environments. Thus, it became a valid tool for designers such as architects, landscape planners and urban planners to evaluate the impact of different existing and proposed settings on the human psyche through design (Ivarsson & Hagerhall, 2008).

Design influenced by Nature: Biophilic Design

Biophilic design uses the concept of Biophilia in developing design elements of built environment and surroundings in order to promote a greener and healthier approach (Kellert et al., 2011; Kellert and Wilson, 1995). Designers and researchers have attempted to enlist the elements or patterns of biophilic design to further understanding of how this concept can be developed and applied to design processes. McGee and Marshall-Baker (2015) tried to bridge the gap between architecture and biophilic design by introducing Biophilic Design Matrix (BDM) as a tool to strategically include features of Biophilia so that health and wellbeing can be optimized through design. Berto and Barbiero (2017) introduced the Biophilic Quality Index (BQI) which focused on restoration through an all building generalized tool created to measure the extent of the biophilic quality of the building. The available matrix, index and tools in this context provide a variety of variables for energy efficiency, aesthetic applications and generalized measures to evaluate a built environment. Our work is an endeavour to move further towards a design module which can classify each biophilic environment variable on the basis of its specific psychological impact in defined building typologies (as the users experience different degrees of stress and anxiety) when the variables are used in a design composition. This paper explores the psychological impact of a number of biophilic built environment variables (BEV) proposed by the Terrapin Bright Green framework - Nature in the Space, Natural Analogues and Human Nature Relationship - for the specific cases of student hostels within technical institutes. It also seeks to understand

the mediation offered by a person's emotional stability or mood in self-reporting the perceived restorativeness of his environment[1].

Methodology
Location and Participants
Two autonomous institutes regarded as 'Institute of National Importance' under the Indian higher education system were selected for this study. The institutes A and B are 105 km (65 miles) apart and situated in the foothills of the Himalayas called Shivalik Range in the hilly state of Himachal Pradesh with average elevation 901 meters above msl (mean sea level) and 1189 meters above msl respectively. Institute A is situated on the ridge line almost 200 meters above the town level with picturesque views of the Dhauladhar range of the Himalayas and experiences moderate summer and cold winters. Institute B is situated on the banks of the River Uhl (a tributary of the glacial River Beas) and has a relatively colder climate as compared to Institute A. Institute B has advantage in terms of visual and auditory comfort and the presence and movement of water over Institute A. Institute A has hostels which represents the static growth of the campus from 1980s to present, it includes buildings built completely in local dressed stone and timber to the recent trabeated concrete constructions. Institute B is a relatively new campus with its foundation stone laid after 2010 and thus most of the buildings belong to a significant planned and module-oriented masterplan. Both the institutes however maintain the same roof profile due to the heavy rainfall and cultural relevance.348 students (convenience sample) of the final year of graduate and post graduate technical courses who reside in single occupancy rooms, spread across six hostels from the two selected institutes, participated in the research study. The final year students were selected on the principal basis that they experience far greater levels of stress, anxiety and depression due to career concerns, placements and CGPI improvement peer pressure, in comparison to the students of other years (Waghachavare et al, 2013). The single occupancy rooms reduce the level of interaction within the built-environment and add layers of isolation to the mental persona of the student, thus magnifying the risks of stress, anxiety and depression (Holt et al, 2012). The hostels located on different orientations and locations are rich in natural-scape and have variations in their exposure to biophilic patterns (elements of natural representation). In this way, an adequate sample for a reasonably significant analysis of the collected data was expected. Institute A has hostels which are part of this study in three separate clusters far from each other whereas the hostels of Institute B which are selected for this study are part of a single cluster which shares a common green area in the centre.

Procedure
Three sets of questionnaires (appendix) were adopted in part, developed and rigorously tested at Institute A before being used for this study: Perceived Restorativeness Scale (PRS), Biophilic Environment Variables (BEV) Investigation and Plutchik's emotion wheel. PRS's original version of 26 items, which was developed by Hartig et al. (1997), was used for evaluating perceived restorativeness of the built environment on a 7-point bipolar scale. Biophilic Environment Variables (BEV) Investigation is based on the original Biophilia Hypothesis and later developed postulates of Biophilic Design by Stephen Kellert and the 14 Patterns of Biophilic Design by Browning, Ryan and Clancy (2014). It evaluates the environment variables on a 3-point scale of the intensity and quality of their presence. There is a possibility that students who are emotionally stable may respond more positively to the PRS, so a modified graphical version of Plutchik's (2001) emotion wheel was used to identify and record the three most common emotions of the participants on a varying scale and given the weight of 60%, 30% and 10% respectively on the basis of their frequency of occurrence. The third questionnaire is used to mediate the results between BEVs and PRS so that an unbiased restorativeness review of the environment can be obtained.

