

Perceived Comfort between Photographed Versus Painted Nature Indoors and Implications for Improvement of Learning Efficiency

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Abstract: Most of a person's lifetime is spent indoors. Existing literature demonstrates that natural elements in indoor spaces were conducive to promote human's well-being. Setting artistic nature such as a nature painting and raw nature such as a nature photograph indoors is very common in our daily life, which raises the question "compared with raw nature, artistic nature are much better or bad for human's well-being?" To answer this question, 10 nature paintings and their corresponding photographs were added into a wall of a room picture. Perceived comfort and learning efficiency of these images were evaluated one by one by 42 college students through comparing the images with a nature painting and a corresponding nature photograph. The results indicated that the images with a nature painting could make students feel more comfortable and had higher learning efficiency than the ones with a nature photograph. Furthermore, perceived comfort was a mediator between room conditions and learning efficiency. The mechanism of painting's well-being is discussed. To the authors' knowledge, this is the first study to compare psychological benefits of nature paintings and nature photographs. These findings add knowledge to understand the relationship between the indoor environments and human well-being.

Keywords: Nature painting; nature photograph, learning environment; indoor environment; graduate students

1. INTRODUCTION

Nowadays, most people in urban areas spend over 80% of their lifetimes indoors (Su and Lin, 2015). Since the pandemic of COVID-19 outbreak at the end of 2019, people have to stay indoors more time due to the quarantine policy and telecommuting mode across the world, further reducing the opportunities of social activities and contact with nature (McGinty et al., 2020; Vindegaard and Benros, 2020). Therefore, indoor environments play a vital role in people's living, work, learning, and health. Previous literature has evidenced that contact with nature could relieve stress and improve psychological well-being (van den Bosch & Ode Sang, 2017; Wang et al., 2018; Zhao et al., 2018; Jiang et al., 2014), so the increase of indoor time may aggravate mental disorders and reduce people's well-being. For example, the prevalence of anxiety amongst U.S. medical students has risen from 20.3% to 31.1% during the COVID-19 pandemic (Guo et al., 2021). Beside, the people who are often most susceptible to the adverse health effects tend to spend more time indoors (Dahmane et al., 2019), leading to a vicious circle.

A study claims that most lifetime mental problems have first onset at the age of 24 (Kessler et al., 2005). College students are just around 24 years old, which implies that they are at high risk of getting mental disorders. Meanwhile, college students also face many challenges in their college life and bear growing pressures to achieve academically, socially, and professionally, lead to further stress (Andersson, et al., 2009). Macaskill (2013) found that the number of psychological problems reported by college students increased by 11% from the first to the second academic year in the United Kingdom. On the other hand, the majority of young students in modern society is poor at expressing emotions or easily insecure (Feijo et al., 2021), coupled with the long-term isolation caused by the COVID-19 pandemic, which not only reduces the opportunities of visiting restorative environments, but also leads to the anxiety about academic performance due to the fact that the pandemic prevents

them from attending classes and having face-to-face discussions, and conducting experiments and(or) investigations. These situations are particularly acute in China. Therefore, improving the quality of indoor environments, in turn enhancing the mental health and improving the moods of college students is not only conducive to their various well-beings, but also play an important role in promotion of their academic performance (Hodson et al., 2017).

Most experts believe that introducing natural elements into indoor spaces would be beneficial to human's well-being and health (Li & Sullivan, 2016; Nejati et al., 2016). For example, Nejati et al. (2016) concluded that people preferred the room with indoor plants, natural artworks, or window views, which provide the opportunities to contact with nature. Wang et al. (2018) concluded that hanging a landscape painting on a wall in a classroom could promote mental fatigue recovery, and introducing the outdoor landscapes into the classroom through window views was much better for students' well-being than that without window views. And Benfield et al. (2015) claimed that interior plants and window views of nature in university classrooms positively affect students' academic performance. In summary, inducing natural elements into interior spaces directly (real plants) and indirectly (window view of nature, photographs or paintings containing natural scenery) would be beneficial to college students who usually spend more time in classrooms than outdoors on campus (MacKerron & Mourato, 2013). However, existing literature fails to provide a fine-tuned understanding of which natural elements are more efficiently for the improvement of students' psychological well-being and academic performance, particularly in the comparison of nature photographs and paintings. Compared with window views of nature and real plants indoors, nature photographs or paintings are very popular indoors due to low cost, no maintenance, no requirements for specific indoor or outdoor growth conditions, and artistic atmosphere. A study conducted by Law et al. (2020) concluded that artworks, like the real nature, could help reduce anxiety, improve mood and increase people's sense of well-being. Currently, artworks depicting nature are widely used in healthcare settings to reduce stress and improve health of patients (Law et al., 2020; Vincent et al., 2010; Wang et al., 2015; Binnie, 2010; Karnik et al., 2014).

