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INTEGRATING BIOPHILIC DESIGN INTO OPEN-PLAN INDOOR OFFICES CAN IMPROVE EMPLOYEES' WELL-BEING

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Abstract:

The "2023 China Employee Mental Health Monitoring Report" shows that increasing workplace stress and prolonged indoor exposure have exacerbated concerns about mental health, highlighting the necessity of evidence-based workplace design strategies.They spend up to 40% of their time in the office each day, lacking contact with nature, which has a significant impact on their mental health, both directly and indirectly. Although numerous studies have confirmed that biophilic design can bring significant psychological benefits, studies on employees' preferences for different biophilic elements and how direct and indirect exposure affects workplace mental health outcomes remain limited, especially in high-density technology companies in China. This study focuses on employee mental health, using qualitative methods and six semi-structured focus groups to collect data. The results show that employees generally prefer Biophilic elements that provide direct experiential benefits, especially indoor plants. However, some employees perceived negative effects, such as fear of pests, feeling oppressed by hanging plants, or experiencing discomfort when seeing greenery. Indirect elements, such as natural colors, support emotional comfort through visual stimulation. Green plants, water elements, and Biophilic natural forms have a dual moderating effect on both physiological and mental health. This study contributes to workplace environmental psychology by demonstrating how different categories of Biophilic elements influence employees' emotional experiences and provides design insights for creating more salubrious and more sustainable work environments. Future research could focus on the application of Biophilic elements at different spatial interfaces to explore their stress-relieving pathways.

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Introduction

According to data from Zhaopin.com's "2025 Survey Report on Sub-health Status of Workplace Employees," 54.9% of employees nationwide suffer from chronic anxiety and irritability, and 52.1% have experienced negative psychological symptoms such as anxiety, restlessness, and low mood, making these the most significant occupational health risks for contemporary employees. Employees spend up to 40% of their time in the office daily; this prolonged indoor environment and lack of contact with nature is directly or indirectly having a significant negative impact on their mental health(Frank-Richter & Gietzen, 2024).

The attention recovery theory (ART) posits that exposure to the natural environment can restore directed attention depleted during cognitive tasks, thereby preventing mental fatigue. (Kaplan & Kaplan, 1989) In 1993, Wilson and Kellert first proposed the "biophilic hypothesis," emphasizing the crucial role of the relationship between humans and nature in human brain evolution and physiological and psychological well-being. Incorporating biophilic design principles into the workplace can mitigate the adverse effects of indoor environmental stressors and promote the physical and mental health of employees (Korpela, de Bloom, and Kinnunen 2015). This study draws on attention restoration theory and biophilic design theory to explore how different natural elements affect employees' emotional experiences in the office environment.Past research has largely focused on the isolated effects of single elements, such as plants improving employee mental health (Fukumoto et al., 2024)、(Mari et al., 2023); or the effects of several elements, such as natural materials and natural colors (Haristianti & Raja, 2025), and natural lighting, vegetation, and natural materials (Tan et al., 2024) alleviating employee stress. Few studies have compared direct and indirect natural experiences or prioritized the effects of different elements. Previous research has primarily used quantitative questionnaires or physiological measurements (Lei et al., 2021; Yin et al., 2020). While one study qualitatively examined biophilic elements such as plants, natural lighting, and ventilation (Gray, 2018), it did not prioritize these elements. Therefore, this study will employ a focus group qualitative study in an open-plan office environment to prioritize biophilic elements in the workplace and explore their impact on employee health in such environments.