The questionnaires were developed and tested through pilot studies carried out 3 months prior to the original study. The observations recorded during the pilot phases were utilized in the later development phases of the final version of the questionnaires. For example, Plutchik's Emotion Wheel Mean was modified for visual understanding as the students found it difficult to associate and communicate their exact emotion with the written words. For this reason, the pictographs were added to enhance the user-friendly design of the experiments.

The Terrapin Bright Green's broad classification-based framework was further broken down into 62 extended individual and detailed variables in order to minutely capture the individual impacts from field surveys and these were then grouped into the major classifications of 14 patterns of biophilic design after analysis in order to facilitate quantifying the results into already set parameters. Some variables were clubbed together and some redistributed if they appeared similar or associational or vice versa during pilot studies.
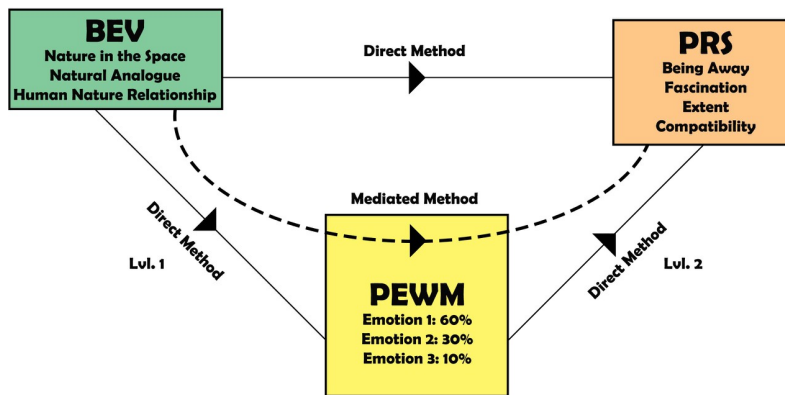
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[1] https://www.terrapinbrightgreen.com/

Figure 2. Tested Methods. **Note**: Biophilic Environment Variable (BEV), Perceived Restorativeness Scale (PRS) and Plutchik's Emotion Wheel Mean (PEWM).

Variable Type	Group ID	Grouped Variables	Recorded Variables
Independent Variables	**NIS**	Nature in the Space	1. Visual Connection with nature 2. Non-visual connection with nature 3. Connection with natural systems 4. Nature and Comfort 5. Light 6. Space
	NATLOG	Natural Analogues	7. Natural Shapes and Forms 8. Material Connection with nature 9. Complexity and order
	HNR	Human Nature Relationship	10. Preservation and Place-making 11. Prospect and refuge 12. Mystery & Risk / Peril
Dependent Variables	**PRS**	Perceived Restorativeness Scale	1. Being Away (BA) 2. Fascination (FA) 3. Extent (EX) 4. Compatibility (CP)
Mediation Variable	**PEWM**	Plutchik's Emotion Wheel Mean	1. Most Frequent Emotion – weight 60% 2. Second Most Frequent Emotion – weight 30% 3. Third Most Frequent Emotion – weight 10%

Table 1. Variables of research study

Four different methods are tested to analyze data acquired from the three different questionnaires used. As shown in Fig. 2, they were developed initially in order to orient the methodology towards the major questions associated with the nature of the research i.e., to ascertain the role of each variable in influencing the overall perceived restorativeness, as well as the mediation offered by the Emotional stability of the student. Firstly, three different regression models were created to address the research questions: a linear regression model between BEVs and PRS prospects (Direct Method), another between BEVs and PEWM (Lvl. 1) and the last between PEWM and PRS prospects (Lvl. 2). Secondly, Sobel mediation analysis was run to test the percentage effect and ratio of indirect to direct method of PEWM as a mediator on the Independent Variable (IV) BEV's impact on Dependent Variable (DV) PRS prospects against the null hypothesis of no effect.