Despite the fact that some researchers claim that directly outdoor nature contact is significantly more effective than indirect nature contact, such as nature pictures in terms of the potential to reduce stress and improve general health (Largo-Wight et al., 2011), visual and(or) auditory contact with nature is still a useful measure to relief mental stress (Zhao et al., 2018; Van Kamp et al., 2015; Cerwén et al., 2016; Annerstedt et al., 2013; Zhao & Wang, 2022). Lottrup et al. (2013) concluded that participants who had only visual access to nature had more positive workplace attitudes than those with no access to nature at all. Furthermore, Wang et al. (2018) concluded that, in a classroom, nature picture was more efficient than real potted plants in terms of mental restoration. The reason may be that the natural environments represented by the picture are more complex, gorgeous and diverse than potted plants. As the indoor space is very limited, it is impossible to create rich real landscapes indoors, therefore, nature pictures are widely used to relieve mental stress and improve psychological well-being of residents (e.g. Wang & Zhao, 2020; Zhao et al., 2018; Memari et al., 2017; Nordh et al., 2009).

Therefore, the question arises: among nature photograph and nature painting, which one is better for promoting perceived comfort and learning efficiency of college students in a room? To answer this question, 10 colored nature photographs and 10 nature paintings which describe the same scenes of the 10 nature photographs were selected and individually hanged on a wall in a room by virtual reality technology. Then the perceived comfort and learning efficiency were assessed by college students quantitatively, which allow us to check the differences in promotion of perceived comfort and learning efficiency between nature photographs and nature paintings, in turn providing guidance for interior environment design which possibly helps college students improve mental health and academic performance.

2. MATERIALS AND METHODS

2.1 Stimuli

This study selected 10 sites to represent the diversity of nature, including wilderness, urban green space, ocean, river, lake and mountain. After the artist completed a painting at a site, a photograph

was taken immediately by the artist and the content of the photograph is as same as that of the painting. All photographs and paintings did not include human figures. They were produced from 2017 to 2021 by two artists who are the teachers of China University of Mining and Technology (CUMT). And the two artists were asked to use the same painting techniques (hue, contrast, white balance, etc) to produce the paintings. Then, these photographs and paintings were added to a room photograph which represented a typical indoor environment used by graduate students for their learning using Photoshop CS6 (see Fig. 1).



Fig.1. Samples of room images with a painting (A) and photograph (B)

2.2 Perceived comfort and learning efficiency measurement

A room image with a painting and a room image with the corresponding photograph were made a slide in which the two images were the same area on the slide, and the two images were named “A” and “B”, as for whether “A” referred to the image with a photograph or painting, it was randomly assigned on different slides. A total of 10 slides were gathered. Forty-two graduate students were invited to participate in the experiment, of which 14 major in art design (art subjects) and 28 major in other disciplines (non-art subjects), including 25 females and 17 males. This study was approved by the ethics committee of China University of Mining and Technology (2022-037).

This survey was conducted online to avoid the infection risk caused by COVID-19 pandemic, and it had not any adverse effect on the students due to the fact that the students just see some room images. All students were asked to use a laptop or computer with a screen size equal to or greater than 12 inches. The first author played the sides one by one on a computer with a random order, and the students could see the slide through the screen shared by telecommuting mode. When a slide was playing, the students were asked to complete a questionnaire which included two questions: (1) imagine you are in the two rooms represented by the two images one by one, which room makes you feel more comfortable? or the two images are equal, and (2) which room makes you concentrate on

your learning better? or the two images are equal. A slide was played 30 s, after that, the first author asked whether the subjects has completed the evaluations or not. The next slide was not played until all students completed the survey of the slide. At the end of the questionnaire the demographic information were collected, including gender and discipline.

