Enhancing Biophilia as a Restorative Design Approach in Egyptian Gardens

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Abstract

The increasing challenges of enhancing public health for communities and managing stressful daily life style raised the call for finding new methods to reduce stress. The research problem is the lack of sufficient data investigating the impact of different characteristics and forms of gardens in terms of stress reduction and restoration benefits. Therefore, the aim of this study is identifying the restorative effects of biophilic design elements in Egyptian gardens. It investigates the main indicators for applying biophilic urbanism in different gardens and how to enhance it to achieve stress restoration for communities. The presented study followed a methodology that comprises three parts. First an integrative literature review for biophilic urbanism and biophilia application to achieve restorative design. Then identifying the likely relationship between biophilia and restorativeness. Finally, a case study research design approach for selected Egyptian gardens which are analysed in reference to concluded relationship and perceived restorativenss. The work points out the potential and effective incorporation of applying biophilic principles in Egypt to achieve stress restoration.

Keywords: Biophilia; Restorative Gardens; Stress Restoration; Attention Restoration Theory, Perceived Restorativeness.

1. Introduction

Returning back to nature for healing and stress reduction has been highlighted in different researches which aimed at identifying the benefits of people-nature connection (Gesler, 2003; Krčmářová, 2017). Urban green spaces positively contribute to communities' health and present various opportunities for recreation and restoration (Chukwuemeke & Stephen, 2018; Tok et al., 2020). Lots of studies highlighted the impact of restoration in gardens. However, the impact of different gardens' characteristics and forms has not been investigated sufficiently in terms of stress reduction and restoration benefits. Also the understanding of relation between biophilic design elements and its restorative impact needs deeper investigation (Kellert, 2008a; Totaforti, 2018; R. Ulrich, 2008). Thus, the presented study aims at identifying restorative effects of different biophilic design elements in gardens. Regarding the mentioned research aim, the study tests the following hypothesis "Restorative experience differs according to the characteristics and context of the garden itself". table 1 presents an illustrated structure of the study identifying different study phases' objectives and outcomes.
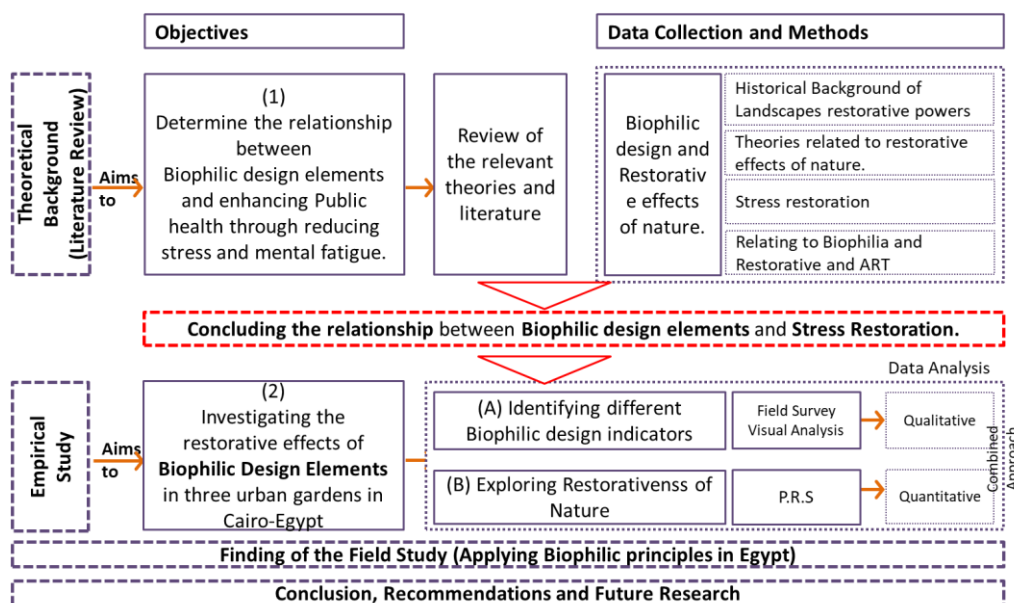

Figure 1. Structure of the Study (Developed by Author).