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Literature Review

Biophilic Design in the Workplace

In 2005, Kellert and Calabrese constructed a biophilic design analysis framework, dividing 24 design attributes into three experience dimensions: direct natural experience, indirect natural experience, and space-place experience. In 2014, Browning, Ryan, and Clancy summarized 14 biophilic design patterns, categorizing them into three main types: natural elements within space, natural analogies, and natural spatial experiences. Subsequently, Lei et al. (2022) used these two classic conceptual frameworks as a foundation, relying on the 24 attributes and 14 design patterns to refine 9 biophilic design patterns applicable to work scenarios., as well as their overlaps/relationships. More recently, we have built upon the nine biophilic design patterns for the workplace proposed by Lei et al. (2022). Yildirim et al. (2023) completed a comprehensive review of bio-friendly design elements in the workplace. This study further expands and optimizes this theoretical framework by adding four design patterns, forming a system of bio-friendly design patterns containing 12 categories.

Design of Biophilic Office Environments

The current trend in most offices is towards open-plan layouts. This is due to the reduced number of partitions required, lower construction costs, lower rental costs due to increased worker density, better spatial configuration, and better lighting (Brennan et al., 2002). However, research shows that open-plan offices can lead to high levels of stress, conflict, hypertension, and high employee turnover (Danielsson & Bodin, 2008). Therefore, addressing the stress and health issues of office space users, especially those in open-plan offices, is urgent and requires in-depth discussion and research. Studies also indicate that Biophilic interventions have different effects on physiological and cognitive outcomes in open and closed workspaces, with Biophilic interventions consistently showing better results in reducing physiological stress in open-plan offices (Yin et al., 2019).

This study is based on nine Biophilic workplace design patterns proposed by Lei et al. (2022) and twelve by Yildirim et al. (2023). This study focuses on visually based open-plan office environments, thus excluding multi-sensory experiences, natural ventilation and thermal comfort, and sunlight and visual comfort. Since natural landscapes outside windows and semi-outdoor natural contact are considered outdoor elements, seven elements are derived after these exclusions: greenery, natural simulation, natural materials, natural colors, organic forms and natural patterns, biological forms, and the presence of water. Yildirim et al. investigated the overlap/connection between natural simulation and simulated nature viewed through paintings, screens, or projectors, and natural images in 24 attributes. They also investigated the overlap/connection between organic forms and natural patterns and natural forms and shapes in 24 attributes, ultimately forming six natural elements: greenery, natural materials, natural colors, natural images, Biophilic natural forms, and the presence of water.

Methods

Research Subjects and Methods

This study employed a qualitative approach, involving 24 employees from two large companies in Beijing, China, specifically Tencent and Alibaba. Case studies were selected from

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participating sustainable development companies. While sustainable development companies do not have Biophilic standards for indoor office environments, environmental well-being design is an integral part of sustainable development. The two companies selected as the top two sustainable development benchmarks by the Internet Society of China in 2025 were chosen as case studies. The selected companies are Tencent (Company A) and Alibaba (Company B). Permissions were obtained from both companies before data collection. Participants were intentionally selected from different functional departments to capture diverse workplace experiences; there were 14 men and 10 women. Respondents consented via WeChat.

The sample was selected using purposive sampling. The sample size is determined by using the theoretical saturation principle of qualitative research. (Hennink et al., 2019). Because the study aimed to explore employees' experiences and personal preferences, 24 participants were considered sufficient to reach topic saturation. Respondents from each company selected employees who were able to communicate and express opinions and perspectives during data collection. This study relied on semi-structured focus group discussions to complete the data collection.

There are six focus groups, averaging three per company. with four people in each group. Each focus group discussion lasts 50-60 minutes, with Chinese as the language of communication. Researchers participated in focus group discussions and became part of the groups, while assistants took notes. The focus group discussions were recorded entirely using audio recorders. This study uses projective techniques as an auxiliary means of communication for respondents, examining their preferences for biophilic design elements from a subjective perspective, and their physiological and psychological effects.

Research Instrumentation

Focus groups used projective techniques and vivid images to initiate communication with employees. These images were evaluated using positive and negative sentiment keywords from the Hownet sentiment dictionary (Dong & Dong, 2003). Discussions were recorded using a voice recording app.

