University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Examining the Impacts of Green and Blue Biophilic Landscapes on University Students' Stress and Anxiety

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Prepared for:

Course Code: PSYC 421

University of British Columbia

Date: 14 April 2022

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PSYC 421: Environmental Psychology

Theme: Biophilic Design

April 14th, 2022

Executive Summary

The current study explored how viewing green or blue biophilic outdoor landscapes impacts university students' stress and anxiety? To operate the study, we hypothesized that a combination of green and blue biophilic landscapes would reduce stress and anxiety to a greater extent than individual elements or non-biophilic urban landscapes. We conducted an online experiment using a between-subject design on the UBC Qualtrics Platform. Participants were randomly assigned to one of the four conditions with different pictorial window views (ocean view, forest view, combined view and urban view) and asked to imagine studying and living in the environments shown in the pictures. Their stress and anxiety levels were measured using the Depression Anxiety Stress Scale (DASS-21) questionnaire. An one-way between groups ANOVA and post hoc Turkey test revealed that participants in the forest view condition showed the greatest reduction of stress and anxiety, followed by the ocean view and combined view condition. Therefore, the results do not support our hypothesis. This can be due to the lack of ecological validity of pictures used and sampling bias. The current research can be applied to future residential zoning plans at UBC to maximize the forest and ocean views exposed to students.

Introduction

Biophilia hypothesis proposes that we have an innate human need to connect with nature (Wilson, 1984). Biophilic design is a strategy that seeks to satisfy this inherent human need by incorporating natural elements into architectural design (Ewert et al., 2021). Natural landscapes refer to places and spaces that include natural elements such as trees and water (Ewert et al., 2021). Window views of natural landscapes such as forests and seascapes are considered key elements of biophilic design (Xue et al., 2019). Two of the most common window views of landscapes are green biophilic landscape and blue biophilic landscape. The window view of nature which features green space (e.g., trees and vegetation) is considered a green biophilic landscape, while the window view of nature which features blue space (e.g., water) is considered a blue biophilic landscape (Kellert & Calabrese, 2015). Research has shown the benefits of viewing green and blue biophilic landscapes on people's psychological well-being (Ryff & Keyes, 1995), including reducing stress and depression (Van Aart et al., 2018; Dempsey et al., 2018). However, previous research has not discussed whether viewing one of them has more positive impacts on people's well-being than viewing the other.

Research on green and blue spaces can provide insight into the impacts of viewing green and blue biophilic landscapes on people's well-being. As to whether viewing green or blue space can have different impacts on people's well-being, researchers found inconsistent results. In a study, Ulrich et al. (1991) compared people's degree of psychological restoration from a stressful situation after watching videos of either a natural vegetation scene (green space) or a water scene (blue space). They found no significant differences between vegetation and water settings. However, a study done by Ulrich (1981) showed that the water view had a more positive influence on people's emotional states than the vegetation view. Similarly, White et al. (2013) found that people's rating of positive affect was higher for blue space than for green space. Regarding studies that discussed the effects of the combination of green and blue spaces on people's well-being, White et al. (2010) found that the perceived restorativeness of the combined view of vegetation and water was higher than any one of them alone. Considering the inconsistent findings in previous research and the fact that these

studies focused on the green and blue spaces (direct views of nature) instead of green and blue biophilic landscapes (indirect window views of nature), the current study explored the impacts of viewing green and blue biophilic landscapes on people's well-being. Our study focused on university students, a group of people who feel high levels of stress interfering with their daily life (Cochrane, 2019). Our research question addressed "How does viewing green or blue biophilic outdoor landscapes impact university students' stress and anxiety?". Based on previous research, we hypothesized that the combination of green and blue biophilic landscapes would reduce stress and anxiety to a greater extent than individual elements or non-biophilic urban landscapes.

The driving forces behind our participants to study in a room with a green biophilic landscape can be motivation to connect with nature, enjoying the visual aesthetics of the landscape (e.g., large size of trees) and the emotional benefits of natural elements (e.g., feelings of relaxation and recovery; Nutsford et al., 2013). Limiting factors may be a lack of awareness of the benefits of biophilic design, the inability to obtain green biophilic buildings due to limited urban green space, and the cost of biophilic buildings. The driving forces behind our participants to study in a room with a blue biophilic landscape can be motivation to connect with nature, enjoying the visual aesthetics of the landscape (e.g., wide stretch of water, freshness and cleanliness) and the emotional benefits of natural elements (e.g., feelings of calm; Völker & Kistemann, 2011). Restraining factors can be a lack of awareness of the benefits of biophilic design, lack of access to blue biophilic buildings due to the scarcity of ocean view, and the cost of biophilic buildings.