The presented study combines two different aspects of investigation, physical and environmental psychology aspects. This investigation will help in answering two main research questions; (RQ1) How could biophilia principles enhance restorativeness in public gardens? (RQ2) To what extent do biophilic design principles are applied in Egyptian gardens to achieve stress restoration? To answer the questions and achieve the objective the study followed a methodology that comprises three parts. Part one: a systematic integrative literature review for different theories about restorative potentials of natural environments and different scales for assessing restoration. The theoretical background focused more on two main theories; Theory of Biophilia by Edward Wilson and Attention Restoration Theory (ART) by Rachel and Steven Kaplan. The second part synthesizes the key findings of the previous literature using a descriptive analytical method to investigate the cross-relation between biophilic design principles and ART requirements of restoration. The third part illustrates an exploratory investigation to identify the impact of different biophilic design elements, characteristics and forms of gardens on restorativeness of Egyptian gardens. It presents a quantitative approach in the selected empirical study using semi-structured interviews to measure different scale to assess the gardens' restorative impact.

2. Theoretical Background

Several theories were developed proving the restorative potentials of natural environment like; Theory f Biophilia, Prospect-Refuge Theory, Attention Restoration Theory, Stress Reduction Theory, and Theory of Supportive Garden. Theory of Biophilia in 1973 which highlights essential attraction for the natural environments for humanity (Cooper Marcus, C., & Sachs, 2013; Souter-Brown, 2015). Prospect-refuge Theory which is also called Theory of Environmental Aesthetics, established by Jay Appelton in 1975. It focuses on human biological connection with nature. It has two main components; prospect and refuge. Where people can unconsciously trust the natural environments, and in return natural environments have restorative influences on them (Kaplan, R., Kaplan, S., & Ryan, 1998; Marcus et al., 2013). Attention Restoration Theory (ART) by Kaplan and Kaplan which emphasizes four requirements for a restorative environment which are: being away, fascination, extent, and compatibility (Kaplan, 1992; Marcus et al., 2013). Stress Reduction Theory (R. S. Ulrich et al., 1991) which Focus on role of nature in psychological and physiological human restoration. It states that landscapes reduce stress through; unconscious response to nature, exposure to natural landscapes. Theory of Supportive Garden by Roger Ulrich, which states that different landscape design elements in gardens of healthcare facilities reduce stress (R. Ulrich, 1999). It Introduces the restorative and coping resources, which are: sense of control, social support, physical movement and exercise and nature distractions. The presented study focuses on Theory of Biophilia and Attention Restoration Theory (ART) to identify the impact of biophilic design principles and elements on restorativeness of gardens.

2.1. Theory of Biophilia

Biophilia is a term derived by the social psychologist Erich Fromm who defined it as "the passionate love of life and all that is alive" (Fromm, 1973 cited in Cooper Marcus & Sachs, 2013, p.23). Then Edward O. Wilson described his beliefs about humanity's essential attraction for the natural environments thus, he defined Biophilia as "The innate tendency to focus on life and life like processes" (Kellert, 2016). It also was identified as a fundamental tendency for human being to affiliate with life (Gullone, 2000). It has been proven through history that 99% of living species has different adaptive responses to nature. This led to increase the dependence of human on natural resources (Acevedo-Whitehouse & Duffus, 2009).

Biophilic environments are helpful in understanding how humans interact with natural elements to promote their health and well-being. Human beings have an actual desire to be connected with nature, and they are evolutionarily programmed to respond to sunny areas over dark or overcast ones (Brown, 2014). Previous researches identified Biophilic elements that have great benefits for people, such as; reducing stress, emotional well-being, boosting creativity, healing effects, increasing productivity (Gillis & Gatersleben, 2015; Xue et al., 2019).

This research study reviewed different biophilic design principles and patterns that were derived to help in applying biophilic design shown in Table 1. According to previous studies there are 11 principles and patterns to achieve biophilic impact derived from three main concepts namely; nature patterns of space, natural analogues and nature of space (Downton et al., 2016; Ryan et al., 2014b). Previous studies explained the biophilic design principles in terms of the generated experience, design characteristics, interaction with other patterns, and how they contribute in integrated biophilic design strategies.

