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Article

Exploring Environmental Restoration and Psychological Healing from Perspective of Resilience: A Case Study of Xinglin Bay Landscape Belt in Xiamen, China

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Abstract: We explored the relationship between environmental restoration and psychological healing and the ecological optimization and healing function of the waterfront landscape from the perspective of resilience in the Xinglin Bay landscape belt of Jimei District, Xiamen City, China through qualitative research, in-depth interviews, and field investigations. 63 interviewees were invited from October 12 to 16, 2022 to collect data on their activity and psychological feelings in the area. The results showed that gender and frequency of activities were important variables affecting the effectiveness of landscape healing. Hydrophilic items in the Xinglin Bay landscape adopt the theme of resilience to promote the interaction between people and the environment, thereby subtly changing the cognition of visitors. The results of this study prove the relationship between resilient landscapes and physical and mental healing, highlighting the importance of the resilient design of waterfront landscapes in the urban environment and social development.

Keywords: waterfront landscape; embodied cognition; dual resilience

1. Introduction

Various problems have arisen in the development of human society. For example, as China's urbanization is accelerating, a large number of cities are concentrated in certain regions. As of the end of 2021 [1], the urbanization rate of the permanent population was 64.72%, an increase of 0.83% compared to the previous year. It was pointed out that the rapid development of population and urbanization were the main reason for the increase in the environment pressure index [2]. The natural environment needs resilience after damage. In 1973, the Canadian ecologist Holing introduced the concept of "resilience" into ecology in 'Resilience and Stability of Ecosystems' and stated that the maintenance of a system remains with the capability of its original state and function to external shocks and disturbances. With the development of disciplines in developing landscape, the concept of resilience has been further developed such as resilient city and resilient planning. In 2010, the concept of a resilient landscape was proposed. A resilient landscape refers to a landscape that is flexible in its ability to recover from sudden or gradual changes while maintaining traditional values and harmony with nature [3]. On the one hand, the fragility of the environment is focused on, and, on the other hand, the resilience of the environment is projected. Both are worthy of in-depth research considering the environmental pressure of urbanization and healing from the pressure.

Human society needs psychological resilience during urban development, and the intersection of the two can be found in landscape design, which is paid more attention to. Healing is related to multiple aspects such as physical, psychological, emotional, social, and others. It generally refers to a process of relieving stress, resting and recovering, and promoting a comprehensive state of health [4]. Studies showed that green space has a healing effect on the mind and body, and the healing effect of water in the landscape is greater than that of green space [5,6]. Humans have been actively exploring their relationship with nature, and many studies proved that nature relieves stress, restores, and helps release emotions, which are reflected in the theory of 'Restorative Environmental Design', 'Attention Restoration Theory', and 'Stress Reduction Theory' [7,8]. A landscape with water is more attractive than that without water, and its cognitive and emotional healing functions are also better [9].

In certain situations, the nervous system of the human body and the environment are constantly interacting to produce a complete cognitive system [10]. Environmental cognition is a continuous development process, from which the body receives stimulation from the environment, embedding cognition in the body. The significance of the embodied cognition theory lies in

that the mind is formed in the interaction of the brain, body, and environment, and cognition is intrinsically linked with embodied structure and activity schema [11]. In the embodied cognition theory, cognition is regarded to originate from the interaction process between the body and the surrounding environment, and the generation and understanding of cognition are based on the body [12]. Environmental stress can be relieved through resilient landscapes [3], while psychological stress can be healed in appropriate accessible spaces such as water in the landscape and biological diversity [13]. According to the biophilia hypothesis, observing plants and animals lowers blood pressure, increases body temperature, and relieves anxiety. Experiment results showed that long-term bird watching was beneficial to the physical and mental health of the elderly [14]. However, the relationship between how people perceive the psychological healing and environmental restoration of the landscape in the environment has been rarely discussed. Therefore, it is important to explore the relationship between environmental restoration and psychological healing through the resilient design of the waterfront in the landscape.

2. Materials and Methods

2.1. Research Framework and Design

Based on the embodied cognition theory, we adopt the view that the body and nervous system co-evolved in the environment when the body is in constant contact with the environment. The dynamic approach hypothesizes that cognitive behavior emerges from situational actions through the sophisticated use of internal states to mediate between perception and action [15]. The dual resiliency of landscape and psychology is recognized in this theory (Fig. 1). Based on the theory, Jimei District was selected as the study area as it is located on the seashore with a long coastline, sandy beaches, rocks, various vegetation, and various landscapes with water. The ecological foundation is excellent for the construction of eco-tourism. In 2004, Xiamen changed its urban planning, started the construction of a bay-type ecological city, and chose the regional layout of tourism development. There were two functional tourism circles: the coastal urban cultural tourism circle and the countryside leisure tourism circle. An ecological belt was built around Xinglin Bay for ecological and environmental protection. The project makes full use of the original wetland landscape of Xinglin Bay to create an "ecological garden" that is dominated by natural succession and supplemented by human management [16].

To explore the healing effect of the landscape with water on the body and mind for the construction of a resilient landscape, we conducted a field survey on the east coast belt of Xinglin Bay and investigated the age, frequency of visits, purpose of visits, and environmental interaction of the visitors and their physical and mental responses. After half a month of participatory observation in the field, the time period with the highest flow of people was selected. Interviews were conducted during 7:00-9:00 AM and 4:00-7:00 PM on October 12−16, 2022, which were decided by onsite observation. The unstructured interview was conducted for 63 interviewees. The interviewees who were interviewed on the sea plank road were classified were classified as group A, and those who were interviewed on the east waterfront were classified as group B.

