Degree Project in Architectural Lighting Design
Second Cycle 15.0 hp

The impact of combining lighting and natural sounds on mood and productivity.

JING WU
Contents

KTH Royal Institute of Technology
Program: Architectural Lighting Design
Course Code: AF270X VT22-1 June 2023

Author: Jing Wu
Thesis Title: The impact of combining lighting and natural sounds on mood and productivity.
Thesis Tutor: Yang Guan
Course Responsible: Federico Favero
Teacher: Foteini Kyriakidou
Examiner: Ute Besenecker

1. Abstract 2
2. Acknowledge 2
3. Introduction 3
   3.1. Topic Motivation 3
   3.2. Background Research 4
4. Methodology 7
   4.1. Experiment 7
   4.2. Experiment Setup 9
5. Results 12
   5.1 Quantitative results 12
   5.2. Interview 18
6. Discussion 19
   6.1. Research Findings 19
   6.2. Research Limitations 20
   6.3. General Conclusion 20
Reference list 22
Figure list 24
Appendix 26
1. Abstract

With the intensification of contemporary urbanization, an increasing number of people are living and working in high-density urban environments. The importance of a good indoor environment for human psychology and health is increasingly evident, so researchers are paying more attention to the impact of indoor environments on human health and well-being. This article first extensively searches and organizes theories related to lighting, natural sounds, and indoor environments. Based on this, a mixed method combining qualitative and quantitative research is used to investigate the effects of combining lighting and natural sounds on emotions and productivity. This study intends to provide a scientific basis for the future design of more restorative indoor environments. Finally, the data analysis of the experimental results shows that the environment combined with cool light and natural sound is more helpful in improving people’s well-being, restoring people’s emotions, and improving people’s attention and work efficiency.

Keywords: Light, indoor, natural sounds, restorative environment

2. Acknowledge

I would like to express my gratitude to all the people who have helped me in the process of writing my thesis.

First of all, I would like to thank my supervisor, Yang Guan, who guided me in the direction when I was confused and provided valuable advice on my thesis. Also, I would also like to thank Federico Favero, who provided a lot of important feedback and urged us to complete the thesis. Finally, the most special thanks to my classmates who are still supporting and encouraging each other in the last time.
3. Introduction

3.1. Topic Motivation

The intensification of contemporary urbanization and the persistent economic downturn in recent years have led to a social involution. People need to put more time and energy into their education and work, which reduces their free time. As we engage in work for extended periods of time, or after intense involvement in a project, our mental resources tend to diminish in a consistent and predictable manner (Packer and Bond, 2010). People’s adaptive resources are exhausted and cannot be recouped in a limited time, leading to chronic stress and health damage. Due to high levels of stress at work and in life, an indoor environment that supports physical and mental recovery and relaxation is required. This is why a place where adaptive resources can be restored is necessary. According to restorative effects, attention restorative and psycho-evolutionary theory think restorative environment refers to the environments that help people overcome mental fatigue and negative emotion brought by stress (SU Qian and XIN, 2010).

Lighting and natural sounds are two common environmental factors that can positively affect people’s emotional and psychological recovery. Some studies have shown that the combination of light and natural sounds in an indoor environment can reduce these negative emotions and improve concentration and productivity. Synesthesia is a neurological phenomenon where the stimulation of one sensory pathway leads to the involuntary activation of another, resulting in a multi-sensory experience that is not just limited to hearing but also involves other senses like touch, taste, and vision. This is a genuine physiological occurrence and is not a result of imagination or acquired knowledge (Voto, 2006). However, current research on the effects of combined lighting and natural sounds in indoor environments on an individual’s emotional and psychological recovery is relatively limited. The aim of this study is to increase knowledge of the emotional and psychological restorative effects of the combination of light and natural sound in indoor environments, primarily exploring their effects on people’s concentration, productivity and stress, and providing a scientific basis for the design of more restorative indoor environments.
3.2. Background Research

3.2.1. The importance of the indoor environment for human health and well-being

The indoor environment is an inevitable part of our life and work. We spend most of our time indoors, and this has a significant effect on our physical and mental health and well-being. The fact that the American Journal of Public Health has dedicated an issue to “the built environment” indicates a current awareness of the importance of indoor environments to people’s health and well-being. Even in moderate climates like that of the United States, individuals spend the majority of their time indoors, whether it be at home, work, during transportation, or in various public and private locations (Samet and Spengler, 2003).