Moreover, Figure2 presents biophilic design dimensions and elements for better reading and understanding for Biophilic design. It shows six dimensions for applying biophilia in design and 71 elements to achieve it. The elements are coded from B01 to B71 to be included in the field survey.

Table 1. Biophilic Principles and patterns adopted from(Browning et al., 2014; Ryan et al., 2014a; Sharifi & Sabernejad, 2016) .

Principles and Patterns	How to achieve it?
Nature in the Space Patterns	Non-Rhythmic Sensory Stimuli; Thermal & Airflow - Variability, Dynamic & Diffuse Light, Connection with Natural Systems
Natural Analogues Patterns	Biomorphic Forms & Patterns; Material Connection with Nature; Complexity & Order
Nature of the Space Patterns	Prospect; Refuge; Mystery; Risk/Peril.
Visual Connection with nature	Providing different views for natural urban elements.
Non-Visual connection with nature	Enhancing the other senses like hearing, smell and touch in experiencing the urban environment.
Presence of water	Improving the multi-sensory experience with water view and sound.
Connection with natural system	Using nature integration to urbanism in order to enhance ecological functions in the ecosystem.
Natural forms and patterns	Following organic and free forms to enhance Biophilic design patterns and avoid using rigid straight forms.
Material connection with nature	Using natural materials to achieve more connection between people and nature.
Complexity	Using complexity in spatial design to enrich people's experience and feelings; like what happens in experiencing nature.
Prospect	Making passable and smooth views while adopting Biophilic design.
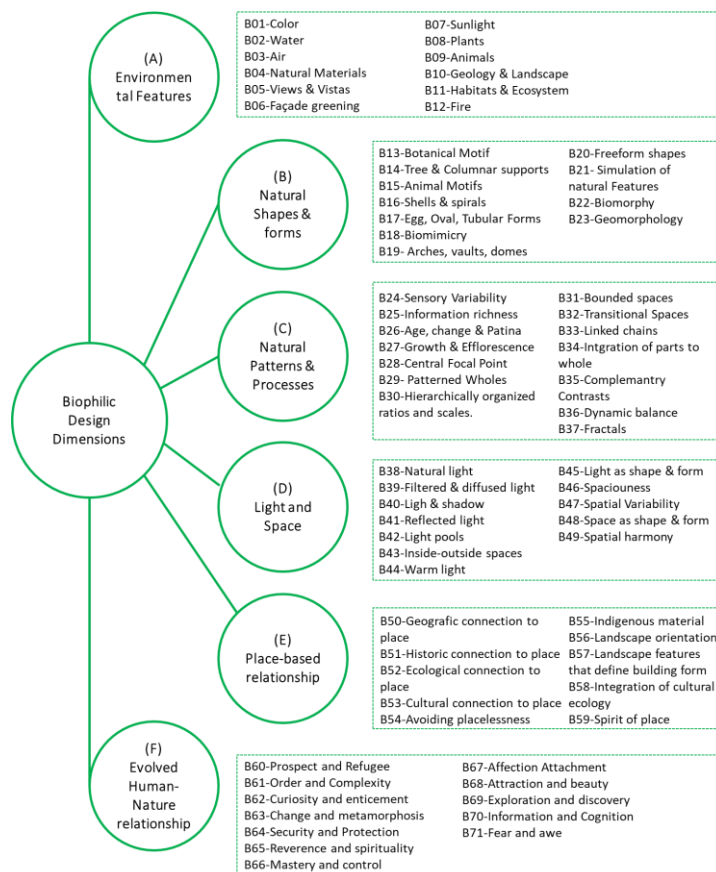
Figure 2. Elements of Biophilic Design. Adopted from (Kellert & Calabrese, 2015) (Kellert, 2008 cited in (Hidalgo, 2014)