Results

Descriptive Statistics

Across the two institutes, a total of 348 students (290, 83.3% from Institute A; 58, 16.7% from Institute B) responded to the questionnaires through paper medium. Institute and hostel wise population characteristics of the study sample are presented in Table 2. Descriptive statistics of mean and standard deviations of targeted age groups, PRS, BEV and PEWM are presented in Table 3. The respondents had average age of 21.92 years with overall PEWM mean of 1.20 (a positive value on a four axial 7-point bipolar scale indicates a positive emotional mean which refers to significant satisfaction deriving from the surrounding environment). There were some initial observations from the descriptive analysis which are graphically analyzed in Fig. 3. Students who responded highly positive on PRS variables Being Away (BA) and Fascination (FA) were more likely to reside in hostels which have significantly higher average score for Nature in the Space (NIS) on the BEV scale. The students who responded highly positively on the PRS variable Compatibility (CP) were more likely to reside in hostels which have significantly higher average score of Human-Nature Relationship (HNR) on the BEV scale. The highest positive Extent (EX) score was recorded from respondents who reside in hostels which have the lowest average score of NIS on the BEV scale. The hostel complex IITM of Institute B had higher qualitative and quantitative presence of BEVs as compared to the average BEVs of hostels of Institute A.

	Institute		Hostel						
	A	**B**	**DBH**	**HH**	**MMH**	**PGH**	**VBH**	**IITM**	**Total**
N	290	58	47	90	58	15	80	58	348
Percent	83.3	16.7	13.5	25.9	16.7	4.3	23	16.7	100
	Gender		**Educational Courses**						
	Male	**Female**	**B.Tech**		**B.Arch**	**M.Tech**	**M.Arch**	**M.Sc**	
N	333	15	267		7	56	4	14	348
Percent	95.7	4.3	76.7		2	16.1	1.1	4.0	100

Table 2. Descriptive statistics of frequency and percentage of surveyed sample from each hostel and institute.

Aspects	Min.	Max.	Mean	Std. Deviation
Age	20	31	21.92	1.695
Plutchik's Emotion Wheel Mean (PEWM)	-2	3	1.20	1.065
PRS Variables				
1. Being Away	-11	19	9.07	5.788
2. Fascination	-18	28	10.84	10.297
3. Extent	-15	9	-5.20	4.972
4. Compatibility	-8	31	11.98	7.767
Biophilic Environment Variables (BEV)				
1. Visual Connection with nature	0	18	11.04	5.953
2. Non-visual connection with nature	0	5	1.91	1.340
3. Connection with natural systems	0	4	2.36	1.478
4. Nature and Comfort	0	5	2.60	1.256
5. Light	1	14	8.95	3.287
6. Space	1	10	6.99	2.363
∑ (1-6): Nature in the Space (NIS)	2	56	33.85	15.677
7. Natural Shapes and Forms	0	12	7.24	4.081
8. Material Connection with nature	0	4	1.85	1.032
9. Complexity and order	0	6	3.73	1.950
∑ (7-9): Natural Analogues (NATLOG)	0	22	12.82	7.063
10. Preservation and Place-making	0	11	5.15	3.019
11. Prospect and refuge	0	9	4.76	2.479
12. Mystery & Risk / Peril	0	7	3.54	2.095
∑ (10-12): Human-Nature Relationship (HNR)	0	27	13.45	7.593

Table 3. Descriptive statistics of mean and standard deviations of surveyed sample from all hostels.
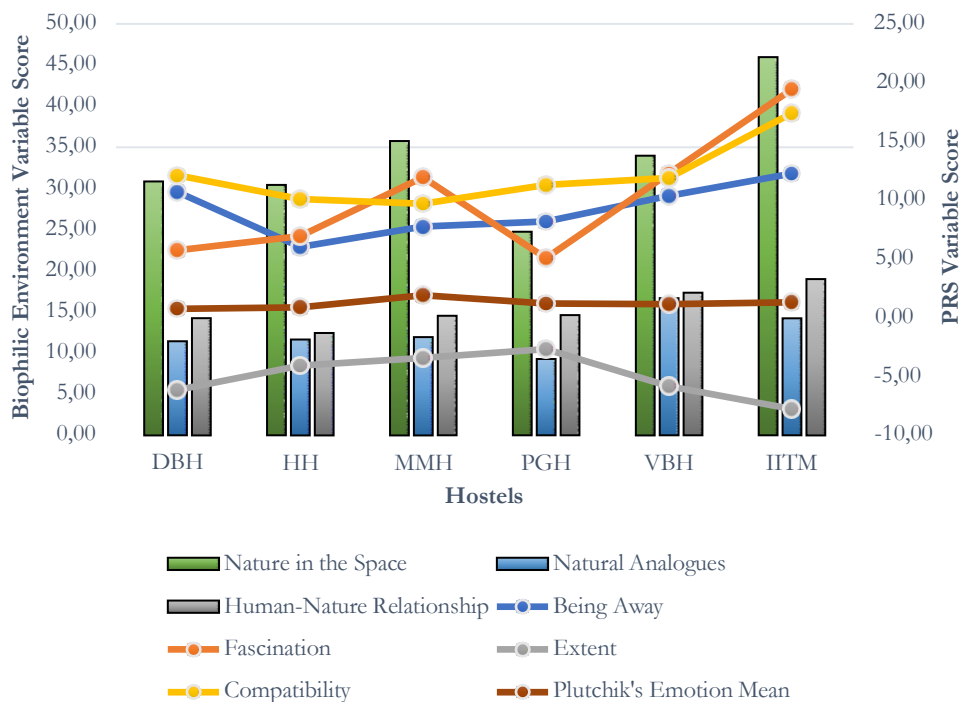