Most of our day is spent indoors, in spaces that are rarely conducive to our well-being (Marjut, Heikki and Petri, 2016). The importance of the impact of indoor environments on human health is not always taken into account in architecture and interior design. Poor indoor environments can cause discomfort, fatigue, increased stress and even adverse physical health effects because some environmental factors, such as air quality, temperature and humidity, can lead to the production of some pollutants if they are not adequate. Indoor air pollutants, surface contamination with toxins and microbes, and contact between people in these places increase the risk of various diseases. These are not new problems; they have been studied and tackled for decades (Samet and Spengler, 2003). Therefore, in order to ensure the comfort and health of people in the indoor environment, factors of the indoor environment should be considered and improved.

There is a lot that can be done to improve the indoor environment, including temperature, humidity, air quality, light, and sound. Among these, light and sound are commonly experienced by people in indoor environments, and are also important contributors to people’s health and well-being. For example, in terms of light, we are more sensitive to taste in a bright environment than in a dim one, so low lighting can make people feel more relaxed and comfortable. At a colour temperature of 3000K, people’s sleepiness increases and their concentration decreases. Therefore, if people feel sleepy at work, they should avoid using light with a low colour temperature (Katsuura et al, 2005). In addition, exposure to bright light (artificial light) at work can significantly increase vitality and reduce psychological stress in some individuals (Beute and Kort, 2013). Exposure to bright light, negative air ions and auditory stimuli can cause rapid changes in mood. The study found that exposure to these stimuli had a positive
effect on mood, reducing feelings of tension, depression and anger. This study also highlights the importance of considering multiple environmental factors when designing indoor spaces, rather than focusing on just one aspect of the environment (GOEL and ETWAROO, 2006). Hence, we can design different lighting for different scenes to help people have a better indoor experience.

For instance, Alvarsson, Wiens and Nilsson (2021) compared the effect on physiological recovery rates of a pleasant natural sound environment with three less pleasant noise-dominated urban sound conditions. This study found that participants exposed to natural sounds showed a faster recovery from physiological and subjective stress compared to ambient noise, and that exposure to natural sounds significantly reduced stress levels compared to ambient noise (see Figure 2). In summary, adding some uplifting sounds to the

**Fig. 1 Different components affecting Indoor Environment Quality (Oluyemi Toyinbo, 2019).**

**Fig. 2 Mean values of perceptual attributes for the nature sound and the high, low and ambient noises. Error bars represent the standard error of the mean (Alvarsson, Wiens and Nilsson, 2010).**
3.3.2. The Purpose of the Research and Research Questions

This study aims to explore the impact of combining lighting and natural sounds on mood and productivity. It focuses on exploring whether the combination of lighting and natural sounds can reduce negative emotions such as stress, anxiety, and fatigue, and whether they can enhance people’s focus and productivity.

This study explores this question using an experimental approach, in which participants receive different types of indoor environmental interventions in a laboratory setting, and then fill out emotional questionnaires and cognitive ability tests. At the same time, I conduct interviews with participants in each group using open-ended questions. Finally, I conduct statistical analysis on the experimental results and draw conclusions.

3.3.3. Sustainability Statement

The global goals are a plan agreed to by all world leaders to build a greener, fairer, better world by 2030, and we all have a role in achieving them (The Global Goals, 2022). Goal 3: Good Health and Well-being promotes healthy lifestyles, preventive measures and modern, efficient healthcare for everyone (The Global Goals, 2022). This sustainable goal can have a huge positive impact on the world. The combination of audio-visual activities can achieve this goal by reducing anxiety and stress and relaxing people, thereby maintaining a healthy mental state.