2.2. Attention Restoration Theory (ART)

Attention Restoration Theory focuses on the restorative benefits of nature that overcome mental fatigue which negatively impacts people and their attention capabilities. Kaplan & Kaplan introduced this theory in 1989 (Kaplan, R., Kaplan, S., & Ryan, 1998; Kaplan, 1992) which is based on two types of attention that human has. First **direct attention** which is connected to brain cognitive functions. It is used in daily activities in people's life like driving in

an unfamiliar place or paper work which depends on concentration. Second **fascination/spontaneous attention** and this is connected to the part of memories in human brain which is scientifically known by its unlimited capacity. It is involuntary and can be evoked by natural settings (Csikszentmihalyi & Nakamura, 2010; Daniel, 2014). It has been proven that using natural elements for drawing attention enhances stress recovery and reduces anxiety that results in physical and psychological fatigue (Cooper Marcus, C., & Sachs, 2013). Therefore, biophilic design elements might be able to focus on and support spontaneous attention where users can relax and reduce their stress (Marcus et al., 2013; Peschardt & Stigsdotter, 2013; Stigsdotter, 2005).

ART introduces four requirements of restoration namely; **Being Away**; which is enhancing the escape feeling from usual life, **Fascination**; which is holding the attention of users without any effort, **Extent**; which is feeling fully engaged in the contextual experience due to the well-structured composition of surroundings, and **Compatibility**; which is being engaged in activities (novel or normal ones) in a way that satisfies user's purpose of visiting (Daniel, 2014; Kaplan, 1992).

3. Biophilia and Requirements of Restoration

Biophilia approach has multiple benefits to contemporary urban life. It aims at connecting the urban setting with nature, integrating natural experience in the contemporary modern urbanism and solving ecological and social problems(Gullone, 2000; Gunderson, 2014; Heymans et al., 2019; Krčmářová, 2017; Ryan et al., 2014a). It deals with people or users as an essential part of the ecosystem and targets satisfactory experience for all people at different scales (Andreucci et al., 2019; Russo & Cirella, 2017). Many studies highlighted that a restorative environment cold be achieved by using natural elements and have a positive psychological impact on urban life (Downton et al., 2016; Hartig et al., 2003; HELOU, 2019; Marcus et al., 2013; McDonald & Beatley, 2021; Nilsson et al., 2011). Therefore, in the light of nature contribution to health and well-being, restoration could be considered a result of biophilic principles integration in the design process (Kellert, 2008b). Accordingly, it is possible to identify the likely relationship between biophilic principles mentioned in Table 1 and the four requirements of restoration from the Attention Restoration Theory. This relationship is illustrated in Table 2 showing contribution of each of the eleven principles of biophilia to each one of the requirements of restoration.

Being away and Fascination require most of the principles to be achieved successfully like nature in space patterns, visual and non-visual connection with nature, the presence of water all to improve multi-sensory experience to help in holding attention, in addition to connection with natural systems, forms, patterns and material. Extent and compatibility both require less principles to be achieved including natural analogues and nature of space patterns, visual and non-visual connection with nature, presence of water and natural forms and patterns.

Table 2. Biophilic Principles interrelationship with the four Requirements of Restoration.

Biophilic Principles and Patterns	Requirements of Restoration (A.R.T)			
	Being Away	Fascination	Extent	Compatibility
Nature in the Space Patterns	√	√		
Natural Analogues Patterns	√	√		√
Nature of the Space Patterns		√	√	
Visual Connection with nature	√	√	√	
Non-Visual connection with nature	√	√	√	
Presence of water	√	√	√	
Connection with natural system	√	√	√	
Natural forms and patterns	√	√		√
Material connection with nature		√	√	
Complexity	√	√	√	√
Prospect	√	√	√	√