Figure 3. PRS and Biophilic Environment Variables: Comparison of Means for all surveyed hostels.

24

Regression Analysis

The regression analysis results were obtained from two different models: 1) Direct method between BEVs and PRS prospects and 2) Direct method Lvl. 1 between BEVs and PEWM are shown in Table 4. The standardized beta coefficient values (β) and adjusted R square for the whole regression model are highlighted if found significant. Out of the 48 tested cases of variable combinations in direct method regression between BEVs and PRS perspectives, 22 were found to be significantly associated. The significantly associated BEVs and PRS perspectives are Being Away (adjusted R square = .499, p < .01), Fascination (adjusted R square = .577, p < .01), Extent (adjusted R square = .170, p < .01) and Compatibility (adjusted R square = .631, p < .01). Although the direct method model shows significant associations between the grouped variables and PRS perspectives,

not all the BEVs established significant relationship. The most significant associations are shown by BEV Visual connection with nature which showed significant correlation with all four PRS perspectives followed by Non-visual connection with nature and Prospect & Refuge which showed significant correlation with at least three PRS perspectives. The BEVs Connection with natural systems, Natural shapes and forms, Material connection with nature and Complexity & Order showed significant correlation with at least two PRS perspectives whereas Nature & Comfort and Light significantly correlated with at least one PRS perspectives. Space is the only BEV which failed to establish any connection with the PRS perspectives. In Direct method Lvl. 1, which involves regression analysis between BEVs and PEWM, four out of the twelve variables were found to have significant correlations with the full model yielding significant association (adjusted R square = .452, p < .01).

Linear Regression Model		Direct Method				Direct Method
		DV under PRS				Lvl. 1
IV under Biophilic Environment		Being Away	Fascination	Extent	Compatibility	PEWM
Nature in Space	Visual Connection with nature	**.313**	**.212**	**.368**	**-.227**	**.323**
	Non-visual connection with nature	-.075	**.146**	**-.239**	**.224**	**.112***
	Connection with natural systems	.103	**.133**	**-.309**	.092	.027
	Nature & Comfort	-.022	**.1***	-.103	.08	.108
	Light	-.04	-.061	.058	**.164**	-.101
	Space	.048	.064	-.149	.076	.100
Natural Analogue	Natural Shapes & Forms	**.191**	**.364**	-.156	-.024	.108
	Material Connection with nature	.025	**-.129**	.094	**.235**	**-.121***
	Complexity & order	.099	.019	**.219**	**-.119***	**.240**
Human-Nature Relationship	Preservation and Place-making	.082	-.046	-.164	**.24**	-.053
	Prospect and refuge	**.149**	**.127**	.008	**.232**	-.069
	Mystery & Risk / Peril	-.024	-.009	-.022	**.125**	.029
Adjusted R square		**.499**	**.577**	**.170**	**.631**	**.452**

Note: ** p < 0.01; *p < 0.05; IV = Independent Variables, DV = Dependent Variables.

Table 4. Regression Results: The effect of Biophilic Environment Variables (BEV) on Perceived Restorativeness (PRS) and Plutchik's Emotion Wheel Mean (PEWM); Standardized beta coefficients.

Table 5 represents the regression model results of Direct method Lvl. 2 between PEWM and PRS prospects. PEWM is found to influence only Being Away (β = .546, adjusted R square = .296, p < .01) and Fascination (β = .408, adjusted R square = .382, p <

.01) out of the four PRS prospects. Extent (β = -.125, adjusted R square = .013, p < .05) and Compatibility (β = .266, adjusted R square = .068, p < .01) showed significant yet weak or negligible association with PEWM.