3.3.4. Conclusion

Sound and light both have an important influence on the indoor environment and there have been many studies examining the effects of light or sound separately, but fewer researchers have combined light and sound conditions in their experiments. Here we explore the effects of combining light of different colour temperatures with natural sound on people’s stress, concentration and efficiency.

Fig. 3 UNSDG’s goals (The Global Goals, 2022).
4. Methodology

4.1. Experiment

**Participants:** The study involved 20 participants, who were recruited from WeChat groups. The sample consisted of people of different ages and genders. The participants are all postgraduate or doctoral students who are studying at KTH, and they come from different majors. They were not paid to take part in this experiment.

**Experimental Design:** This study used a mixed method combining qualitative and quantitative research methods. Madey states (1982) that "combining quantitative and qualitative research helps to develop a conceptual framework, to validate quantitative findings by reference to information extracted from the qualitative phase of research, and to construct indicators from qualitative data that can be used to analyze quantitative data."

In this experiment, we chose two conditions, light and sound. For sound, we chose the sounds of the natural environment; we used birdsong, wind, the rustling of branches, etc. These sounds can enhance the positive perception of the natural environment presented through visual means. Natural sounds and soundscapes lead to subjective and objective predictive performance and reduce arousal after stress and/or fatigue (Eleanor, 2021). Features of the natural environment have particular advantages in providing opportunities for reflection, which can further enhance the benefits of recovery from directed attention fatigue (Gobster, Science and Arbor, 1993). Low colour temperature and high colour temperature light

---

*Fig. 4 Methodology process diagram.*
were chosen as variables. Light of different colour temperatures affects not only visual but also non-visual functions of human physiological functions (Yasukouchi and Ishibashi, 2005). Changes in colour temperature can enhance positive mood and improve fatigue (Hawes et al., 2012).

The experiment designed four different scenes, a total of 20 participants were randomly assigned to these four environments: a group exposed to natural sounds and warm light, a group exposed to natural sounds and cool light, a group exposed to light with only warm colors, and a group exposed to light with only cool colors. Five participants were assigned to each condition, and each participant participated in the experiment for only one of the conditions. All participants were asked to read the same book during the experiment. Participants in each setting were exposed to their respective conditions for 30 minutes.

Table. 1 Sound and lighting conditions for four scenes.

<table>
<thead>
<tr>
<th>Scene</th>
<th>Sounds</th>
<th>Lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scene 1</td>
<td>Natural sounds</td>
<td>Cool light (5000k)</td>
</tr>
<tr>
<td>Scene 2</td>
<td>Natural sounds</td>
<td>Warm light (3000k)</td>
</tr>
<tr>
<td>Scene 3</td>
<td>/</td>
<td>Cool light (5000k)</td>
</tr>
<tr>
<td>Scene 4</td>
<td>/</td>
<td>Warm light (3000k)</td>
</tr>
</tbody>
</table>

The experiment took place between 5pm and 9pm. In May it gets dark in Sweden at around 10.30 pm. In order to avoid the effects of daylight on the experiment, the windows were covered with blackout curtains during the experiment.
**Experimental Sounds:** For the natural sound condition, the experimental sounds include recordings of natural sounds such as birdsong, rustling of leaves and wind.

**Experimental Lighting:** The values were set 3000k for warm light and 5000k for cool light, depending on the actual scene and equipment.

To ensure the stability of the lighting, I used adhesive tape to fix the light fixture to the wall. The height of the lamp is 190cm. The brightness and color temperature of the lamps are adjustable. I adjusted the color temperature of the lamp through the mobile phone software - Hue Essentials to ensure that the brightness of the light used in the experiment is consistent. The brightness of the light used in the experiment was constant, the horizontal illuminance of the desktop was 112 lux, and the illuminance of the surface of the iPad used in the experiment was 56 lux. The sounds of nature (see Appendix 1) were played through a speaker system, which was placed on a table with a height of 74 cm.