√ *The likely contribution*

Nature in space patterns, natural analogues patterns and natural forms and patterns provide comfort and relaxation and has a significant impact on psychological stress (Helene, 2016; Sharifi & Sabernejad, 2016; R. S. Ulrich et al., 1991; Van den Berg et al., 2014). That is why they contribute in enhancing being away and fascination requirements of restoration (Cooper Marcus, C., & Sachs, 2013; Helene, 2016; Rennit & Maikov, 2015). Visual connection with nature improves mental engagement with natural surroundings which has a very strong contribution on health and the attitude of users. Non-visual connection with nature enhances calmness, and perceived mental health thus, it reduces stress and pressure (Abdelaal & Soebarto, 2019; Birkeland, 2016; Nilsson et al., 2011; van den Bosch & Ode Sang, 2017). Therefore, both principles contribute in achieving being away, fascination and extent restorative requirements. Material connection with nature enhances achieving fascination and extent as it contribute to the multisensory experience of users and engage them more with natural surroundings (Kellert, 2016; Ohly et al., 2016;

Totaforti, 2020). Complexity has a positive impact on stress, prospect reduces mental fatigue and providing a refuge which improves concentration as well as attention. That highlights their importance in achieving all the four requirements of restoration since they are more related to spatial design and people experience (Groenewegen et al., 2006; Nilsson et al., 2011). In other words, restorative settings can be provided and enhanced by biophilic elements as shown in previous studies. Biophilic design elements and principles can contribute to enhancing both direct attention and fascination/spontaneous attention.

4. Methods and Procedures

This study aims to identify the extent of biophilic design principles application and its restorative potential in Egyptian gardens. To achieve this aim, the study combined both qualitative and quantitative data gathering approaches. This study was conducted at the end of winter and the beginning of the spring season, between February and April 2021. The gardens were visited in random week days and in random order. All the three gardens had the same amounts of visits.

4.1. Selected Gardens

Three selected gardens in Cairo-Egypt, which are typically used for recreational purposes. These gardens are; **Al-Azhar park**, **International garden**, and **Al-Hurriyah garden**. These gardens represent different areas (large, medium and small), level of service and contexts (historical and ordinary) with different design character and style. The gardens also encompass variety of biophilic elements like water and varying terrain in addition to multiple activities occurrence in the garden itself. All selected gardens are located in Cairo (the capital city of Egypt) inside its compacted urban structure and they are easily accessible. **Al-Azhar park**; one of Cairo's largest parks, located in the heart of historical Cairo. It lies on the top of a small hill offering magnificent view of Cairo for its visitors. **International garden**; is located in Nasr City district, it has a variety of plants and flowers which are brought from foreign countries that is why it is called international, it also includes a small zoo inside it. **Al-Hurriyah garden**; located in Zamalek across from Cairo Opera House, known for the presence of 11 statues for people who had made positive major contribution for their countries. Table 3 presents the description for the selected gardens, Figure 3 (a-c) presents satellite images for the selected gardens.

Table 3. Selected gardens description. Source: author.

z	Area	Location	Level
Al-Azhar Park	71 Feddan	Historic Cairo	Regional
International Garden	47 Feddan	Nasr City	City
Al-Hurriyah Garden	7.5 Feddan	Zamalek	District

Figure 3(a). Satellite image for Al-Azhar Park
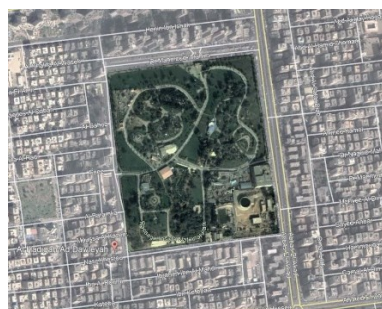
Figure 3(b). Satellite image for International garden

Figure 3(c). Satellite image for Al-Hurriyah garden

4.2. Data Collection and Measurements

Two data collection techniques were used, visual analysis for the three gardens and survey. **Visual analysis** for the selected gardens was performed to document and identify biophilic design elements existence and quality. This helped in identifying the interrelationship between biophilic design principles and requirements of restoration. Descriptive narratives, photos and sketches were used in this stage. **Survey** which is designed based on reviewing previous methods for investigating restorativeness in different sites (Rennit & Maikov, 2015; Tenngart Ivarsson & Hagerhall, 2008) the survey comprised three parts; the first part is background information about the participants like gender, age, and educational background. The second part asks about their frequency of visiting the garden and their current mood. The third part is Perceived Restorativeness Scale (PRS) in order to measure restorative impact of the selected gardens. PRS is based the four requirements of restoration identified by the ART to measure restorative qualities of environments (Hartig et al., 1997, 2003). Twenty-six items are identified to measure

perception of users for the four requirements of restoration shown in Table 4. Participants are asked to select how extent they perceive each one of the 26 items on a seven points scale (0= Not at all and 6 = Completely).