Methods

Participants

Using an effect size of 0.2, $\alpha = 0.05$, power = 0.8, we need a minimum of 280 participants in our study (UBC students, age over 18 years old), with at least 70 subjects in each condition. In the end, a total of 291 participants completed this survey (participants who started but failed to finish were excluded). The average age was 22 years old (M=22, SD=3.02; see Appendix A, *Figure 1*). For gender, 62% of the participants were women, 36% were men, and 2% were other (see *Figure 2*); for cultural background, 70% were East Asian, 10% were European, and 20% were other (see *Figure 3*); for education level, 68% either had a bachelor's degree or were in the process of obtaining one (see *Figure* 4). Overall, 74% of the participants were UBC students. 47% of participants were fourth year undergraduates.

Conditions

Our independent variable was different types of window views. Using a between-subject design, we randomly assigned participants to one of the four conditions (ocean view condition, forest view condition, combined view condition and urban view condition). In each condition, participants were shown a picture of a student residence with one of the four different window views: 1) ocean view, which refers to a large area of water covering 50% of the area of the picture (see Appendix B, *Figure 1*, *N*=70), 2) forest view, which refers to a large area of trees covering 50% of the picture (see *Figure 2*, *N*=76), 3) a combination of the ocean and forest view, in which half of the window view is ocean and the other half is forest (see *Figure 3*, *N*=73), and 4) an urban view which was our control condition, which refers to all high-rise buildings in the city for both sides of the window (see *Figure 4*, *N*=72). Participants were asked to imagine living and studying in the residence

shown in the picture. The inside study environment including a wooden desk and a wooden chair was controlled across the four conditions.

Measures

Participants' stress levels (dependent variable#1) and anxiety levels (dependent variable #2) were recorded and measured using the Depression Anxiety Stress Scale (DASS-21) questionnaire. The DASS-21, taken from the study of Lovibond & Lovibond (1995), is a self-reported 21-item scale designed to measure emotional distress in three subcategories of depression, anxiety, and stress. DASS-21 has been proven to have high reliability; the Cronbach's alpha was 0.92 for the depression, 0.90 for the stress, and 0.86 for the anxiety, indicating a good internal consistency for each subscale (Vignola et al., 2013; Vignola et al., 2014); the convergent validity coefficient was 0.87 (Lee, 2019).

In the self-reporting questionnaire, 14 items from *DASS-21* (7 about stress and 7 about anxiety, see Appendix C, *Figure 1*) were chosen to measure participants' stress levels (e.g., I found it hard to wind down) and anxiety levels (e.g., I experienced breathing difficulty) based on a four-point rating scale. Participants were asked to rate to what degree the statements can be applied to them after seeing the picture being provided, with 0 = "did not apply to me at all" to 3 = "applied to me very much or most of the time". According to the instructions of DASS-scale (Lovibond & Lovibond, 1995), the result was obtained by adding the scores of each seven-item scale and then multiplying by two. Higher scores represented higher anxiety or stress. Demographic information such as gender, age, year level, ethnicity, and educational level were also gathered (see *Figure 2*). All data were collected with the Qualtrics survey.

Procedure

Due to the current situation with COVID-19, data collection was recruited exclusively online. Our survey was developed and distributed using the UBC Qualtrics platform. Participants received a link to the survey through different social media (Facebook, WeChat, Whatsapp, and Instagram). After clicking the link and indicating their consent to participate, participants would proceed to the survey. In the first part of the survey, participants were randomly assigned to see one of the four pictures (ocean view, forest view, a combination of ocean and forest view, or an urban view) and were asked to imagine studying or living in this place. After viewing the picture, participants answered the 14 questions related to stress and anxiety chosen from DASS-21 with a 4 point Likert scale (see Appendix C, *Figure 1*). Participants then answered a few demographic questions (see *Figure 2*). After they completed the study, a debriefing form was provided. Everything in the survey remained the same, except for the pictures they saw.