**Experimental Setup**

The experimental environment is the studio of KTH student apartment building Malvinas väg, which is the single apartment of KTH school (see Figure 7). The apartment has an area of about 20 square meters, including a bathroom, kitchen and bedroom. In the room there is a bed, a table and three chairs. The experiments were carried out in the table area (see Fig. 8).
Experiment Procedure

Fig. 8 Experimental environment floor plan.

Fig. 9 Section A-A Natural sounds+Cool light (5000k).

Fig. 10 Section A-A Natural sounds+Warm light (3000k).

Fig. 11 Section A-A Only Cool light (5000k).

Fig. 12 Section A-A Only Warm light (3000k).
The experiment invited 20 participants to participate in the experiment, and they needed to be carried out in four different environments. The experimental process includes four steps. First, the participants need to complete a questionnaire to test their state of mood, stress and attention before the experiment. Then take part in the experiment and read the same book for 30 minutes in the context of the experimental design. Then, they need to complete a questionnaire similar to the previous to compare the changes in various indicators before and after the experiment. Finally, we interviewed some of the four groups of participants to gain a deeper understanding of their experiences and feelings about the experiment.
5. Results

5.1. Quantitative results

5.1.1. Preference for indoor environmental factors

Fig. 18 Some of the factors selected by the participants have a strong influence on the quality of the interior. A total of 20 people participated in this question, and each person could choose multiple options.

In the questionnaire survey before the experiment, I set a question about the participants' preference for indoor environmental factors. This graph shows the participants' choice of factors that most influence interior quality (each individual can select multiple factors). Among the 20 people who participated, 17 people chose that light has a great influence on indoor quality, followed by temperature and sound, and 16 people chose that sound and temperature have a great influence on indoor quality. The least number of people chose temperature and air quality.

5.1.2. Stress, efficiency and concentration test results for Scene 1 Natural sounds+Cool light (5000k)

Table 2 Comparison of the stress levels of the five participants before and after the experiment in the first scenario.
This set of charts recorded changes in the participants' stress, productivity and concentration before and after the experiment. Each factor was classified into five levels and analyzed and recorded before and after the experiment through questionnaires filled out by the participants. The first group of environments is a combination of cool light (color temperature 5000K) and natural sound. After the experiment, the stress of most participants was reduced, the efficiency of some participants was improved, the attention of some participants was improved, and the attention of one participant decreased.

5.1.3. Stress, efficiency and concentration test results for Scene 2 Natural sounds+Warm light (3000k)

Fig. 20 Quantitative experiment, scene 2 Natural sounds+Warm light (3000K) .
The second set of environments combines warm light (color temperature 3000K) and natural sounds (such as wind, leaves and birdsong). In this set of experiments, most participants experienced a significant reduction in stress levels, shifting from areas of high stress to areas of low stress. The levels of work efficiency and attention showed a more even distribution after the experiment, with some people's efficiency and attention levels increasing, while others' levels decreased.
5.1.4. Stress, efficiency and concentration test results for Scene 3 No sounds+Cool light (5000k)

Table 8: Comparison of the stress levels of the five participants before and after the experiment in the third scenario.

Table 9: Comparison of the efficiency levels of the five participants before and after the experiment in the third scenario.

Table 10: Comparison of the concentration levels of the five participants before and after the experiment in the third scenario.
The third group of experiments adopted cool color light (5000K color temperature) and no sound environment. In this group of experiments, the stress of some participants was reduced, the attention of most people was significantly improved, and the work efficiency of some people was also improved to a certain extent.