Analysis

This study used content analysis based on captured images to analyze the observational data. Simultaneously, NVivo software was used to process focus group discussion data and perform qualitative coding analysis. The data were analyzed using a targeted summative content analysis method. First, After the interview data was transcribed, coding extraction was carried out. The recurring codes, sub-themes and themes in the data related to employees' preferences for biophilic design elements were summarized and a summary content analysis was conducted.

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Results and Analysis



Figure 1: Open Office BiophilicElements.

Source: (Author's Rendering)

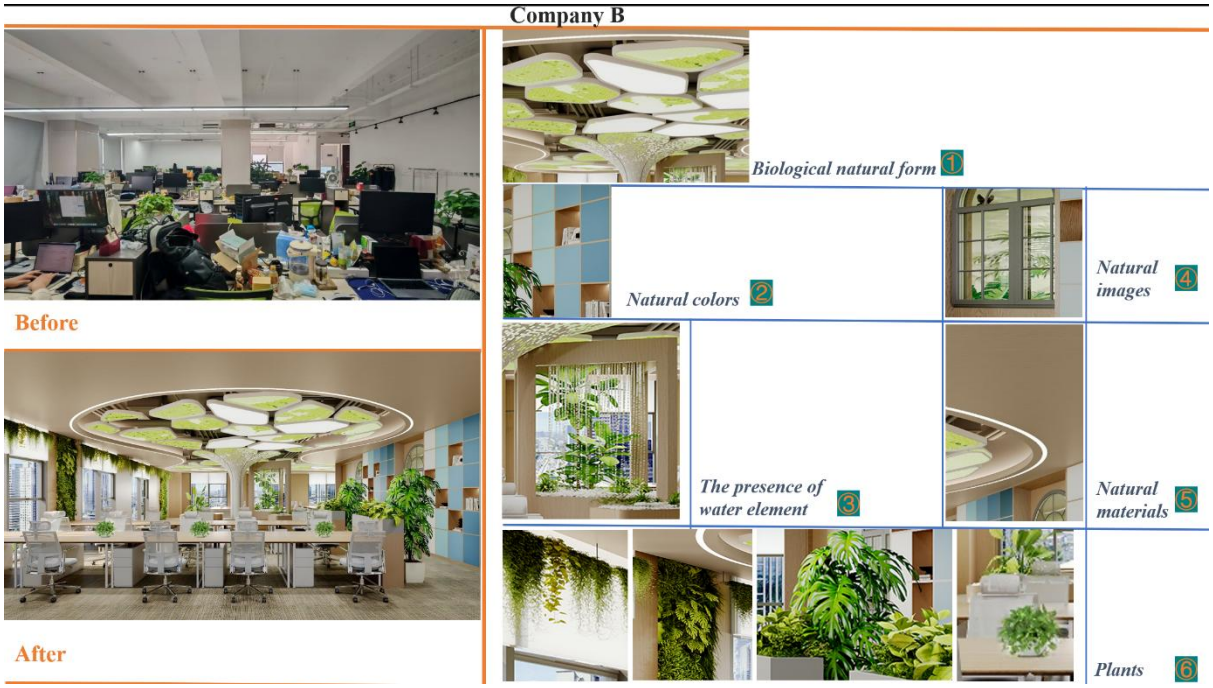


Figure 2: Open Office Biophilic Elements.

Source: (Author's Rendering)

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Employee Preferences for Biophilic Elements

The study results indicate that employees generally prefer Biophilic elements that provide a direct experience, especially indoor plants, while indirect elements such as natural colors support emotional comfort through visual stimulation.

Green plants are the most favored Biophilic element, having a dual regulatory effect on both positive psychology and physiology. For example, they can regulate mood, promote a sense of closeness, vitality, relaxation, reduce stress and anxiety, and also relieve fatigue. However, many employees report disliking plants due to negative physiological effects, such as pest infestations, the oppressive feeling of hanging plants, and discomfort from seeing greenery. A semi-high green wall with 80% coverage exhibits the best physiological and psychological effects (Li et al., 2022). "I feel that having plants around allows me to look at them during breaks, relieving my stress." "After staring at the computer for a long time, I want to look at green plants to relieve eye strain." "I don't really like green plants because the plants here attract a lot of pests."