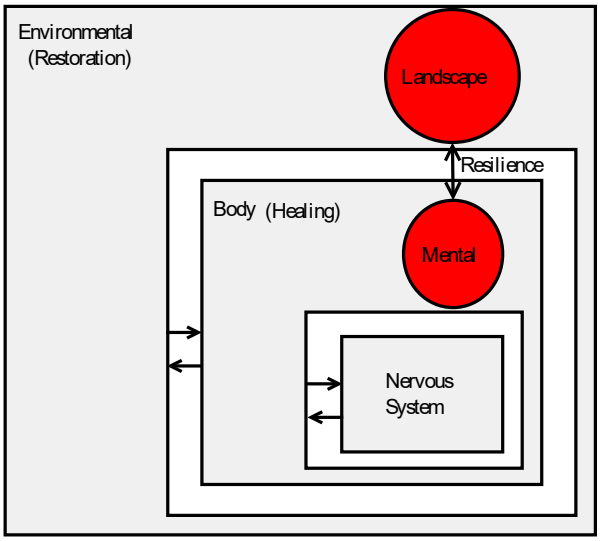


Fig. 1. Main concept of this research [15].

2.2. Study Area

Xinglin Bay is located in Jimei District, Xiamen with mountains facing the sea, and has rich geoscience tourism resources owing to its advantageous geographical location. Xinglin Bay used to be a small bay but, in 1979, a semi-enclosed water body was formed by the beach embankment. The upper stream connects to Zhuxi and flows eastward into the Taiwan Strait. The landscape belt of the east coast of Xinglin Bay extends 2.6 km. Two traffic routes run along the coast through the entire landscape belt of the east coast.

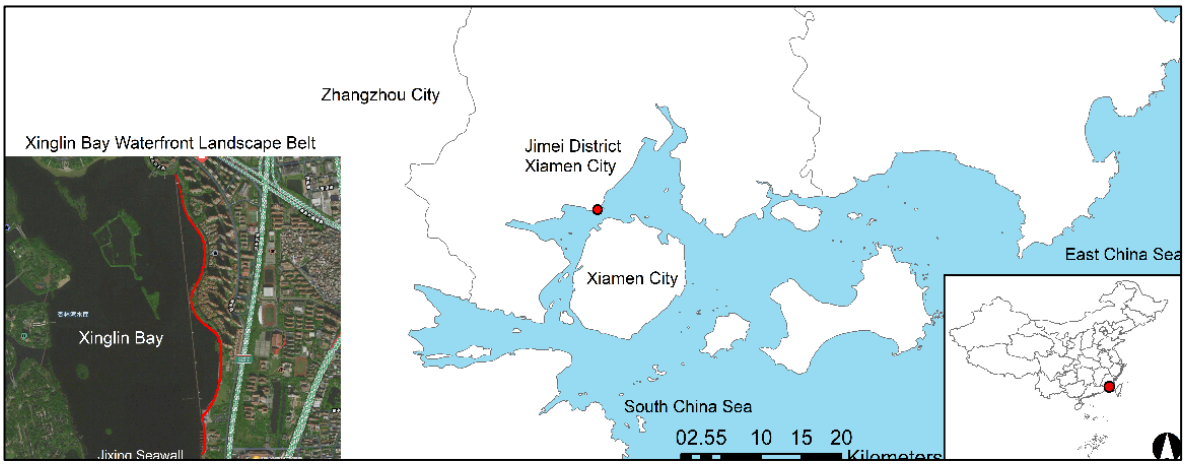


Fig. 2. Study area.

3. Results

3.1 Data Analysis Result

Gender, visit frequency, age, identity, the behavior of interacting with the environment, and pedestrians' purpose were analyzed in the research as the basic descriptive data. Among 63 interviewees, 55.56% were male, and 44.44% were female. 57 were residents, and 6 were tourists. The frequency of visits is shown in Fig. 3. Interviewees between 20−35 years old accounted for 34.92%, followed by those between 20−35 (34.92%) and 46-65 (33.33%) (Fig. 4). Most of the interviewees had visited the study area more than once, and 36.51% of them visit the area every day (Fig.5).

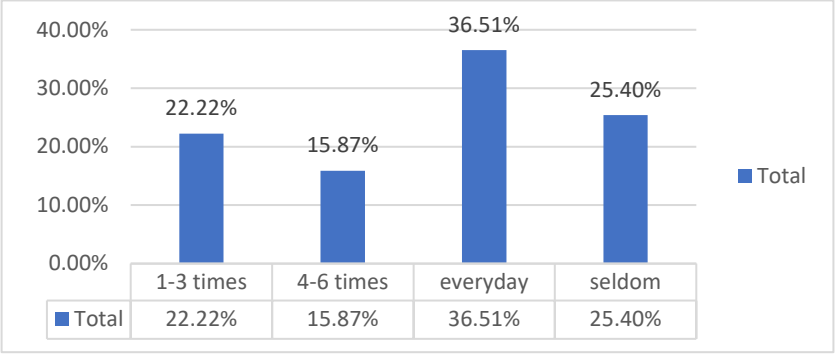


Fig. 3. Frequency of visits.