2.3 Data analysis

If a student selected an image that could make him/her feel more comfortable or better focused on learning, the image was scored “1”, and the other image was scored “0” in a slide. If he/she thought the two images were generally equal, both of them were scored “0.5”. Therefore, the score of an image ranged from 0 to 42 in terms of both perceived comfort and learning efficiency. All data were treated using SPSS 17.0 software. The interclass reliabilities of perceived comfort and learning efficiency were tested to confirm the availability of the data collected, and then the one-way ANOVA was conducted to check the difference in perceived comfort and learning efficiency between the images with a painting and photograph, and between students with different demographic variables, such as gender and discipline. Finally, mediation analyses were conducted to check if the perceived comfort mediates the associations between room conditions and learning efficiency.

3. RESULTS

3.1 Reliability

The interclass reliabilities of perceived comfort and learning efficiency scores were calculated. Cronbach’s Alpha for perceived comfort scores was 0.823, and learning efficiency scores was 0.704, suggesting good internal reliabilities according to the criteria built by Landis & Koch (1977) who claimed that if the Cronbach’s Alpha was more than 0.701, it was good.

3.2 Perceived Comfort and Learning Efficiency in Different Room Conditions

The mean scores of perceived comfort and learning efficiency in the 20 room images are presented in Fig. 2. Obviously, there were similar scores of perceived comfort and learning efficiency between nature paintings and photographs in the sixth comparison, similar learning efficiency in the first comparison and similar perceived comfort in the ninth comparison. However, for the other comparisons, nature paintings possessed higher scores in perceived comfort and learning efficiency than nature photographs. The one-way ANOVA indicated that there were significant differences in perceived comfort and learning efficiency between paintings and photographs (for perceived comfort, $F = 44.449$, $p < 0.001$; for learning efficiency, $F = 31.401$, $p < 0.001$). The results suggested that, generally, nature paintings were much better for promoting graduate students’ well-being and learning.

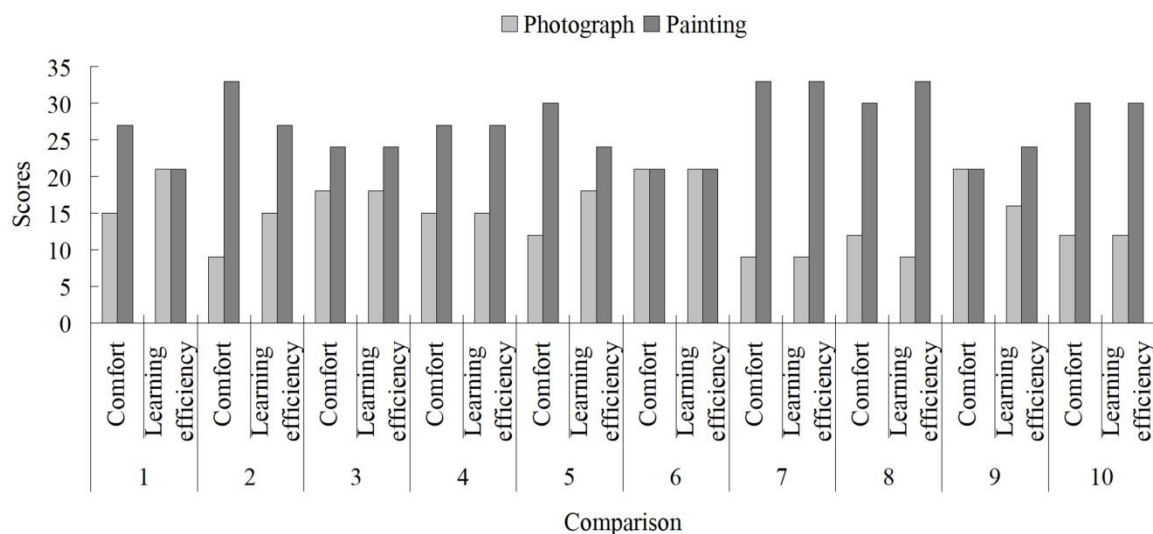


Fig.2. Mean Scores Of Perceived Comfort And Learning Efficiency Of Respondents In10 Comparisons