Results

Previous research has shown a strong correlation between stress and anxiety scores (Coker et al., 2018). Within our expectations, our findings were consistent with previous studies. Strong correlations between stress and anxiety were noted across the four conditions (combined view condition $r = 0.90$, forest view condition $r = 0.80$, ocean view condition $r = 0.84$, and city view condition $r = 0.93$). In addition, there were statistically significant effects ($p<0.001$) between the stress and anxiety across four conditions.

Stress: An one-way between groups ANOVA revealed a significant main effect ($p<0.05$; see Appendix D, *Table 1.1*) of the biophilic landscapes participants viewed on their stress score [$F(3, 287)=3.48$, $p=0.01$, $\eta^2=0.035$]. Post hoc Turkey test revealed that participants' stress

scores in the forest view condition (M=8.97, SD=7.99) were significantly lower than the stress scores in the control condition (M=14.00, SD=12.06) (p<0.05). Participants' stress scores in the ocean view condition (M=10.06, SD=9.73) were significantly lower than stress scores in the control condition (M=14.00, SD=12.06) (p<0.10). Participants' stress scores in the combined view condition (M=10.22, SD=10.10) were significantly lower than the stress scores in the control condition (M=14.00, SD=12.06) ($p>0.10$).

Anxiety: An one-way between groups ANOVA revealed a significant main effect (p<0.05; see Appendix D, Table 2.1) of the biophilic landscapes participants viewed on their anxiety score [F(3, 287)=4.10, p=0.01, η^2=0.04] (see *Table 2.1*). Post hoc Turkey test revealed that participants' anxiety scores in the forest view condition (M=7.79, SD=7.29) were significantly lower than the anxiety scores in the control condition (M=13.25, SD=11.63) (p<0.05). Participants' anxiety scores in the ocean view condition (M=9.26, SD=9.21) were significantly lower than anxiety scores in the control condition (M=13.25, SD=11.63) (p<0.10). Participants' anxiety scores in the combined view condition (M=10.71, SD=10.78) were significantly lower than the anxiety scores in the control condition (M=13.25, SD=11.63) ($p>0.10$) (See *Table 2*).

Our results did not support our hypothesis. From the results, we found that the forest condition was the most effective in reducing stress and anxiety. However, the combined conditions did not show any effect, either in reducing stress or anxiety. Our results suggested that individual elements (green or blue biophilic landscapes) can reduce stress and anxiety; however, once these two factors are present, the effect diminishes.

Discussion

The central question of our research stated how viewing green or blue biophilic outdoor landscapes impacts students' stress and anxiety. Our results revealed that the forest view was the most effective in reducing stress and anxiety, followed by the ocean view. Our research is inconsistent with the previous study which suggested that blue space may have an especially positive influence on people's emotional state and psychological well-being (Ulrich, 1981; White et al., 2010; White et al., 2013). This inconsistency can be explained by while blue space is associated with a higher preference rating of attractiveness and willingness to pay, green space may be related to a more significant sense of restoration (White et al., 2013), which can lead to a more substantial reduction in stress and anxiety. Moreover, our results revealed that the combined view had no significant effect on reducing stress or anxiety. This is inconsistent with previous research showing that combined views of green and blue spaces are more perceptually restorative than either alone. This inconsistency may be because people have different perceptions of their psychological state (stress and anxiety) when viewing green/blue spaces versus green/blue natural landscapes.

We acknowledged a few limitations of our study. The participants in our study were primarily female and of East Asian descent. Owing to this knowledge the findings from our study may not generalize well to the total population or other gender groups. Second, because we used photoshopped images of the four conditions, these pictures may not represent enough ecological validity or portray real-world imaging to that of real green and blue biophilic landscapes. Third, because of the ongoing COVID-19 pandemic, our experiment was done online, where we gathered our sample and administered the survey. Naturally, this limits not only our in-person engagement with study participants, but also how the research

was conducted. If COVID-19 had not been a detrimental factor, perhaps we could have organized the study in a room where we can imply more experimental control. Moreover, the primary challenge of our study was to obtain high ecological validity. Since our research was conducted online, the images used were photoshopped and not pictures of a true biophilic environment. This event challenges our efforts to validate and represent the real world as it exists in nature. To prevent this challenge from reoccurring for future replications of our study, we suggest altering a few aspects of the experiment. Utilizing images of the real world instead of photoshop promotes high ecological validity that we can generalize to real-life situations (Gouvier et al., 2014). Moreover, using a larger, diverse population of people with different backgrounds and genders can further expand the possibilities of analyzing how viewing green or blue biophilic outdoor landscapes impact students' stress and anxiety.