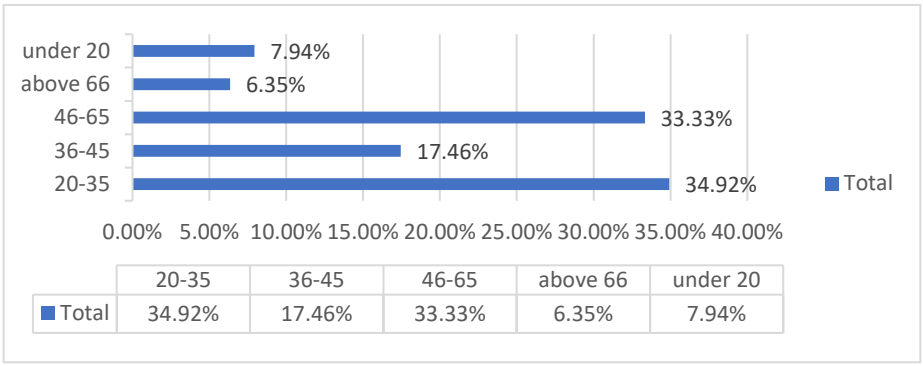


Fig. 4. Age distribution of interviewees in this study.

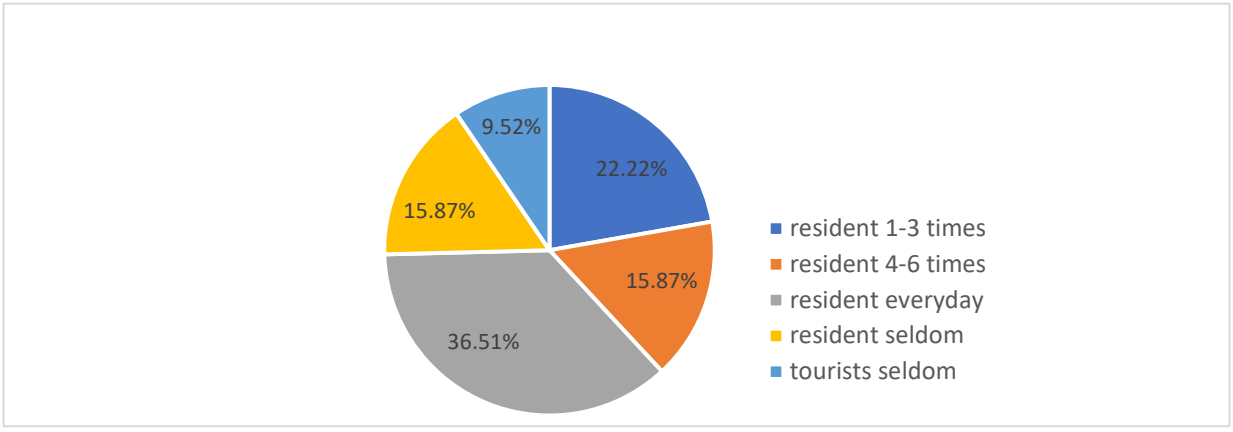


Fig. 5. Frequency of visiting study area.

Males and females showed similar frequency of visits, and the majority of them visited the area more than once (74.29% of the females and 75.0% of the males). 37.14% of the females and 35.71% of the males visited the area every day (Figs. 6−8).