3.3 Effects Of Students’ Gender And Discipline Background On Perceived Comfort And Learning Efficiency

The one-way ANOVA claimed that there was no significant difference in both perceived comfort and learning efficiency between female and male students (for perceived comfort, $F = 0.741$, $p = 0.395$; for learning efficiency, $F = 1.138$, $p = 0.258$), and between students with art discipline and non-art discipline (for perceived comfort, $F = 0.046$, $p = 0.832$; for learning efficiency, $F = 0.506$, $p = 0.481$). The results indicated that respondents’ gender and discipline background had a non-significantly impact on perceived comfort and learning efficiency.

3.4 Mediation Testing Room Conditions, Perceived Comfort and Learning Efficiency

As previous literature has not specified the clear direction of the relationship between perceived comfort and learning efficiency, two mediation analyses were conducted to see whether perceived comfort mediates the associations between room conditions and learning efficiency or learning efficiency mediates the associations between room conditions and perceived comfort. In the first analysis, perceived comfort was assumed to be a mediator between room conditions and learning efficiency. The second analysis assumed that learning efficiency preceded perceived comfort, which meant that painting in a room setting helped increase learning efficiency of respondents, in turn affecting perceived comfort. The results of the first analysis are shown in Table 1, which indicated that independent variable (room conditions) was a reliable predictor of possible mediator (perceived comfort, $p < 0.001$) and the dependent variable (learning efficiency, $p < 0.001$) (see the first two models in Table 1). The third model in Table 1 suggested that the possible mediator (perceived comfort) significantly predicts learning efficiency ($p = 0.002$), whereas the effects of room conditions on learning efficiency reduced to a non-significant level ($p = 0.399$). According to the criteria built by Baron and Kenny (1986), we concluded that perceived comfort mediated the relationship between room conditions and learning efficiency, implying that painting in a room setting helps to improve students’ learning efficiency due to increased perceived comfort.

Table1. Perceived comfort mediating the relationship between room conditions and learning efficiency

| Dependent | Independent | Unstandardized Beta | Standardized Beta | T | Sig. |
|---|-------------------|---------------------|-------------------|-------|-------|
| Perceived comfort ($R^2 = 0.712$; <i>adjusted</i> $R^2 = 0.696$) | (constant) | 1.200 | | 0.383 | 0.706 |
| | Room conditions | 13.200 | 0.844 | 6.667 | 0.000 |
| Learning efficiency ($R^2 = 0.636$; <i>adjusted</i> $R^2 = 0.615$) | (constant) | 4.400 | | 1.148 | 0.173 |
| | Room conditions | 11.000 | 0.797 | 5.604 | 0.000 |
| Learning efficiency ($R^2 = 0.790$; <i>adjusted</i> $R^2 = 0.766$) | (constant) | 3.624 | | 1.490 | 0.154 |
| | Room conditions | 2.469 | 0.179 | 0.865 | 0.399 |
| | Perceived comfort | 0.646 | 0.733 | 3.544 | 0.002 |

The results of the second analysis suggested that although independent variable (room conditions) was a reliable predictor of possible mediator (learning efficiency, $p < 0.001$) and the dependent variable (perceived comfort, $p < 0.001$) (see the first two models in Table 2), the third model in Table 2 showed that the possible mediator (learning efficiency) significantly predicted perceived comfort, but, the effect of room conditions was not reduced to an insignificant level ($p = 0.032$). In other words, learning efficiency did not mediate the relationship between room conditions and perceived comfort.