5.1.5. Stress, efficiency and concentration test results for Scene 4 No sounds+Warm light (3000k)

![Image of Quantitative experiment, Scene 4 No sounds+Warm light (3000k)](image)

Table 11 Comparison of the stress levels of the five participants before and after the experiment in the fourth scenario.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Before the Experiment</th>
<th>After the Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low pressure</td>
<td>High pressure</td>
</tr>
<tr>
<td>2</td>
<td>Low pressure</td>
<td>High pressure</td>
</tr>
<tr>
<td>3</td>
<td>Low pressure</td>
<td>High pressure</td>
</tr>
<tr>
<td>4</td>
<td>Low pressure</td>
<td>High pressure</td>
</tr>
<tr>
<td>5</td>
<td>Low pressure</td>
<td>High pressure</td>
</tr>
</tbody>
</table>

Table 12 Comparison of the efficiency levels of the five participants before and after the experiment in the fourth scenario.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Before the Experiment</th>
<th>After the Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low efficiency</td>
<td>High efficiency</td>
</tr>
<tr>
<td>2</td>
<td>Low efficiency</td>
<td>High efficiency</td>
</tr>
<tr>
<td>3</td>
<td>Low efficiency</td>
<td>High efficiency</td>
</tr>
<tr>
<td>4</td>
<td>Low efficiency</td>
<td>High efficiency</td>
</tr>
<tr>
<td>5</td>
<td>Low efficiency</td>
<td>High efficiency</td>
</tr>
</tbody>
</table>
Table. 13 Comparison of the concentration levels of the five participants before and after the experiment in the fourth scenario.

In the last group of environments, only under the condition of warm color light (color temperature 3000K), after the end of the experiment, the stress of some participants increased, their work efficiency decreased, and their attention improved. Data for other participants did not change significantly.

5.1.6. Comparison of scenes with and without sound

Fig. 23 Statistical table of stress, efficiency, and attention levels of participants in the sounds scenes before the experiment.

Fig. 24 Statistical table of stress, efficiency, and attention levels of participants in the sounds scenes after the experiment.
Comparing the data of the two scenes with and without sound separately, it can be found that in the experimental data of the scene with sound, the stress of the participants is significantly reduced, and there is no obvious trend in the change of the participants' attention. The data did not change much. In the scene data without sound, part of the participants' stress increased, and the data of efficiency and attention did not change significantly.

5.2. Interview

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>sounds</th>
<th>Interview content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>23</td>
<td>female</td>
<td>✓</td>
</tr>
<tr>
<td>Participant 2</td>
<td>25</td>
<td>male</td>
<td>✓</td>
</tr>
</tbody>
</table>
6. Discussion

6.1. Research Findings

In this study, experimental results showed that participants experienced different changes in stress, productivity, and attention under different environmental conditions. Lighting color temperature and natural sound are two main variables that can have a dramatic impact on personal mood and productivity. By comparing the two experimental groups with sound and the experimental group without sound, the study found that most of the participants in the experimental group with sound said that their mood was more peaceful and their stress decreased. Because higher levels of nature and daylight in the environment seem to be associated with better emotional states, with higher hedonic tone and energy levels, and lower tension levels (Beute and de Kort, 2018). Some elements of nature may create a more relaxed atmosphere and help restore the mood.

In addition, by comparing the experimental groups with different color temperature lights, warm light is more likely to make people sleepy, and some participants said that they are more willing to use cool light in the working environment to help improve concentration. Higher color temperature lights like cool lights can more strongly emphasize and activate the autonomic and central nervous systems (Noguchi and Sakaguchi, 1999). However, at home, they prefer to use warm lighting. This may be related to the difference in environment and tasks. Especially in the working environment, when doing some less delicate work such as reading, the combination of using cold light and natural sound is better, because it can help improve emotional recovery and work efficiency.

These findings are informative for designing different types of indoor environments such as workplaces, schools and hospitals. Creating an environment that combines cool light and natural sound can create a more productive and comfortable working and learning environment for individuals. Particularly where rehabilitation is required, such as in
hospitals, natural sound and the right lighting design can provide a better therapeutic environment for patients.

6.2. Research Limitations

Although the results of this study are encouraging, there are some limitations that need to be considered. Firstly, the sample size was relatively small, only 20 participants were selected for this experiment and most of them were KTH students, most of the participants were between the ages of 18-25, I did not collect data from different ages or occupations which may have influenced the results and limited the generalisability of the findings, and the experiment was only 30 minutes long and it was not possible to determine whether these conditions would have a sustained positive effect on people positive effect on people.