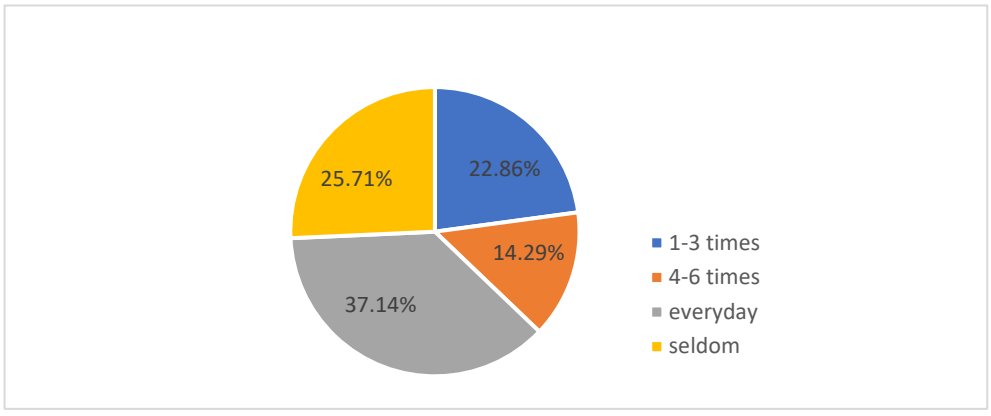


Fig. 6. Frequency of visiting area of female interviewees

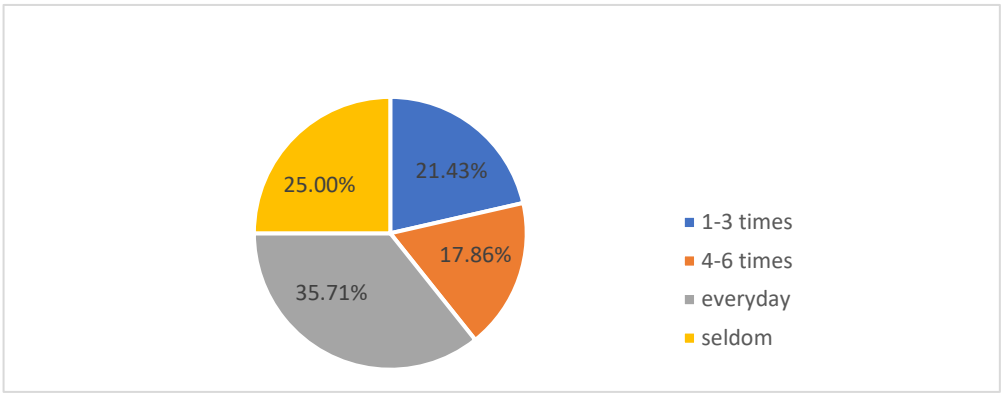
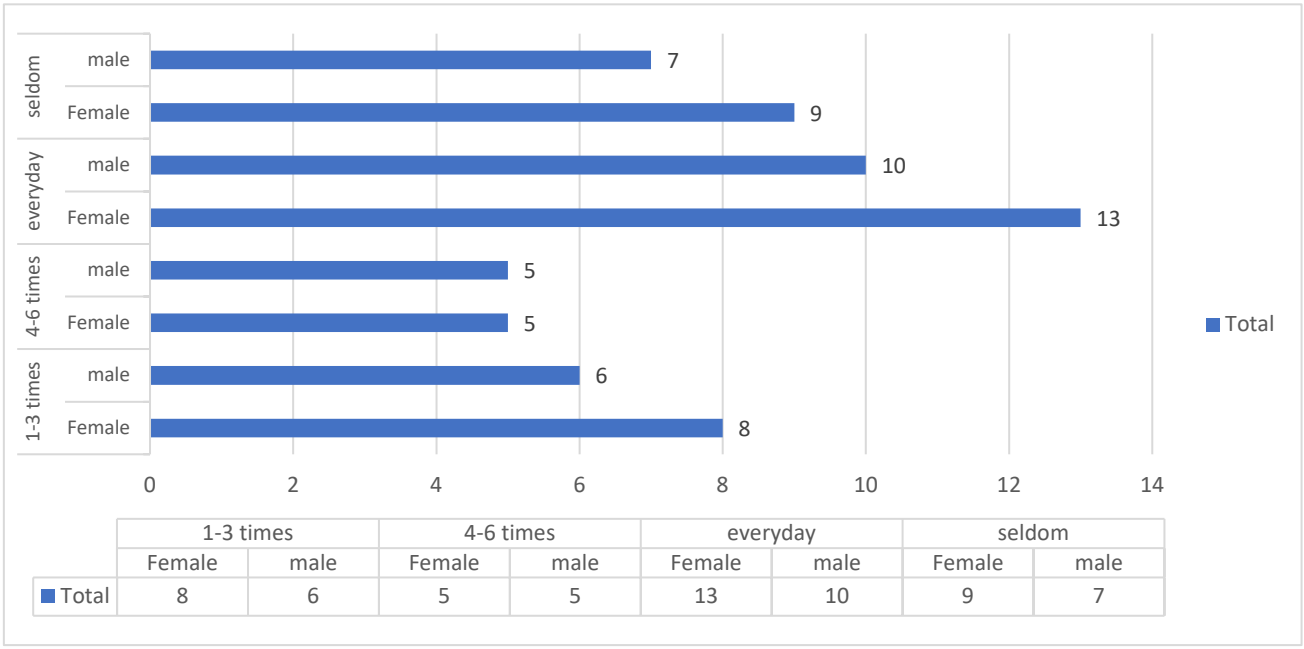


Fig. 7. Frequency of visiting area of male interviewees



	1-3 times		4-6 times		everyday		seldom	
	Female	male	Female	male	Female	male	Female	male
Total	8	6	5	5	13	10	9	7

Fig. 8. Comparison of frequency of visits of males and females.

Figure 9 shows that the interviewees between 46−65 years old visited the study area most frequently, followed by those between 36−45. The interviewees under 20 years old rarely visited the area while all of those above 66 years old visited the area every day. This reflects that young people under 20 years old have low demand for the scenery, which is opposite to those above 66.