Even so, our study is the first to investigate the potentially different impacts of green and blue biophilic landscapes on people's well-being. The implications of our study suggest incorporating individual components of forest and ocean landscapes on university campuses will benefit students' overall mental well-being, promoting a greener and healthier learning environment. Further incorporating such biophilic designs into our environment also incorporates nature, allowing us to design new spaces that are both inspired and regenerated (Hady, 2021). Such spaces not only connect humans to their environment, but also preserve natural resources and global ecosystems to support health and well-being (Sphera, 2020) for years to come.

Recommendation

Since stress and anxiety have a very serious impact on college students, our clients should pay more attention to how to help UBC students reduce stress through a biophilic setting. According to the UBC's new Sustainability Hub Plan, UBC is planning to build some residences to improve students' accommodation. The results of the current study imply that living in rooms with window views of forests or the ocean can reduce anxiety and stress levels. Previous research has also implied that maintaining green and blue space benefits human mental health and helps humans restore from stress and mental fatigue (Couper, 2018; Mireia, 2015; Madureira et al., 2015; Grahn et al., 2010). Our first suggestion for the clients is to build new residences or study places nearby forests or the seaside as many as possible in the future. In this way, students who live in residence can open the window to see the forest or the ocean. Moreover, UBC has a good geographical advantage. The campus is surrounded by ocean and green plants, so the client should make good use of these geographical advantages when building residences in the future. This can promote the overall mental health of UBC students and reduce stress and anxiety. Secondly, considering increasing the green space near the original dormitory and library, we suggest our clients plant more trees and increase the visual area of the window to let the students see more green. People who live near trees report a stronger sense of connection to nature, which is associated with better mental health and less mental distress (Nisbet et al., 2020). Finally, Couper (2018) suggested that, for humans, the significance of green and blue space may be not only the nature's presence but also humans' encountering nature or exposure to nature. Thus, our suggestion to our client is to frequently encourage students' experience or exposure to UBC campus green and blue spaces. For example, students may be able to engage with nature while performing daily activities, such as walking to the classroom or enjoying nature in the bedroom.