In addition, I only examined the effects of light and sound on a single task (reading). For other tasks, such as coding or writing, natural sounds may have a negative impact on productivity. Furthermore, the variables of natural sounds should be further refined. Not all natural sounds have a positive effect on mood, while some of the noisier birdsong effects may be similar to white noise. Future research should include a more precise and detailed examination of the effects of different types of natural sounds on mood and productivity. The different activities of the participants prior to the experiment could also have an impact on the results.

Finally, the study may be influenced by demand characteristics, as the two conditions of the experiment sound and colour temperature of the lights were very distinctive features and participants may have guessed the purpose of the study and changed their behaviour accordingly. The study may also be influenced by differences in individual environmental preferences. Preferences are features of the environment that can elicit emotional responses even without conscious attention to them (Ulrich, 1983). Because the experiment could not be conducted in a soundproof room, there may have been interference from other sounds during the course of the experiment.

In conclusion, although this study has established the positive effects of combining cold light and natural sounds on mood, productivity and attention, further research is needed to refine the understanding of the variables involved and the extent of these effects.

6.3. General Conclusion

In a work environment, the combination of cold light and natural sounds can create a more productive and comfortable environment for individuals. In a home environment, warm light can create a more welcoming atmosphere for people.

Future research could further investigate the effects of lighting and natural sounds on different tasks, as well as the effects of more types of natural sounds on mood and productivity. In addition, the sample
size can be further increased to include people of different ages, positions and cultural backgrounds to improve the reliability and universal validity of the research findings.

This study aimed to investigate the effects of light and natural sounds on mood and productivity. The results show that a combination of cold light and natural sounds can help improve productivity and restore mood, especially in work environments. At the same time, warm light is more appropriate for home environments and can create a warmer atmosphere.

However, we are also aware of the limitations of the study, such as the small sample size, which limits the generalization of the results, and the limitations of the experimental environment, which may have some influence on the experimental results. In addition, the variable of natural sound needs to be investigated more carefully. Creating a suitable indoor environment also has an impact on SDG 3: Good health and well-being. An environment that promotes human health and well-being can help people improve their mental and emotional health, make the environment more productive and help promote better social and psychological connections.

Nevertheless, this research has important implications for the application of environmental design for light and sound in different environments.
Reference list


**Figure list**

Fig. 1 Different components affecting Indoor Environment Quality (Oluyemi Toyinbo, 2019).

Fig. 2 Mean values of perceptual attributes for the nature sound and the high, low and ambient noises. Error bars represent the standard error of the mean (Alvarsson, Wiens and Nilsson, 2010).

Fig. 3 UNSDG’s goals (The Global Goals, 2022).

Fig. 4 Methodology process diagram.

Fig. 5 Sketches, sounds and lights of different colors were the two variables in the experiment. Set the color temperature of light according to different experimental groups when conducting experiments, as well as natural.

Fig. 6 Colour temperature(Lighting Design Studio, 2017).

Fig. 7 Malvinas väg single studio(KTH, n.d.).

Fig. 8 Experimental environment floor plan.

Fig. 9 Section A-A Natural sounds+Cool light (5000k).

Fig. 10 Section A-A Natural sounds+Warm light (3000k).

Fig. 11 Section A-A Only Cool light (5000k).

Fig. 12 Section A-A Only Warm light (3000k).

Fig. 13 3000k color temperature and 5000k color temperature used in the experiment, personal photo.

Fig. 14 The light fixture is fixed to the wall with tape, personal photo.

Fig. 15 The experimental participants sat to the right of the light fixture and used an iPad to read a book, personal photo.

Fig. 16-17 The horizontal illuminance of the desktop is 112lux, and the illuminance of the iPad surface is 56lux, personal photo.

Fig. 18 Some of the factors selected by the participants have a strong influence on the quality of the interior, a total of 20 people participated in this question, and each person could choose multiple options.

Fig. 19 Quantitative experiment, scene 1 Natural sounds+Cool light (5000k).