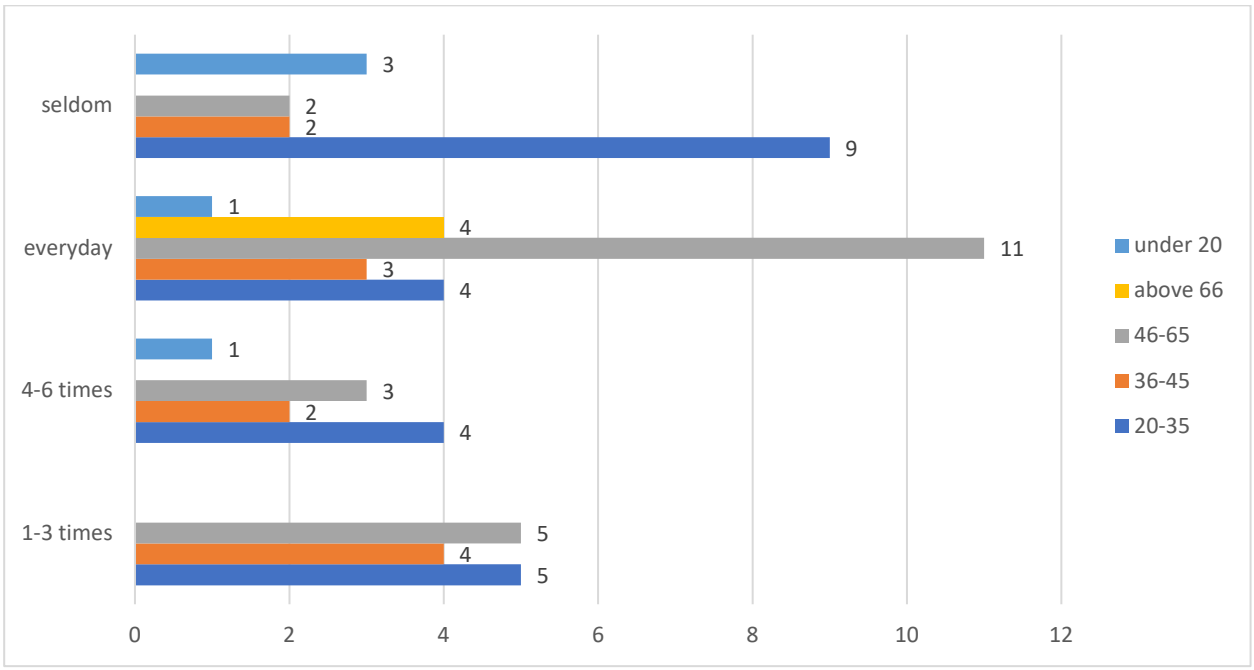
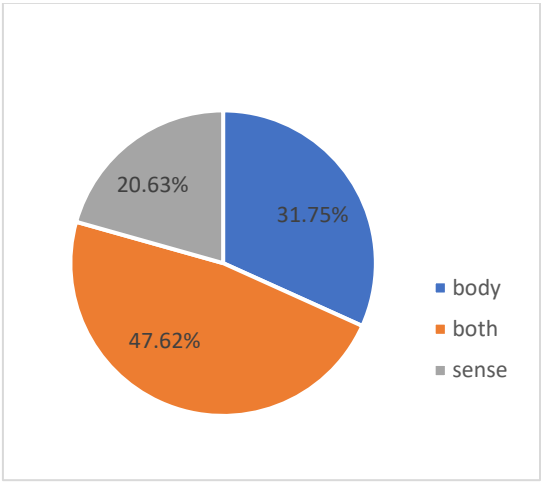


Fig. 9. Comparison of frequency of visits by age.

3.2 Interaction with Environment

Based on the embodied cognition theory, interaction with the environment was categorized into sense, body, and both. 20.63% of the interviewees interacted with the environment through their senses to heal themselves and relieve their stress. 31.75% interacted with the environment through their bodies (Fig. 10). They strengthened their bodies and regained vitality through exercise, walking, and rowing (Figs. 11−14). Nearly half (47.62%) interacted with the environment with their bodies and senses, letting out negative emotions while exercising and rejuvenating their bodies and recovering their mind and body from the environment. Nearly half of the interviewees felt the interaction with the environment through mind and body (45.71% of the females and 50% of the males, Fig. 11). 28.57% of the females interacted with the environment through senses, while only 10.71% of the males perceived the impact of the environment through senses. 71.42% of the females and 89.29% of the males interacted with the environment with their bodies. The interviewees had multiple purposes for the visit to the area. The main purpose was to appreciate its scenery (53.85%), which was related to the healing effect on the sense. Scenery and fitness were important purposes for the interviewees (Fig. 13). They were concerned significantly about their health. 23.33% of them had multi-purposes of "scenery", "scenery, fitness", and "scenery, relaxation". It seems that when the scenery is attractive to people, most people try to release stress and stay healthy in such an environment (Fig. 14).



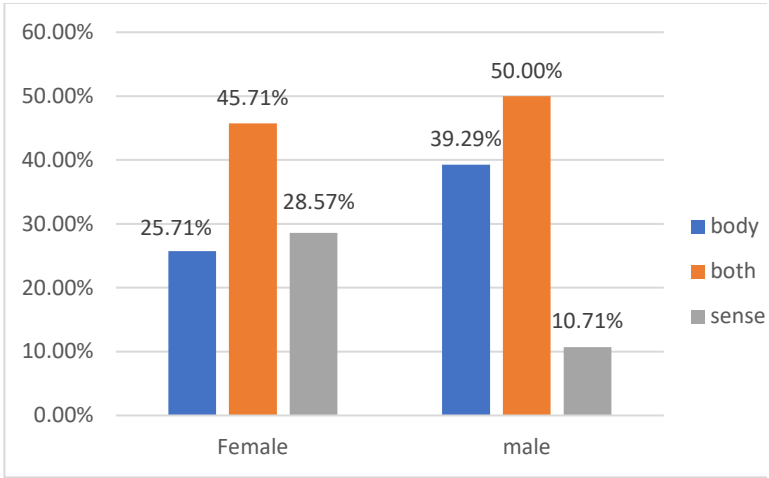


Fig. 10. Interaction with environment.

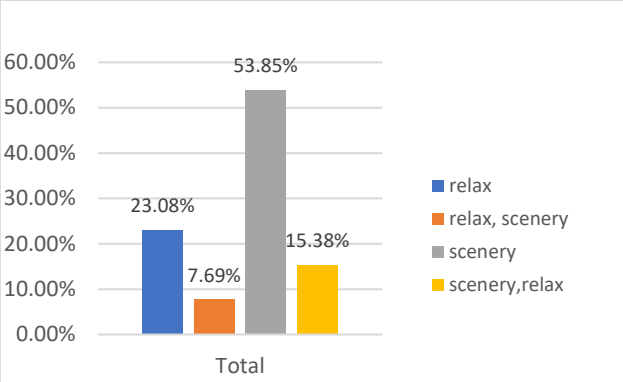


Fig. 12. Purpose of interaction with environment through senses.