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Appendix A

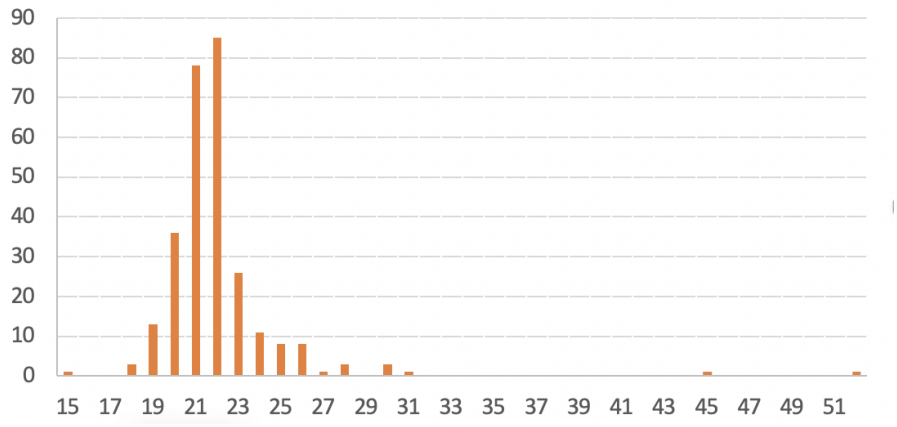

Figure 1: *Age*

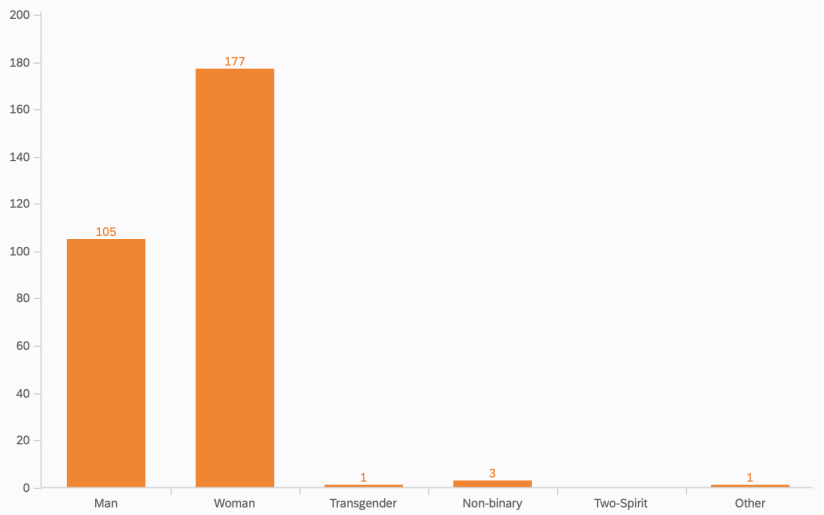

Figure 2: *Gender information*

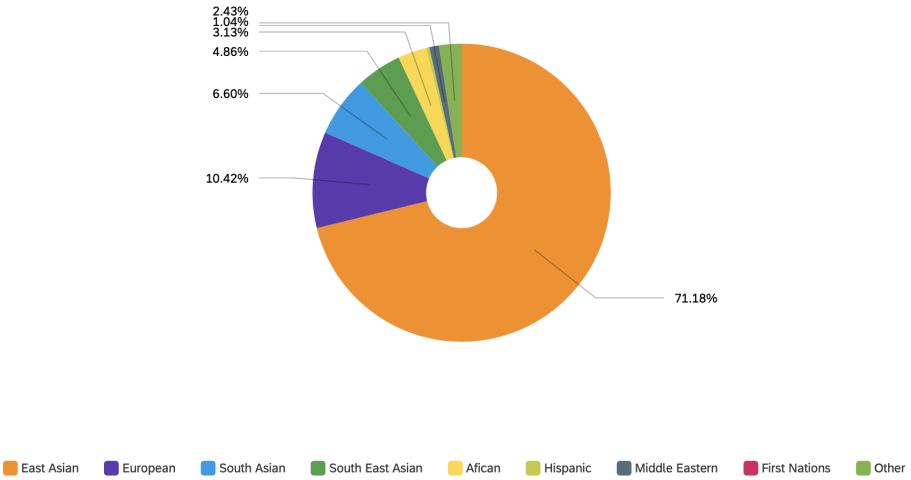

Figure 3: *percentage about participent cultural background*

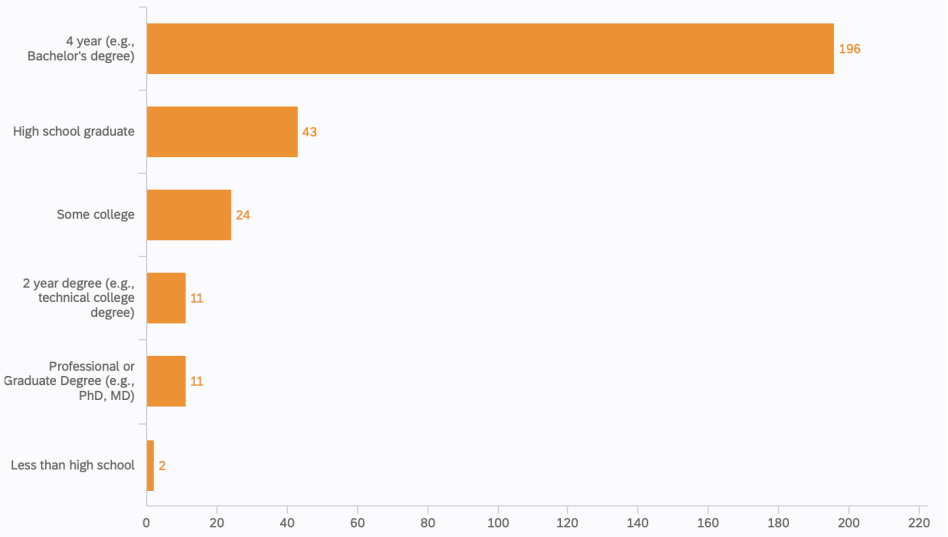

Figure 4: *educational level*

Appendix B
Four Conditions

Figure 1: *ocean view*

Figure 2: *forest view*

Figure 3: *ocean and forest view*

Figure 4: *urban view*

Appendix C
Survey Questions

Figure 1

Please see the picture below, and please imagine that you study or live in this place