Linear Regression Model	Direct Method Lvl. 2: **DV under PRS**			
IV	Being Away	Fascination	Extent	Compatibility
PEWM	.546**	.408**	-.125*	.266**
Adjusted R square	.296**	.382**	.013*	.068**

Note: ** p < 0.01; *p < 0.05; IV = Independent Variables, DV = Dependent Variables.

Table 5. Regression Results: The effect of Plutchik's Emotion Wheel Mean (PEWM) on Perceived Restorativeness (PRS); Standardized beta coefficients.

Mediator: PEWM	DV - PRS											
	Being Away			Fascination			Extent			Compatibility		
IV - BEV	Sobel	% Effect	Ratio I/D	Sobel	% Effect	Ratio I/D	Sobel	% Effect	Ratio I/D	Sobel	% Effect	Ratio I/D
Visual Connection with nature	4.47**	24.06	0.316	5.98**	28.25	0.393	-1.32	51.56	1.06	-0.95	-7.6	-0.07
Non-visual connection with nature	6.54**	55.56	1.25	6.97**	43.05	0.756	-0.73	8.93	0.098	0.95	4.04	0.042
Connection with natural systems	6.15**	31.45	0.458	6.93**	33.85	0.511	0.215	-1.78	-0.01	0.91	4.07	0.042
Nature & Comfort	6.64**	47.38	0.9	7.30**	40.9	0.692	-0.88	15.65	0.18	1.3	8.44	0.092
Light	6.23**	41.85	0.719	6.79**	43.77	0.778	-1.58	34.42	0.52	1.86	9.34	0.103
Space	6.18**	32.94	0.491	7.23**	38.14	0.616	-0.24	3.1	0.03	0.008	0.042	0.000
Natural Shapes & Forms	5.63**	24.72	0.328	6.95**	29.05	0.409	-0.36	5.57	0.05	-0.242	-1.26	-0.012
Material Connection with nature	5.20**	32.28	0.476	5.48**	43.5	0.769	-1.65	24.36	0.32	2.07	5.75	0.061
Complexity & order	5.64**	30.71	0.443	7.29**	41.28	0.703	-1.86	94.71	17.91	0.087	0.626	0.006
Preservation & Place-making	5.77**	26.86	0.367	6.30**	35.23	0.543	-0.58	4.77	0.05	0.64	1.64	0.016
Prospect & Refuge	4.46**	25.48	0.341	4.60**	30.9	0.448	-1.39	10.2	0.113	2.34	4.75	0.049
Mystery & Risk / Peril	5.61**	31.8	0.466	6.00**	38.42	0.624	-0.93	8.11	0.088	1.25	3.22	0.033

Table 6. Sobel Mediation Analysis for Indirect and Direct methods. **Note:** The table summarises 48 different Sobel mediation analyses results highlighting significant indirect effects, ** p < 0.01; % Effect = Percentage of the total effect that is mediated; Ratio I/D = Ratio of the indirect to the direct effect; IV = Independent Variables, DV = Dependent Variables, PRS = Perceived Restorativeness Scale, PEWM = Plutchik's Emotion Wheel Mean.

Sobel mediation analyses was conducted to elaborate the relationship between BEVs and PRS perspectives when PEWM acts as a mediating variable. Table 6 summarizes results of 48 different mediation analyses as three different values to explain the effect: 1. Sobel values (s), 2. Percentage of the total effect that is mediated (% effect) and 3. The ratio of indirect to direct effect (Ratio I/D). The

Sobel mediation analyses results confirm and strengthen the conclusion of Lvl.2 regression results that PEWM influences only Being Away and Fascination out of the four PRS prospects. The BEVs which are majorly influenced (above 40%) by the PEWM mediation for PRS prospect Being Away are Non-visual connection with nature (s = 6.54, % = 55.56, Ratio I/D = 1.25, p < 0.01), Nature & Comfort

(s = 6.64, % = 47.38, Ratio I/D = 0.9, p < 0.01) & Light (s = 6.23, % = 41.85, Ratio I/D = 0.719, p < 0.01). The BEVs which are majorly influenced (above 40%) by the PEWM mediation for PRS perspectives Fascination are Non-visual connection with nature (s = 6.97, % = 43.05, Ratio I/D = 0.756, p < 0.01), Nature & Comfort (s = 7.30, % = 40.9, Ratio I/D = 0.692, p < 0.01), Light (s = 6.79, % = 43.77, Ratio I/D = 0.778, p < 0.01), Material Connection with Nature (s = 5.48, % = 43.5, Ratio I/D = 0.769, p < 0.01), Complexity and Order (s = 7.29, % = 41.28, Ratio I/D = 0.703, p < 0.01).