Fig. 20 Quantitative experiment, scene 2 Natural sounds+Warm light (3000k).

Fig. 21 Quantitative experiment, Scene 3 No sounds+Cool light (5000k).

Fig. 22 Quantitative experiment, Scene 4 No sounds+Warm light (3000k).
Figure list

Fig. 23 Statistical table of stress, efficiency, and attention levels of participants in the sounds scenes before the experiment.

Fig. 24 Statistical table of stress, efficiency, and attention levels of participants in the sounds scenes after the experiment.

Fig. 25 Statistical table of stress, efficiency, and attention levels of participants in the no-sound scenes before the experiment.

Fig. 26 Statistical table of stress, efficiency, and attention levels of participants in the no-sound scenes after the experiment.
Appendix

Appendix 1

Natural Sounds Link: https://youtu.be/MJg-HmGWw1k

Appendix 2

Questionnaire Questions and Results (before the experiment)

Scene 1

Question 1

What's your gender?
(5条回复)

40%
60%

Question 2

What's your age?
(5条回复)

80%
20%
Question 3

What emotions are you experiencing right now? (multiple choice)
(5条回答)

- Peaceful: 3 (60%)
- Irritable: 2 (40%)
- Anxiety: 2 (40%)
- Lonely: 1 (20%)
- Emptiness: 2 (40%)
- Frustration: 2 (40%)
- Bored: 1 (20%)
- Tragedy: 1 (20%)
- Happy: 0 (0%)
- Unhappy: 0 (0%)
- Satisfied: 0 (0%)
- Unsatisfied: 0 (0%)
- Joyful: 0 (0%)

Question 4

Are you feeling stressed? (Life pressure, work pressure, study pressure, etc.)
(5条回答)

- 1: 60%
- 2: 20%
- 3: 20%

Question 5

How efficient are you at work or study?
(5条回答)

- 40%
- 20%

Question 6

Do you often feel tired when working or studying?
(5条回答)

- 100%
Question 7

Do you find it difficult to concentrate?
(5 多回覆)

Question 8

What do you think are the factors that affect the indoor environment?
(5 多回覆)

Scene 2

Question 1

What's your gender?
(5 多回覆)

Question 2

What's your age?
(5 多回覆)
Question 3
What emotions are you experiencing right now? (multiple choice)
(5 条回复)
- peaceful: 4 (80%)
- irritable: 2 (40%)
- anxiety: 2 (40%)
- lonely: 2 (40%)
- emptiness: 1 (20%)
- boring: 1 (20%)
- fear: 1 (20%)
- tragedy: 2 (40%)
- happy: 1 (20%)
- anger: 1 (20%)
- happiness: 0 (0%)
- sad: 0 (0%)
- joyful: 1 (20%)

Question 4
Are you feeling stressed? (Life pressure, work pressure, study pressure, etc.)
(5 条回复)
- 1: 20%
- 2: 20%
- 3: 20%
- 4: 20%
- 5: 20%

Question 5
How efficient are you at work or study?
(5 条回复)
- 1: 60%
- 2: 20%
- 3: 20%

Question 6
Do you often feel tired when working or studying?
(5 条回复)
- yes: 80%
- no: 20%
**Question 7**

Do you find it difficult to concentrate?

- 60% [5条回答]
- 20% [5条回答]

**Question 8**

What do you think are the factors that affect the indoor environment?

- sound: 5 (100%)
- light: 4 (80%)
- temperature: 4 (80%)
- air quality: 3 (60%)
- Tidiness of the room: 3 (60%)
- smell: 2 (40%)

**Scene 3**

**Question 1**

What's your gender?

- male: 60%
- female: 40%

**Question 2**

What's your age?