Flowing water is the second most favored Biophilic element among employees, with positive psychological effects. For example, seeing water can make one feel relaxed and energetic, fostering a sense of closeness, relieving anxiety, promoting pleasure and relaxation, and relieving stress. It also has positive physiological effects such as relieving eye fatigue. A few respondents said they disliked water elements because the flow of water creates noise that disrupts the office environment. However, indoor water elements, as Biophilic design elements, can significantly improve user well-being and reduce stress (Nevzati et al., 2021). I chose water elements first, as they are my top priority for relieving stress. Seeing flowing water immediately calms me down. There is the issue of sound disturbance; seeing flowing water makes me feel it's a bit noisy and disrupts my quiet work environment.

Natural colors are the most preferred Biophilic elements in indirect experience, with positive psychological effects, inspiring imagination, relieving stress, promoting relaxation and tranquility. Introducing natural colors such as green, blue, and earth tones (e.g., wall colors) into the workplace can produce many beneficial effects, including relieving stress and promoting overall physical and mental health. (Demirkol & Önaç, 2024).

White and blue can reduce brain activity, support mood regulation, and have significant stress-reducing effects (Dehan et al., 2025). "I find natural colors very soothing; they belong to nature and seeing them helps relieve my stress"."Looking at blue can create a calming visual experience, making me feel like I'm in a natural space, less oppressive".

The psychological effects of natural materials: a return to simplicity, warmth, comfort, affinity, and vitality. When the wood coverage is between 35-65% and the wood surface variation is at level 4 or 5, the psychological impression of a wooden space is optimal (Li et al., 2021). "Natural materials have more warmth and affinity".

Biophilic natural forms have both positive psychological and physiological regulatory effects. Positive psychological effects include evoking associations, comfort, softness, intimacy, and vitality; it also has a physiological effect of relieving fatigue. Switching to natural forms during a very busy and anxious work state provides a relaxing, breathing experience; "it has a feeling of vitality. When experiencing visual fatigue, there's a strong need for visual distractions from

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Biophilic natural forms".The appearance of natural shapes and forms (leaf-like patterns on pillars) can transform static spaces into dynamic spaces with the qualities and characteristics of living systems (Kellert, 2018). Biomimetic forms and patterns, derived from research on visual preferences, can reduce stress caused by attention shifts and enhance attention (Nevzati et al., 2021).

Although natural images received the least attention, they brought a sense of vitality and relaxation, creating a positive psychological effect; however, some respondents disliked natural images because they brought negative psychological effects such as tension and anxiety. Natural images and the presence of plants are among the most commonly used elements in Biophilic design, and these elements are beneficial to both mental and physical health (Hung & Chang, 2021) . *"Places with relaxing paintings or many relaxing plant images are good places to relax when you're tired from work. Natural images make me feel a little tense".*