Table2. Learning efficiency mediating the relationship between room conditions and perceived comfort

| Dependent | Independent | Unstandardized Beta | Standardized Beta | T | Sig. |
|---------------------|-------------|---------------------|-------------------|-------|-------|
| Learning efficiency | (constant) | 4.400 | | 1.148 | 0.173 |

| | | | | | |
|--|---------------------|--------|-------|--------|-------|
| $(R^2 = 0.636;$ $adjusted R^2 = 0.615)$ | Room conditions | 11.000 | 0.797 | 5.604 | 0.000 |
| | (constant) | 1.200 | | 0.383 | 0.706 |
| $(R^2 = 0.712;$ $adjusted R^2 = 0.696)$ | Room conditions | 13.200 | 0.844 | 6.667 | 0.000 |
| | (constant) | -1.693 | | -0.657 | 0.520 |
| $(R^2 = 0.834;$ $adjusted R^2 = 0.815)$ | Room conditions | 5.968 | 0.381 | 2.332 | 0.032 |
| | Learning efficiency | 0.657 | 0.580 | 3.544 | 0.002 |
| | (constant) | | | | |

4. DISCUSSION

4.1 Possible Mechanism of Painting's Well-Being

This study concludes that, compared with nature photographs, nature paintings can make students feel more comfortable and learn more efficiently, which generally replicates the findings of Wang et al. (2015) who suggested that traditional Chinese landscape paintings were associated with higher subjective ratings of relaxation and mind wandering than realistic oil landscape paintings. Realistic oil landscape paintings usually involve rich and bright colors, well-defined forms, and are filled with narrative details, which are somewhat like the natural photographs used in this study. This result can be possibly explained by the following three aspects.

First, paintings are not to reproduce exactly the appearance of nature, but to embody emotion or atmosphere that expresses the thoughts of the artist. Nature paintings convey the experience of “being in nature” rather than “seeing nature” (Law, 2011). The atmosphere produced by the paintings can affect the observers, and an emotional connection between the paintings and observers is established easily. However, nature photograph just records the objective nature features which basically do not contain human emotions. On the other hand, the boundaries in paintings are more blurred than those of photographs (Fig. 1), and “drawing-blank” is usually used to maintain a balance in the painting and give prominence to concrete images (Cahill, 1960). The features of paintings mentioned above engage appreciators in an attempt to construct a mental image of nature spontaneously (Wang et al., 2015), thereby linking the aesthetic appreciation with their own experience (Cupchik et al., 2009). Thus, compared with nature photographs, viewing nature paintings would evoke greater levels of relaxation due to the close relationship between aesthetic preference and mental stress recovery (Zhao & Wang, 2020; Korpela & Ylén, 2007; Nordh et al., 2009). Furthermore, painting can help observers experience a relatively greater mind-wandering state, during which they might become relaxed and tend to engage in mental states possibly unrelated to the painting content per se, such as imagining and recalling (Mason et al., 2007; Vessel et al., 2012).

Second, nature is the cradle of human beings, but its effects on humans' well-being have two sides. Nature provides water, foods and shelters to support survival and reproduction of human. Meanwhile potential hazards possibly hide in it, inducing the sense of insecurity. Tabrizian et al. (2018) concluded that perceived insecurity would cause mental stress and reduce human well-being. Therefore, the nature represented by the photographs maybe has negative effects on humans because the photographs faithfully record the raw nature. While, nature always was manipulated when the artist produces a painting, the negative elements of nature usually are removed from the painting. It just likes an artist' words: “of course, I will naturally remove some ugly factors in my eyes, because I want to make my artwork more beautiful”. The negative elements in nature can reduce human well-being (Appleton, 1975).

Third, Freud (1908) indicated that artists were driven by strong instinctive desires, but could no find the ways to achieve these desires in real world, thus they escaped from real life and entered their inner imaginary world where they could realize their wishes. Therefore, artworks such as paintings express the ideal world imagined by the artists through whitewashing the real world. Obviously, participants are more familiar to the scenes represented by the photographs than the paintings. Familiar environments constrain people's sense of “being away” (Von Lindern, 2015; Von Lindern et al., 2013) which is defined that the environment allows visitors escape from daily context (Greenwood &

Gatersleben, 2016), and is identified as one of the four necessary factors of restorative environments (Kaplan & Kaplan, 1989).