Table 4. Measured Restorative qualities for **PRS**

Four requirements of restoration.	Code #	Restorative qualities
1- Being Away	PRS01	Being here is an escape experience.
	PRS02	Spending time here gives me a break from my day-to-day routine.
	PRS03	It is a place to get away from it all.
	PRS04	Being here helps me to relax my focus on getting things done.
	PRS05	Coming here helps me to get relief from unwanted demands on my attention.
2-Fascination	PRS06	This place has fascinating qualities.
	PRS07	My attention is drawn to many interesting things.
	PRS08	I want to get to know this place better.
	PRS09	There is much to explore and discover here.
	PRS10	I want to spend more time looking at the surroundings.
	PRS11	This place is boring.
	PRS12	The setting is fascinating.
	PRS13	There is nothing worth looking at here.
3-Extent	PRS14	There is too much going on.
	PRS15	It is a confusing place.
	PRS16	There is a great deal of distraction.
	PRS17	It is chaotic here.
4-Compatibility	PRS18	Being here suits my personality.
	PRS19	I can do things I like here.
	PRS20	I have a sense that I belong here.
	PRS21	I can find ways to enjoy myself here.
	PRS22	I have a sense of oneness with this setting.
	PRS23	There are landmarks to help me get around.
	PRS24	I could easily form a mental map of this place.
	PRS25	It is easy to find my way around here.
	PRS26	It is easy to see how things are organized.

4.3. Sampling and Participants

Study sample is a random sample of 180 participants; 60 participants in each garden were selected to participate in the survey. The selected sample size was thought to be adequate at this phase of investigation, to give reliable indicators and support preliminary conclusions regarding the study's (Bryman, 2012; Creswell, 2012). The questionnaire was conducted during March and April 2021. Participants were selected according to their frequency of visits to the parks, and they answered the questionnaire after 25-35 minutes sitting in the park. Questionnaires were answered face to face. Participants were 18-65 years old, of which 88 are women (49%) and 92 men (51%). 75.6% had a high education, 13.3% with secondary education, 6.7% with a PhD. and 4.4% with Master degree. Demographic data summary for the 180 participants in the three gardens (60 participant in each one) is represented in Figure 4.