Please read each statement and choose a number 0, 1, 2 or 3 which indicates how much the statement applied to after you see the picture. There are no right or wrong answers. Please do not spend too much time on any statement. The rating scale is as follows:

0 Did not apply to me at all

1 Applied to me to some degree

2 Applied to me to a considerable degree

3 Applied to me very much

	0	1	2	3
I was aware of dryness of my mouth	○	○	○	○
I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	○	○	○	○
I tended to over-react to situations	○	○	○	○
I experienced trembling (e.g. in the hands)	○	○	○	○
I felt that I was using a lot of nervous energy	○	○	○	○
I was worried about situations in which I might panic and make a fool of myself	○	○	○	○
I found myself getting agitated	○	○	○	○
I found it difficult to relax	○	○	○	○
I found it hard to wind down	○	○	○	○
I was intolerant of anything that kept me from getting on with what I was doing	○	○	○	○
I felt I was close to panic	○	○	○	○
I felt that I was rather touchy	○	○	○	○
I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	○	○	○	○
I felt scared without any good reason	○	○	○	○

Demographic Questions

Figure 2

Are you a student?

- ○ Yes, I'm a UBC student
- ○ Yes, but I'm not a UBC student
- ○ No

Which year are you in?

- ○ Undergraduate Year 1
- ○ Undergraduate Year 2
- ○ Undergraduate Year 3
- ○ Undergraduate Year 4
- ○ Undergraduate Year 5+
- ○ Graduate

Which gender do you identify with?

- ○ Man
- ○ Woman
- ○ Transgender
- ○ Non-binary
- ○ Two-Spirit
- ○ Other

What is your age (in years)?

What is your cultural background?

- ○ European
- ○ East Asian
- ○ South Asian
- ○ South East Asian
- ○ Afican
- ○ Hispanic
- ○ Middle Eastern
- ○ First Nations
- ○ Other

What is your highest education?

- ○ Less than high school
- ○ High school graduate
- ○ Some college
- ○ 2 year degree (e.g., technical college degree)
- ○ 4 year (e.g., Bachelor's degree)
- ○ Professional or Graduate Degree (e.g., PhD, MD)

Generally speaking, how stressed are you regarding climate change?

- ○ No stress at all
- ○ A negligible amount of stress
- ○ A small amount of stress
- ○ A noticeable but tolerable amount of stress
- ○ A just manageable amount of stress
- ○ A slightly stressful amount of stress
- ○ A noticeable amount of stress
- ○ A considerable amount of stress
- ○ An overwhelming amount of stress

Appendix D

Result Data

Descriptives – Stress NB Score

Condition	Mean	SD	N
Combine	10.219	10.097	73
Control	14.000	12.061	72
Forest View	8.974	7.990	76
Ocean View	10.057	9.732	70

Table 1. Descriptive Data of Stress vs. Different Window View Conditions

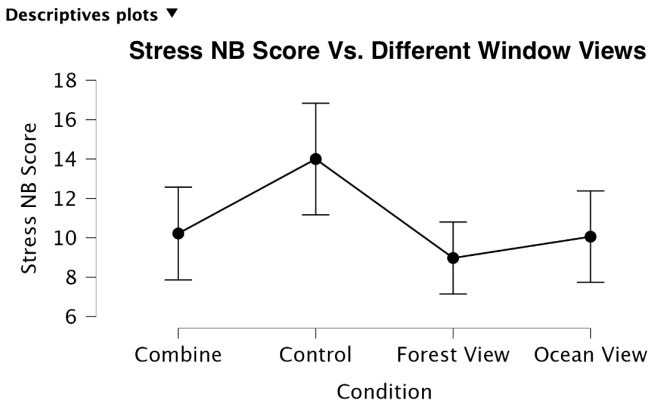

Figure 1. Descriptive Data of Stress vs. Different Window View Conditions

ANOVA – Stress NB Score

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Condition	1054.001	3	351.334	3.478	0.016	0.035
Residuals	28992.212	287	101.018			