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Preferred biophilic elements					
Experience	**Perception**	**Elements/effect**	**Document**	**Reference point**	**Proportion**
Direct experience	Green plants		1	36	31.58%
	Positive psychological	Regulate your mood	1	1	
		Getting close to	1	2	
		vitality	1	6	
		Relax	1	13	
		Reduce stress and relieve anxiety	1	7	
	Positive physiological	Relieve visual fatigue	1	7	
/	I don't like plants		1	3	2.63%
	Negative physiological	Pests	1	1	
	Negative psychological	Too much discomfort	1	1	
	Negative psychological	depress	1	1	
Direct experience	Flowing water + green plants		1	4	/
	Positive psychological	Liveliness, vitality	1	3	
		Mood improved	1	1	
Direct experience	Flowing water		1	19	16.67%
	Positive psychological	Relaxed and energetic	1	5	
		Friendly and anxiety-relieving	1	2	
		Pleasant and relaxing	1	7	
		Relieve stress	1	4	
	Positive physiological	New things relieve eye fatigue	1	1	
/	Don't like water elements		1	4	3.51%
	Negative psychological	Noise interference with office work	1	4	
Indirect experience	Natural colors		1	17	14.91%
	Positive psychological	Full of imagination	1	1	
		Relieve stress	1	3	
		Relax and enjoy	1	7	
		calm	1	6	
Indirect experience	Natural materials		1	15	13.16%
	Positive psychological	Back to simplicity	1	2	
		Warm and comfortable	1	8	
		Affinity, vitality	1	5	
Indirect experience	Biological natural form and shape		1	14	12.28%
	Positive psychological	Association, imagination	1	4	
		comfortable	1	3	
		gentle, approachable	1	3	
		vitality	1	1	
	Positive physiological	Relieve fatigue	1	3	
Indirect experience	Natural Images		1	5	4.39%
	Positive psychological	Vibrant and energetic	1	2	
		Relax	1	3	
/	Don't like natural images		1	1	0.88%
	Negative psychological	tension and anxiety	1	1	
Summary				**114**	**100.00%**

Figure 3: List Of Biophilic Elements Preferred By Employees

Source: (Author's Rendering)

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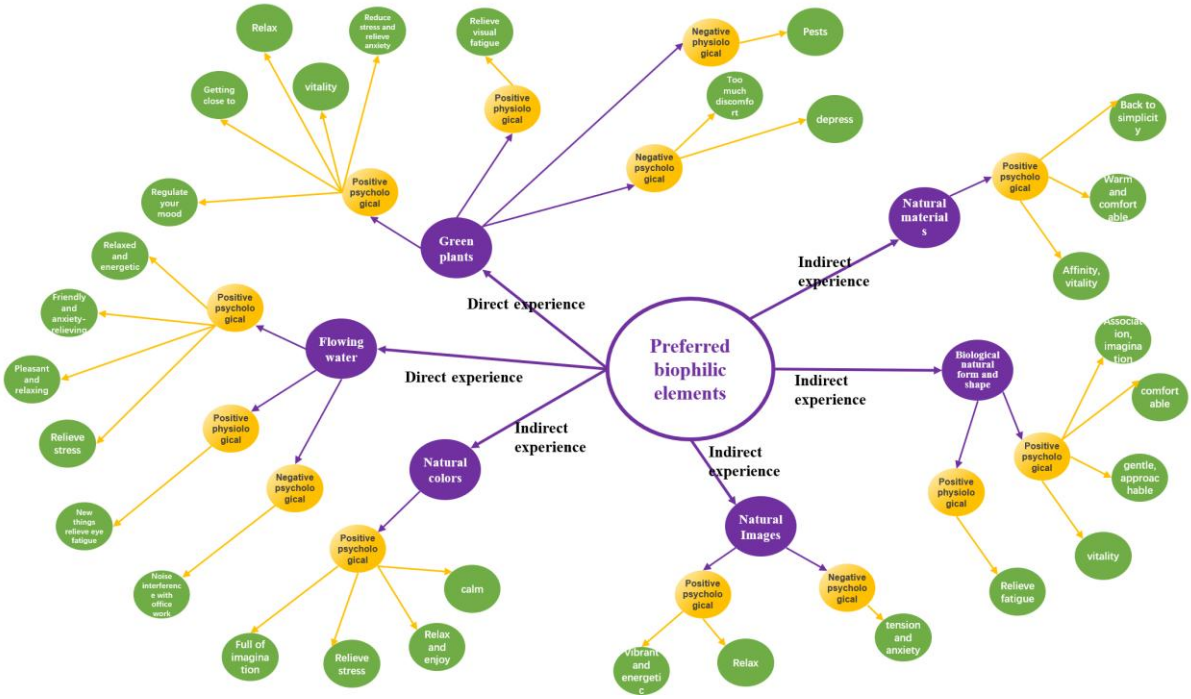


Figure 4: Biophilic Element Coding.