Participants were asked to rate their current mood after staying in the garden for 25-30 minutes on a scale from 1 to 10 where 1 represents very sad or desperate, 5 represents neutral mode (doesn't feel anything) and 10 represents extremely happy mood. All ratings started from 5 and Al-Azhar park scored largest percentage of an average happy mood, then comes the international garden and AL-Hurriyah garden. Figure 5 (a-b) presents visiting frequency and mood of the participants in the three gardens.
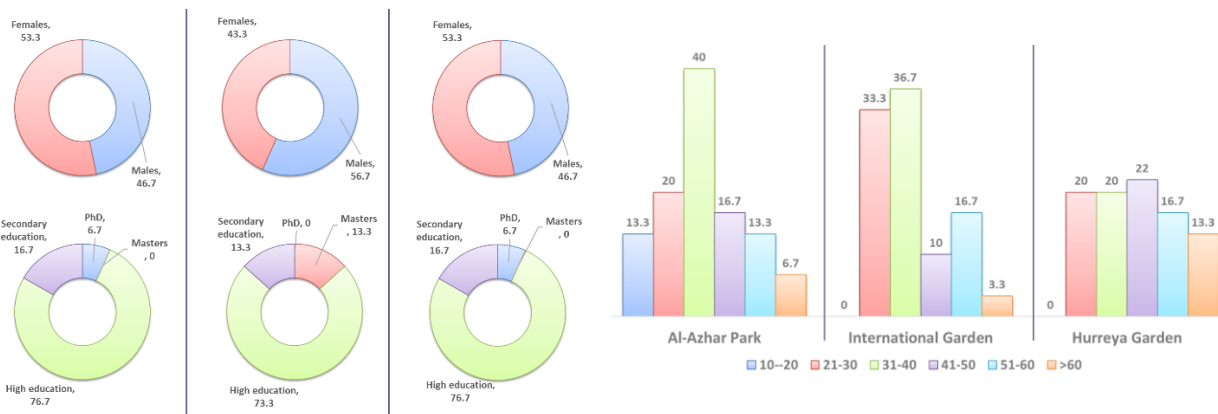
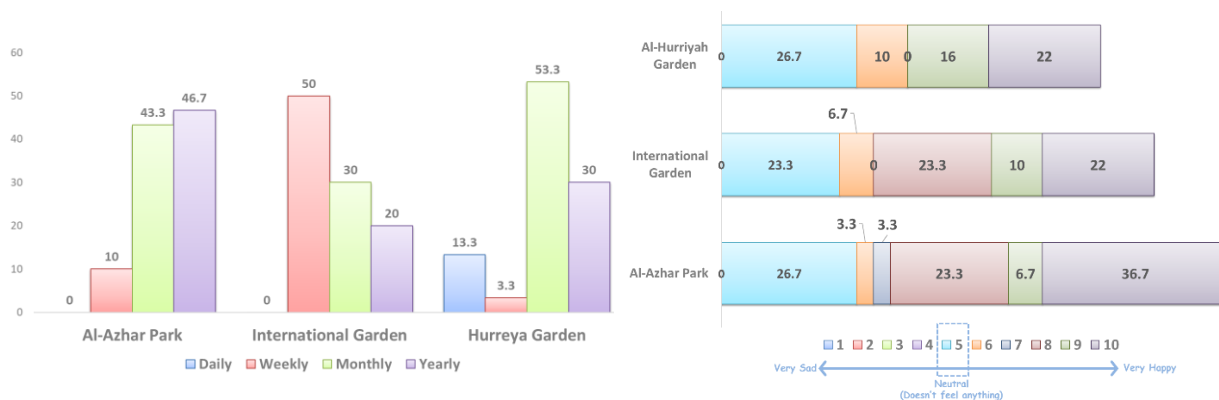**Figure 4.** Sample's demographic data summary (Developed by Author).

Figure 5(a). Visiting frequency for the three gardens   **Figure 5(b).** Mood scale
Figure 5. Participants' visit frequency and mood scale three gardens (Developed by Author).

4.4. Reliability Test

In order to check the measurement consistency for the given ratings for the designed questionnaire in the three gardens reliability test was conducted using Cronbach's Alpha coefficient. Cronbach's Alpha was 0.846, 0.939, 0.950 for AL-Azhar Park, International garden and AL-Hurriyah garden respectively, which is larger than 0.7. This showed all the ratings were considered reliable and had a very good consistency so it is safe to draw out conclusion using further statistical analysis(Pallant, 2001).

5. Results and Discussion

This section presents the analysis of the data collected by the two data gathering techniques. Additionally, it presents the findings and discussing them in relevance to the discussed theories and relevant literature.

Statistical Package for Social Sciences (SPSS) software was used for analyzing the collected data from the survey. Simple descriptive statistics were used in this study. In addition to calculating Cronbach's Alpha and conducting validity check using Pearson correlation, mean ratings and standard deviation were calculated.

5.1. Visual Analysis

The visual analysis of the physical site technique helped in documenting the existence and condition of different biophilic design elements in the three gardens. This in turn helped in identifying and verifiying the proposed interrelationship of the four requirement of restoration and the princples of biophilia.

5.1.1. Elements of Biophilic design

A sample of the existing biophilic elements in the three gardens is shown in Figure 6. The existence and condition of the different biophilic elements in the three gardens are documented in Tables 5(a) to 5(f). There is (89%) of the biophilic design elements exist in AL-Azhar park in a very good and good condition. This percent is considered the highest one in compared with the present of the biophilic design elements exist in the other two selected gardens. As (76%) of the biophilic design elements exist in the International garden where most of them in a very good and good condition. On the other hand, Al-Hurriyah garden showed (58%) existence of biophilic design elements.