Note. Type III Sum of Squares

Table 1.1. One Way ANOVA Between Subject Design. Stress vs. Four Conditions

Post Hoc Comparisons – Condition

		Mean Difference	SE	t	p_{tukey}
Combine	Control	−3.781	1.669	−2.265	0.109
	Forest View	1.245	1.647	0.756	0.874
	Ocean View	0.162	1.681	0.096	1.000
Control	Forest View	5.026	1.653	3.041	0.014
	Ocean View	3.943	1.687	2.337	0.092
Forest View	Ocean View	−1.083	1.665	−0.651	0.915

Note. P-value adjusted for comparing a family of 4

Table 1.2. Post Hoc Comparisons of Stress Between Subject

Descriptives - Anxiety NB Score

Condition	Mean	SD	N
Combine	10.712	10.783	73
Control	13.250	11.630	72
Forest View	7.789	7.285	76
Ocean View	9.257	9.214	70

Table 2. Descriptive Data of Anxiety vs. Different Window View Conditions

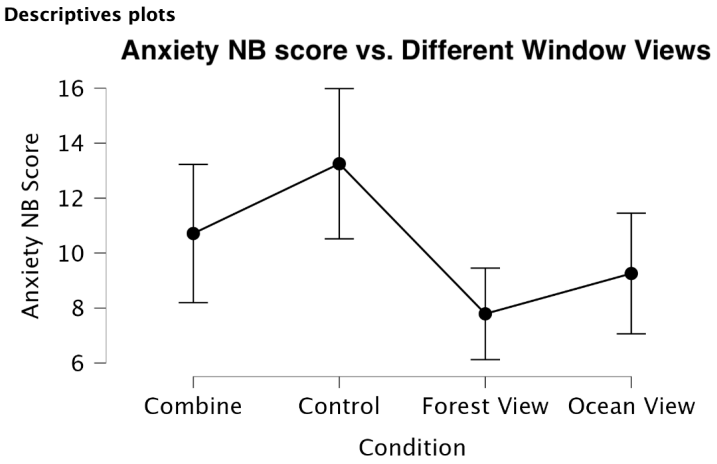

Figure 2. Descriptive Data of Anxiety vs. Different Window View Conditions

ANOVA - Anxiety NB Score

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Condition	1192.569	3	397.523	4.102	0.007	0.041
Residuals	27812.462	287	96.908			

Note. Type III Sum of Squares

Table 2.1. One Way ANOVA Between Subject Design. Anxiety vs. Four Conditions

Post Hoc Comparisons - Condition

		Mean Difference	SE	t	p_{tukey}
Combine	Control	−2.538	1.635	−1.552	0.408
	Forest View	2.923	1.613	1.812	0.270
	Ocean View	1.455	1.647	0.884	0.813
Control	Forest View	5.461	1.619	3.373	0.005
	Ocean View	3.993	1.652	2.416	0.076
Forest View	Ocean View	−1.468	1.631	−0.900	0.805

Note. P-value adjusted for comparing a family of 4

Table 2.2. Post Hoc Comparisons of Anxiety Between Subject

Pearson's Correlations

			n	Pearson's r	p
Stress NB Score	-	Anxiety NB Score	76	0.797	< .001

Table 3. Correlation between Stress and Anxiety in Forest Condition

Pearson's Correlations ▼

			n	Pearson's r	p
Stress NB Score	-	Anxiety NB Score	70	0.842	< .001

Table 3.1. Correlation between Stress and Anxiety in Ocean Condition

Pearson's Correlations

			n	Pearson's r	p
Stress NB Score	-	Anxiety NB Score	73	0.902	< .001

Table 3.2. Correlation between Stress and Anxiety in Combined Condition

Pearson's Correlations

			n	Pearson's r	p
Stress NB Score	-	Anxiety NB Score	72	0.930	< .001

Table 3.3. Correlation between Stress and Anxiety in Control Condition

Appendix E
Contribution of Team Members

John, Raveen, Sandy, Sichan, Yanbing and Yixin were responsible for **writing the proposal.**

John, Raveen, Sandy, Sichan, Yanbing and Yixin contributed to **running data collection.**

John, Sandy, Sichan and Yixin **mainly helped with the data analysis.**

John, Raveen, Sandy, Sichan, Yanbing and Yixin **made the presentation together.**

John, Raveen, Sandy, Sichan, Yanbing and Yixin **wrote the final report.**