4.2 Limitations and Future Research

The perception of a person in a place should be considered a complex phenomenon, affected by beyond environmental characteristics. Previous literature suggested that presence of other people in a place could affect person's perception positively and negatively depending on various factors, such as the expectations of the person, crowdedness, and behavior (Edwards et al., 2012; Grahn & Stigsdotter, 2010; Ratnayake, 2017). The room images used in this study do not include the figures of human (see Fig. 1), which possibly weaken the practical value of the results because there are normally many students in the room. A future study is strongly recommended to explore how the presence of other students and its interaction with the features of indoor environments affect perceived comfort and learning efficiency.

The method of pairwise comparison used by this study transforms perceived comfort and learning efficiency evaluation into a clear comparison of two images, which facilitates the evaluation and alleviates the respondents' mental tension. Furthermore, it does not need to build a referring mental image, eliminating the risk of respondents using different mental image. However, this method has two disadvantages. (1) It can not identify the different gradients of perceived comfort and learning efficiency between the two images. For example, a student may slightly feel comfortable in "A" room over "B" room in a comparison, he/she may strongly feel comfortable in "A" room over "B" room in another comparison, but the two "A" room are scored "1"; and (2) respondents may be forced to establish ordinal differences even if they do not clearly perceive the differences in perceived comfort and learning efficiency between two images (Sayadi et al. 2005), because they are informed to choose one from the two images, and they natively believe that any two things are not the same in the world.

The ten comparisons in favor of the painting are different. For example, the number of participants supporting the painting in the seventh comparison is much larger than that in the sixth comparison (Fig. 2), which implies that the content of a scene possibly has a great influence on the results. Existing literature also suggested that specific environment features had an essential effect on visitors' perception, leading to the fact that different environment features induced various psychological well-beings (Zhao et al., 2018; Xu et al., 2018; Jiang et al., 2014). And, as mentioned above, concerning different features, artists use different painting techniques, generally, good features are highlighted and bad ones are removed, which may be the reason of various differences in perceived comfort and learning efficiency between the photograph and painting among the 10 comparisons. Although identifying the environment features of the scenes and picking out the optimal paintings are not the aims of this study, understanding the effects of environment features of the scenes on human well-being is important for further improvement of the indoor environment quality and the benefits of users, which calls for a future study. Due to these limitations, practitioners should exercise caution in any attempt to generalize these results in practice.

5. CONCLUSIONS

Hanging pictures describing nature on the walls of a room is the most convenient and economical measure to improve the quality of indoor environments, thereby benefiting health and well-being of users. This paper compares the perceived comfort and learning efficiency of graduate students between the classroom with raw nature (nature photographs) and artistic nature (nature paintings). The main findings include: first, the images with a nature painting in the room make students feel more comfortable and produce higher learning efficiency than the ones with a nature photograph; second, perceived comfort is a mediator between room conditions and learning efficiency. Providing a high-quality indoor environment for college students is crucial to promote their health and academic performance, because they are at the ages prone to mental disorder which is possibly deteriorated by other factors including fierce competition and the longer periods of isolation due to COVID-19 pandemic. These findings add knowledge to our understanding of the relationship between indoor environments and human well-being, and provide some clues to guide interior design.

DECLARATION OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGEMENTS

The authors thank the 42 postgraduate students who judged the perceived comfort and learning efficiency. And, the authors owe special thanks to Mr. Gang Xu (a professor in School of Humanities and Arts, China University of Mining and Technology) and Mr. Qunshan Liu (a lecture in School of Architecture and Design, China University of Mining and Technology), who provide the paintings and photographs used in this study. This research is supported by the National Natural Science Foundation of China (32071830).

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Citation: Jingwei Zhao*, Xintao Li. " Perceived Comfort between Photographed Versus Painted Nature Indoors and Implications for Improvement of Learning Efficiency" *International Journal of Humanities Social Sciences and Education (IJHSSE)*, vol 10, no. 10, 2023, pp. 31-40. DOI: <https://doi.org/10.20431/2349-0381.1010004>.

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