Fig. 11. Interaction with environment of males and females.

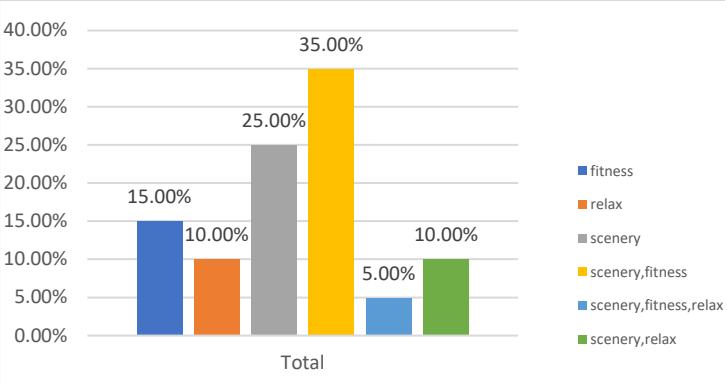


Fig. 13. Purpose of interaction with environment through bodies.

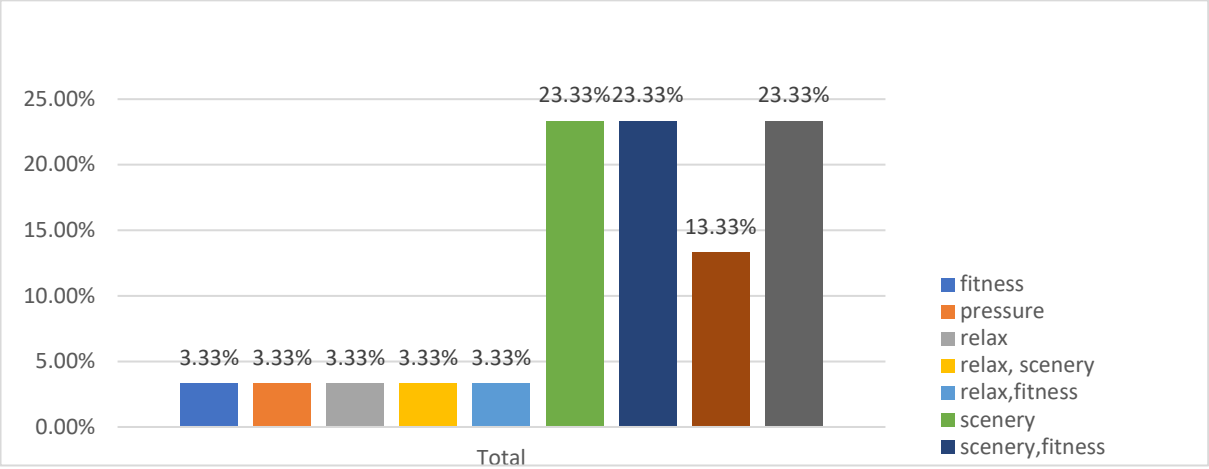


Fig. 14. Purpose of interaction with environment through senses and bodies.

3.3 Environmental Restoration and Healing

15.87% of the interviewees felt the healing effect on the body from the environment, and 33.33% observed that the ecology was being restored in a positive trend. 50.79% thought that the study area provided the healing effect and experienced environmental restoration (Fig.15). Interviewee B-8 said: "*The air here is clear, and with age, the body often feels pain, and going out for a walk can relieve the pain; and there are many kinds of plants here, and seeing them will make you feel better.*" This narrative intuitively reflected the healing effect of the environment on the body. Interviewee B-6 said, "*I will go out for a walk in the morning, breathe fresh air, dispel the hazy feeling of the body, and maintain a good mood for the day."* It seems that a beautiful landscape is beneficial to people's bodies and minds. 33.33% of the interviewees noticed changes in the environment and ecology, as described by interviewee B-7: "*The water quality here has been improved to a certain extent compared to before, and there is no longer any foul odor. In spring (March-May), a large number of seabirds circled here, especially near the sea plank road. It was so dark that even CCTV came to report.*" Interviewee B-12 said: "*Lots of birdwatchers on the weekends*." These testimonies proved that the ecological environment of Xinglin Bay was improving, promoting the increase of biological species and making the ecosystem of Xinglin Bay more stable. 50.79% of the interviewees not only observed changes in the ecological environment but also recovered their bodies and minds as explained by interviewee B-7:*"It has been found that the government has carried out special treatment for pollution, and the water quality has been greatly improved compared with the previous one, but the water quality of the residential villa area still needs to be improved. I usually go out for a walk, bask in the sun, stay healthy, and keep this habit, I feel happy and the stress is gone."* 66.66% of the interviewees had a healing effect in the environment, of which the females accounted for 39.68% compared to 26.98% of the males (Figs. 15 and 16). The proportion of the males and females who felt "body healing" was 6.35% and 9.52% respectively, while those who felt "both" was 20.63% and 30.16% (Fig. 16). Therefore,

when females and males were in the same environment, the beautiful environment is more likely to have a better healing effect on females.