- 18-25: 40%
- 25-32: 40%
- 32-38: 20%
- 39-46: [chart data not visible]
Question 3
What emotions are you experiencing right now? (multiple choice)
(5 选项)
- peaceful: 1 (20%)
- irritable: 0 (0%)
- anxiety: 0 (0%)
- Lonely: 4 (80%)
- emptiness: 4 (80%)
- bored: 2 (40%)
- fair: 1 (20%)
- tragedy: 0 (0%)
- happy: 0 (0%)
- anger: 1 (20%)
- happiness: 0 (0%)
- satisfied: 0 (0%)

Question 4
Are you feeling stressed? (Life pressure, work pressure, study pressure, etc.)
(5 选项)
- 1: 20%
- 2: 20%
- 3: 60%

Question 5
How efficient are you at work or study?
(5 选项)
- 1: 80%
- 2: 20%

Question 6
Do you often feel tired when working or studying?
(5 选项)
- 1: yes
- 2: no
Question 7
Do you find it difficult to concentrate?
(5 件回复)

- 60%
- 40%

Question 8
What do you think are the factors that affect the indoor environment?
(5 件回复)

- Sound: 5 (100%)
- Light: 4 (80%)
- Temperature: 3 (60%)
- Air quality: 2 (40%)
- Tidiness of the room: 4 (80%)

Scene 4
Question 1
What's your gender?
(5 件回复)

- Male: 60%
- Female: 40%

Question 2
What's your age?
(5 件回复)

- 18-25
- 26-32
- 32-39
- 39-46

- 100%
Question 7

Do you find it difficult to concentrate?

(5条回答)

40% 40% 20%

Question 8

What do you think are the factors that affect the indoor environment?

(5条回答)

- Sound
- Light
- Temperature
- Air quality
- Tidiness of the room

Scene 1

Question 1

What emotions did you experience during the experiment? (multiple choice)

(5条回答)

- Peaceful
- Irritable
- Anxiety
- Lonely
- Emptiness
- Boring
- Fear
- Tragedy
- Happy
- Angry
- Happiness
- Satisfy
- Joyful

4 (80%)

Question 2

How did your feelings about stress change before and after the experiment?

(5条回答)

- Pressure increased
- No change in pressure
- Pressure reduced

80% 20%
Question 3
How you feel about stress right now
(5 条回复)

Question 4
How effective were you during the experiment
(5 条回复)

Question 5
Did you find it difficult to concentrate during the experiment
(5 条回复)

Question 6
Do you feel fatigued affecting your concentration after experimenting?
(5 条回复)
Scene 2

Question 1

How did your feelings about stress change before and after the experiment?

(5 items回头)

Question 2

How you feel about stress right now

(5 items回头)

Question 4

How effective were you during the experiment

(5 items回头)
Question 5

Did you find it difficult to concentrate during the experiment?
(5 问题)

Question 6

Do you feel fatigued affecting your concentration after experimenting?
(5 问题)

Scene 3

Question 1

What emotions did you experience during the experiment? (multiple choice)
(5 问题)

Question 2

How did your feelings about stress change before and after the experiment?
(5 问题)
Question 3
How you feel about stress right now
(5 条回复)

Question 4
How effective were you during the experiment
(5 条回复)

Question 5
Did you find it difficult to concentrate during the experiment
(5 条回复)

Question 6
Do you feel fatigued affecting your concentration after experimenting?
(5 条回复)
Scene 4

Question 1
What emotions did you experience during the experiment? (multiple choice)

<table>
<thead>
<tr>
<th>Emotion</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaceful</td>
<td>4 (80%)</td>
</tr>
<tr>
<td>Irritable</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Lonely</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Emptiness</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Boring</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Fear</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Tragedy</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Happy</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Angry</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Happiness</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Satisfy</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Joyful</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

Question 2
How did your feelings about stress change before and after the experiment?

Pressure increased: 40%
No change in pressure: 20%
Pressure reduced: 40%

Question 3
How you feel about stress right now

(5 条回复)

60%
40%

Question 4
How effective were you during the experiment

1
2
3
4
5
Question 5
Did you find it difficult to concentrate during the experiment
(5条回复)

- 40%
- 20%
- 20%
- 20%

Question 6
Do you feel fatigued affecting your concentration after experimenting?
(5条回复)

- 80%
- 20%

Yes
No