Discussion

The data collected suggests that students living in hostel rooms which had higher quantity and quality of BEVs were more likely to self-respond highly positively on PRS and this association was significantly mediated by PEWM of the students. The results lead us to the conclusion that the emotional stability represented by PEWM plays a significant role in the perception of hostel rooms as psychologically restorative environments when there is quantitative and qualitative presence of BEVs in them. The BEVs are strong proponents of creating restorative environments but their impact is significantly influenced by the emotional state of the resident students. The data further suggests that BEVs Visual connection with nature, Non-visual connection with nature, Material connection with nature and Prospect & Refuge have direct influence on the emotional stability of the students, their impact can be maximized through experimental design solutions and this in turn can increase the ability of the student to perceive their environments as restorative. Table 4 can be used to prepare a priority-wise hierarchy of proportionate use of BEVs so that a balanced environment can be created for user specific needs. Every space has a different use and it also differs in the degree of restoration they provide. However, the hostel rooms have limited space and scope for internal design interventions. The biophilic design of hostels could expand and seek more from its surrounding environment. It could thus be concluded that the design should not promote the idea of containment for students, rather it should just play a role of a membrane between them and the nature. The hostels should protect the students from the eventual hostilities of the natural environments (severe weather and climatic conditions) while making them aware of the surrounding environment in order to strengthen BEV Prospect and Refuge. They should also offer scope to interact with the natural environments so that the highly restorative BEVs

Visual connection with nature, Non-visual connection with nature, Material connection with nature, can be an active part of student life.

The hostels serve as the home to the students of technological branches for at least 4 to 5 years and play a significant role in influencing their emotional stability. If this is consolidated over time, then it may affect the development of their personality at the initial stages of their career when they experience severe levels of stress and anxiety. We believe that the results of our study point to how both emotional stability and the built environment play a role in the student's perception of their environment as restorative and can indicate a range of possible developments in this particular domain. If the BEVs are slowly affecting the restorative quality of the environment as well as the emotional stability of the student, then more research needs to be undertaken in order to understand their potential in creating a psychologically healthy society and restorative resident campuses for institutes. This study offers a partial conceptual framework for further investigating the modern daily life psychological health problems of the students around the world. We hope that it can provide a useful tool for environmental psychologists and designers in order to create and offer mentally sustainable built environments.

Conclusions

The study investigated possible triangular associations between Biophilic Environment Variables (BEVs), Emotional Stability (PEWM) and Perceived Restorativeness (PRS). It was limited in its approach to only final year students of technical courses who reside in single occupancy hostel rooms. The samples taken from each hostel were not of the same size but followed the same population to sample ratio. The two selected institutes had variations in the type of micro-climates with Institute A being a bit warmer than Institute B. The results are specific to the student hostel environments and should not be taken as generalizable for other similar studies. At the same time, we believe that the tools and questionnaires which were part of this study could be modified and reproduced within similar studies. Future research could attempt to enlarge the sample sizes with additional biophilic environment variables if available in any specific region or be created through redistribution of the existing tools. While our study targeted specific to the BEVs and psychological domains, other studies could include broader social and physiological health measures.

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28

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Appendix – Survey Questionnaires - © Farhan Asim & Venu Shree

Biophilic Environment Variables (BEV) Investigation for Student Hostels

Likert Scale				NA	Apparent	Strong
NATURE IN THE SPACE	Environmental Processes	Visual Connection with Nature	Vibrant colours			
			Presence of water			
			Reflections*			
			Presence of Sunlight			
			Presence of plants			
			Presence of animals			
			Preferred views and vistas			
			View of Clouds*			
			Facade greening			
			Geology and landscape			
			Diversity in habitats and Ecosystems (Plants, Animals, Birds, etc.)			
		Non-Visual Connection with Nature	Auditory Variability (Natural Sounds)			
			Haptic Variability (Textures)			
			Olfactory Variability (Fragrance)			
			Gustatory Variability (Taste)			
	Natural Patterns & Processes	Connection with Natural Systems	Growth and change			
			Dynamic balance and tension			
		Nature and Comfort	Integration of parts to wholes			
			Ease of access to nature			
			Natural Ventilation**			
	Light & Space	Light	Natural Light			
			Filtered and diffused light			
			Light and shadow*			
			Reflected light			
			Light as shapes and form			
			Warm Light**			
		Space	Spaciousness			
			Spatial variability			
			Inside-outside spaces			
			Space as shape and form			
			Transitional spaces			
			Spatial Harmony			