Source: (Author's Rendering)

Discussion

This provides important evidence of employees' preferences for biophilic design elements and their impact on employee well-being. The research shows that employees prefer Biophilic elements, both directly and indirectly, but with a stronger preference for direct experience. In open-plan office environments, the most preferred Biophilic element is plants, followed by water, natural colors, natural materials, Biophilic forms, and natural imagery. This study emphasizes that the most preferred Biophilic element, plants, is acquired through direct experience. The study also found that greenery, water, and Biophilic forms have both psychological and physiological regulatory effects on employees, while natural colors, natural materials, and natural imagery only have a physiological regulatory effect; natural colors, natural materials, and Biophilic forms have no negative feedback. The most preferred plant element can regulate employees' mood, reduce stress and anxiety, and also have a positive psychological effect of relieving fatigue. The results support previous research, showing that plant walls have the best effects in both physiological and psychological regulation (Li et al., 2022), and that indoor desktop plants alter the perceived attractiveness of a space, thereby affecting stress reduction (Yeo, 2021). Indirect experiences involving bio-related elements are also crucial. Natural colors, materials, bio-related natural forms, and images all have positive psychological effects, promoting relaxation and stress relief for employees. Indoor water, ranked second in preference, alleviates anxiety, promotes pleasure and relaxation, and reduces stress, supporting previous research that indoor water significantly improves user well-being and reduces perceived stress (Nevzati et al., 2021). Previous research also indicates a lack of support for the effectiveness of natural sounds in reducing psychophysiological stress levels (Aristizabal et al., 2021). Employees' negative psychological explanation is that flowing water creates noise that disrupts the work environment. Natural colors are the most preferred bio-related element in indirect experiences, offering positive psychological relief, promoting imagination, relieving stress,

relaxation, and calm. Introducing natural colors such as green, blue, and earth tones (e.g., wall colors) into the workplace can produce many beneficial effects, including relieving stress and promoting overall physical and mental health. (Demirkol & Önaç, 2024).

Overall, this study strongly recommends incorporating biophilic elements into the design of open-plan indoor office environments, including direct experience of nature indirect experience of nature. These elements are intuitively important because they have a positive mitigating effect on the indoor office environment. This is consistent with the restorative effects delivered by workplace biophilic design. (Yildirim et al., 2023). Theoretically, this study also emphasizes that the biophilic frameworks for the workplace proposed by Lei et al (2022) and Yildirim et al (2023) exhibit complementary properties when considering biophilic patterns and related elements.

Conclusion

The deployment of biophilic features in open-plan office spaces is recommended for promoting occupants' mental and physical well-being of employees. Biophilic design elements provide employees with direct and indirect natural experiences, thereby evoking positive emotions and effectively regulating individual stress responses. and increasing productivity. This study contributes to workplace environmental psychology by demonstrating how different categories of biophilic elements influence employees' emotional experiences and provides design insights for creating healthier and more sustainable work environments. Policymakers and industry practitioners in the field of indoor environment and workplace should promote good health and well-being by enabling employees to reconnect with nature through Biophilic design in office spaces. The findings can provide design teams with guidance, assisting them in carefully selecting and applying biophilic design strategies to their office environments to achieve their intended design goals.Research findings can also be incorporated into sustainable work initiatives as part of sustainable enterprise standards, An effective way to achieve sustainable development goals.Future research can focus on the application of Biophilic elements at different spatial interfaces to explore their stress-relief pathways.

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Ethics Statement: This study did not involve any human participants, animals, or sensitive data requiring ethical approval. The authors confirm that the research was conducted in accordance with accepted academic integrity and ethical publishing standards.

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