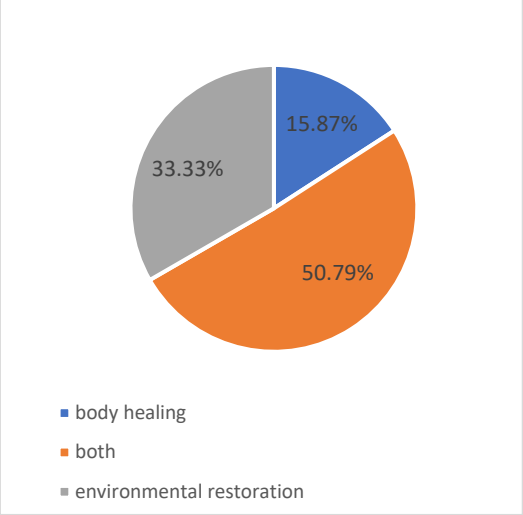


Fig. 15. Healing and environmental restoration felt by the interviewees

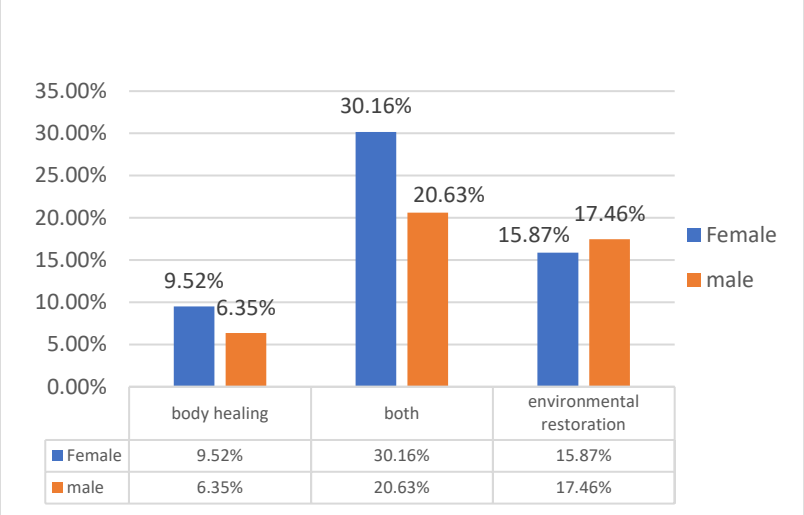


Fig. 16. Healing and environmental restoration felt by males and females.

4. Discussions

The relationship between the engineering purpose of 13 landscape projects and the design of landscape resilience was investigated as shown in Table 1. A large amount of domestic and industrial wastewater flows into Xinglin Bay, polluting the water source and resulting in eutrophication. Thus, it is imminent to solve the pollution problem, and dredging and sewage collection are particularly important. In 2006, Xiamen Municipal Government carried out the construction of a dredging and dyke for sewage collection in the coastal zone of Xinglin Bay [17]. After large-scale dredging, regular local dredging is essential to improve the ecological environment of Xinglin Bay and adjust the water level of Xinglin Bay and consolidate the embankment and purification of water. By laying a plastic runway to build China's first marine walkway, a landscape of "people at sea" was realized, providing a place for interaction between people and the environment. An independent moving line was constructed on the waterfront. Stairs were built as water entry trails to meet the needs of tourists for hydrophilicity. The resilience of the landscape was reflected in the entry steps with varying water levels during high tide. Lawns were planted in a large area to restore ecology, widen green coverage, and provide leisure places for tourists. Landscape chairs were placed along the east bank of Xinglin Bay for space functionality and facilities.

The overall construction followed the concept of a sponge city. Basketball courts were coated with water-permeable plastic to enhance water circulation. The walking path provides an independent moving line for people and also can be used as an evacuation path in emergencies. The walking path usually provides a place for strolling and cycling. The semi-open landscape pavilion can cope with various extreme weather while providing gathering space. The lower-level waterfront space with granite provides a place close to the water. As the granite is hard and corrosion-resistant, the lower-level waterfront space copes with the ebb and flood tides in different periods. Retaining the original vegetation can save costs and improve biodiversity. The ecological restoration of the islands in the waters of Xinglin Bay has been performed by planting a large number of mangroves and building egret habitats to maintain the ecological balance of the islands to prevent erosion, purify water quality, and reduce storm surge attacks. The previous flood control method has been changed by using vegetation to build resilient space, remove the hard revetment, and construct a flexible landscape. Trees of better water resistance and adsorption of harmful odors and impurities are planted on the water bank to cope with seasonal floods and environmental pollution and create porous soil.

Table 1. Interviewees' Opinions on Integration of Landscape Engineering, Embodied Cognition, and Healing

Landscape Design Themes	Method	Engineering purpose	Landscape Resilience Indicator	Body-environment interaction	Embodied cognition	Resilience content	Interviewee
Dredging and breaking the embankment	Desilting project, Ecological restoration	Wetland ecology	Adjust the water level	Boating	Smell difference in water quality	Open-minded	A-43