*Elements of Non-Rhythmic Sensory Stimuli
**Elements of Thermal and Air Flow Variability

Legends: 2 - Strong, 1- Apparent, NA - Not Available				NA	Apparent	Strong
NATURAL ANALOGUES	Simulation of Natural Features	Natural Shapes & Forms	Botanical motifs			
			Tree and columnar supports			
			Animal motifs			
			Shells & Spirals			
			Egg, oval and tubular forms			
			Arches, vaults, domes			
			Shapes which resist straight lines and right angles			
			Biomorphy			
			Biomimicry			
			Geomorphology (Rocks, stones, pebbles)			
		Material Connection with Nature	Natural materiality			
			Natural texture			
		Complexity & Order	Information richness			
			Complementary contrasts			
			Hierarchically organized ratios and scales			
HUMAN-NATURE RELATIONSHIP	Place-Based Relationship	Preservation & Place-making	Indigenous materials			
			Landscape features that define building form			
			Integration of cultural and ecological values / elements			
			Sustainability			
			Spirit of place			
			Avoiding placeless-ness			
	Evolved Human-Nature Relationship	Prospect & Refuge	Unrestricted open and vast views			
			Security and protection			
			Mastery and control			
			Affection and attachment			
			Attraction and beauty			
		Mystery & Risk/Peril	Curiosity and enticement			
			Exploration and discovery			
			Fear and awe			
			Reverence and spirituality			

Perceived Restorativeness Scale (PRS) for Student Hostels
(Based on PRS – 26 by Hartig, Evans, Korpela & Garling, 1997 and ART by Kaplan & Kaplan, 1989)

This survey will collect information about your perception of the hostel environment. Please, indicate the extent to which the given statement describes your experience in this built environment on the below 7 points bipolar scale.

Factors	Statement	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
Being Away	Being here is an escape experience.							
	Spending time here gives me a break from my day-to-day routine.							
	It is a place to get away from it all.							
	Being here helps me to relax my focus on getting things done.							
	Coming here helps me to get relief from unwanted demands on my attention.							
Fascination	This place has fascinating qualities.							
	My attention is drawn to many interesting things.							
	I want to get to know this place better.							
	There is much to explore and discover here.							
	I want to spend more time looking at the surroundings.							
	This place is not at all boring.							
	The setting is fascinating.							
	There is a lot worth looking at here.							
Extent	There is too much going on.							
	It is a confusing place.							
	There is a great deal of distraction.							
	It is chaotic here.							
Compatibility	Being here suits my personality.							
	I can do things I like here.							
	I have a sense that I belong here.							
	I can find ways to enjoy myself here.							
	I have a sense of oneness with this setting.							
	There are landmarks to help me get around.							
	I could easily form a mental map of this place.							
	It is easy to find my way around here.							
	It is easy to see how things are organized.							
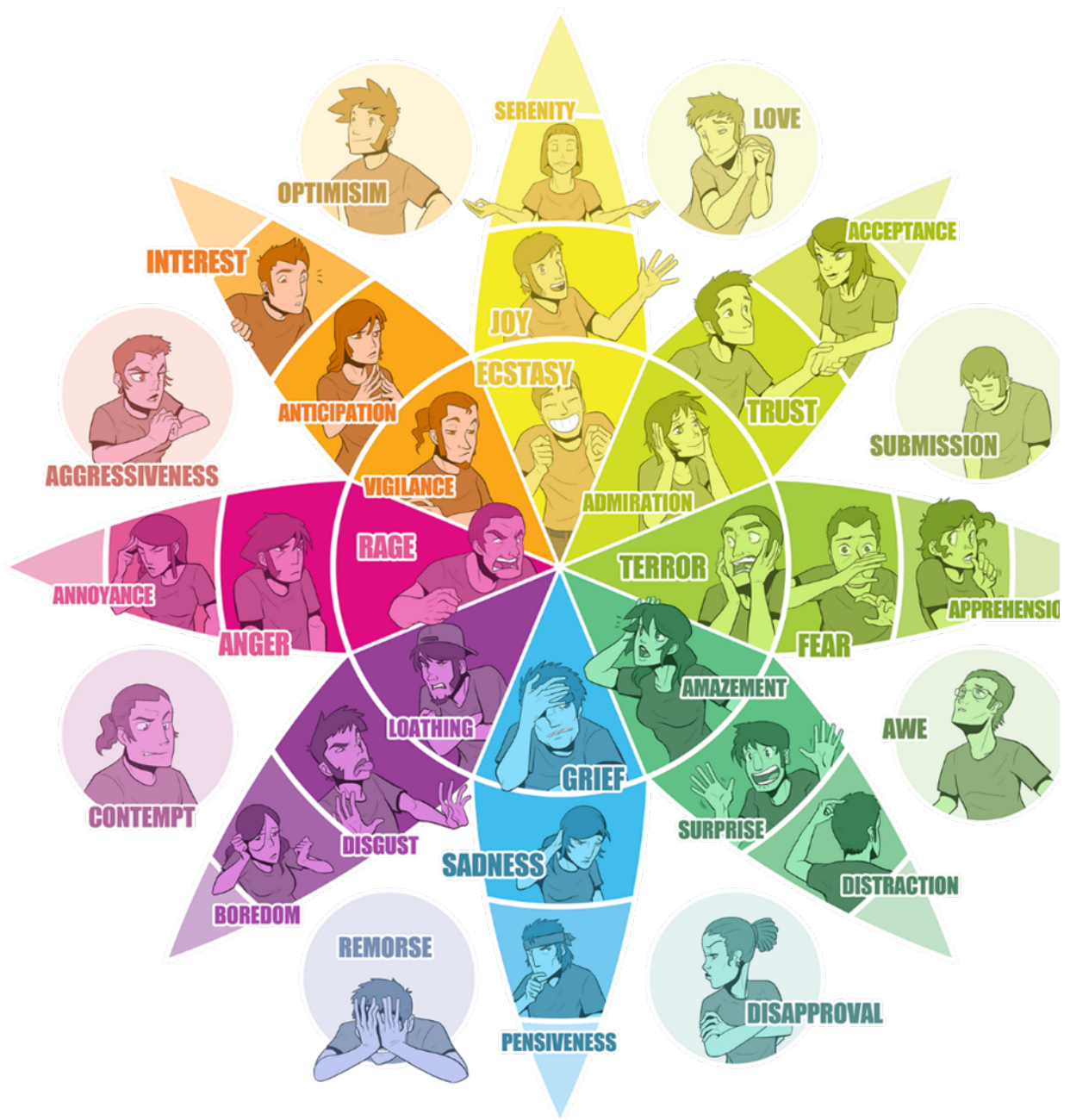
A modified version of Plutchik's psycho-evolutionary emotion wheel.