Pollution interception system	Establish a sewage cut-off system	Backup water source	Restore water quality	Long-term exercise	Reduce water odor, observe birds	Relax anxiety	B-10
Sea plank road	Plastic runway connection	Interaction between water and people	The moving line is divided to reduce the environmental bearing pressure of the water bank	Run, view	Watch, photograph sunsets, observe birds, watch training	Relax	A-7
Water entry trail	Height difference steps	Provide a hydrophilic platform	Buffer the rising water level at high tide	View, play in the water	Fresh air and direct contact with water	Happy physically and mentally	B-14
Lawn square	Plant lawn	Provide a place to relax	Restoring ecology and improving green coverage	Picnic, kite flying	Watching the migration of migratory birds, increasing outdoor activities, the water quality has improved	Relax and improve parent-child relationship	B-3; B-5
Casual seating chair	Placing Landscape Chairs	For rest	Improve the diversity of landscape facilities	View, empty	Feel the plants are diverse, the air is good, and the pain is relieved	Soothing	B-8
Basketball court	Laying permeable plastic	Sports space	Strengthen the water cycle	Play ball	Fresh air and high greening rate	Happy physically and mentally	B-14
Landscape walking trail	Laying a soft track	Provider line of action	Emergency exit	Running, cycling	Fresh air, better health	Release stress and improve mood	A-34
View Pavilion	Architecture semi-open space	Provide gathering space	Cope with different weather conditions	View; picnic	Admire wild waterfowl	Pleasure body and mind	B-2
Waterfront platform	Granite material lower level space	Close to water	Coping with water level changes of ebb and flow	Pay attention to the smell of plants; look out at the sea; do some stretching	Good air; improved water quality; many birds	Stay away from anxiety	B-10
Diverse vegetation	Preserve the original vegetation	Save costs, Restoring the ecology of Xinglin Bay	Biodiversity	Admire the four seasons vegetation scenery and get in touch with nature	The air is clear, and plants give people different feelings of sight, hearing and smell throughout the year	Relax and reduce stress	B-10 B-11 A-46
	Variety of high and low trees and shrubs		Biodiversity				
Restoring island ecology	Planting coastal mangroves	Egret Ecological Reserve	Stabilize island ecology, prevent erosion, purify water quality, prevent wind and reduce the impact of storm surges	Enjoy the scenery of the island from a distance	Bird excrement smells great; vegetation is rich and the landscape is rich in layers	Feel comfortable	A-44 A-49
Resilient Landscape Vegetation and Revetment	Plants with strong water resistance and absorbing harmful substances are selected in the waterfront area	Restore the ecology of Xinglin Bay landscape and increase ecological diversity; Plants absorb harmful substances and noise	Adapt to seasonal floods	Sightseeing, sports	Clear air and quiet environment	Relieve stress and get out of the inner volume space	A-22 A-21 B-10
	Remove the hard revetment and restore the ecological landscape revetment		Porous environment				

The water purification project makes people more willing to visit the waterfront and participate in water activities. The interviewees felt the changes in water quality during the waterfront activities without bad odor. People were rowing, exercising, and having open-minded, anxiety-relieving psychological effects (interviewee A-43). The sea plank road shortens the distance between people and water enabling people to walk on it and enjoy the environment. Visitors feel the psychological changes of relaxation when enjoying the sunset, watching birds, and seeing athletes in training (interviewee A-7). Because of the plants around the water body, most of the interviewees felt clean air. Using steps with different heights, people can touch the water. After watching the scenery and playing in the water, they reach a state of physical and mental pleasure (interviewee B-14). A large lawn square is a good place for people to gather for a picnic and flying kites. While accompanying relatives and friends, watching the migration of birds, and interacting with birds, people can relax physically and mentally and enhance the parent-child relationship (interviewees B-3 and B-5).

The benches in the space are a good place for people to watch the scenery and relax, and feel the diversity of plants. Interviewees who suffered from pain for a long time said that taking a walk relieved pain and brought physical and mental relief (interviewee B-8). Basketball courts and walking trails gather sports-loving people (basketball, running, and cycling) who feel the changes in physical fitness and enjoy fresh air in their daily activities, thereby releasing inner pressure and improving their mood (interviewees B-14 and A- 34). The semi-open pavilion does not block the continuous scenery, and the interviewee tends to have a picnic and watch the various birds scattered on the grass (interviewee B-2). The sunken waterfront space made of granite attracts people's attention to the change of plant smell, looking at the sea surface and doing exercises. Through repeated contact with nature, while staying away from anxiety, the interviewees gradually found changes in water quality and time of bird migration (interviewee B-10). Diversified vegetation gives people different visual, auditory, and olfactory feelings throughout the year, which play a role in relaxing and relieving stress (interviewees B-10, B-11, and A-46). To increase the stability of the Xinglin Bay ecosystem, the island ecology needs to be restored by planting mangroves and helping a large number of birds live. Then, the island scenery can be appreciated from far and near. The pungent odor of bird droppings on the island can be smelled while rowing (interviewees A-44 and A-49). The resilient landscape revetment attracts the interviewees to exercise, watch the scenery, and enjoy the fresh air and quiet environment (interviewees A-21, A-22, and B-10). It was found that the above-mentioned landscape design has played an important role in relieving stress and making the body and mind heal.

5. Conclusions

The dual resilience of landscape design was explored using the theory of embodied cognition in the study area of the Xinglin Bay landscape belt of Jimei District, Xiamen City, China. The physical and mental changes caused by the interaction between people and the environment were also investigated with the consideration of the relationship between environmental restoration and psychological healing. This study was conducted mainly through interviewees. There were two important findings in this study. (1) In the same situation, the surrounding environment is more likely to have a healing effect on females. (2) Landscape design projects promote the interaction between people and the environment to change cognition, especially with the healing effect caused by the water in the landscape which promotes hydrophilic activities. The ecological diversity of animals and plants on the waterfront strengthens the connection between people and the environment. Frequent visitors release pressure by observing the migration and diversity of birds. This demonstrates the relevance of environmental restoration and psychological restoration. Thus, we propose that the theme of resilience in landscape design be reinforced in future landscape design. It is necessary to focus on increasing the possibility of interaction between people and the environment through the ecological restoration of bio-diversity and the provision of a resilient landscape. Landscapes conducive to the sustainable development of the environment and society must be constructed and proliferated more.

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