List of emotions with their meanings:

1. **Acceptance:** willingness to tolerate a difficult situation.
2. **Admiration:** respect and warm approval.
3. **Apprehension:** anxiety or fear that something bad or unpleasant will happen.
4. **Ecstasy:** an overwhelming feeling of great happiness or joyful excitement.
5. **Fear:** an unpleasant emotion caused by the threat of danger, pain, or harm.
6. **Joy:** a feeling of great pleasure and happiness.
7. **Love:** a strong feeling of affection.
8. **Serenity:** the state of being calm, peaceful, and untroubled.
9. **Submission:** the action of accepting or yielding to a superior force or to the will or authority of another person.
10. **Terror:** extreme fear.
11. **Trust:** firm belief in the reliability, truth, or ability of someone or something.
12. **Amazement:** a feeling of great surprise or wonder.
13. **Surprise:** a feeling of mild astonishment or shock caused by something unexpected.
14. **Distraction:** a diversion or recreation.
15. **Awe**: a feeling of reverential respect mixed with fear or wonder.
16. **Disapproval:** possession or expression of an unfavorable opinion.
17. **Pensiveness:** engaged in, involving, or reflecting deep or serious thought.
18. **Sadness:** the condition or quality of being sad.
19. **Grief:** an instance or cause of intense sorrow.
20. **Remorse:** deep regret or guilt for a wrong committed.
21. **Boredom**: the state of feeling bored
22. **Disgust:** a feeling of revulsion or strong disapproval aroused by something unpleasant or offensive.
23. **Loathing:** a feeling of intense dislike or disgust; hatred.
24. **Contempt:** the feeling that a person or a thing is worthless or beneath consideration.
25. **Annoyance:** the feeling or state of being annoyed; irritation.
26. **Anger:** a strong feeling of annoyance, displeasure, or hostility.
27. **Rage:** violent uncontrollable anger.
28. **Aggressiveness:** hostile or violent behavior.
29. **Interest:** the feeling of wanting to know or learn about something or someone.
30. **Anticipation:** the action of anticipating something; expectation or prediction.
31. **Vigilance:** the action or state of keeping careful watch for possible danger or difficulties.
32. **Optimism:** hopefulness and confidence about the future or the success of something.