Al-Azhar park characterized by its huge area and the existence of different water features distributed in different spots in the garden. International garden has a moderate are in relevance to Al-Azhar park and it has a unique collection of plants and flowers in addition to the small Zoo exist in it which gives it a different experience. Al-Hurriyah garden is characterized by its small area which make its experience more intimate and make users recognize

it easily by forming a mental map to its features and views. Both Al-Azhar park and Al-Hurriyah garden had interesting vistas. Al-Azhar park has the view for Historic Cairo with its wonderful skyline and Al-Hurriyah garden has the view for Cairo Tower and Cairo Opera House, this added a new experience to the gardens.
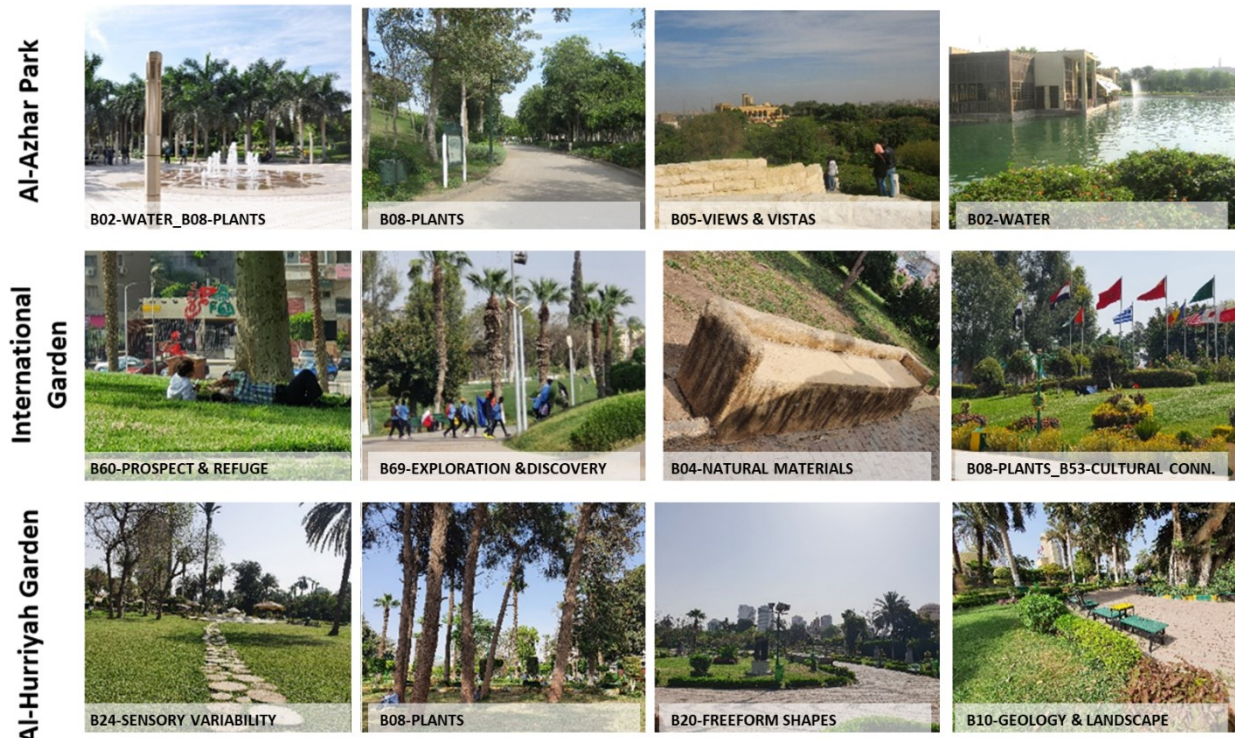

Figure 6. Sample photos of the biophilic features in the three gardens (Taken by Author).

Table 5. Biophilic design elements in the selected gardens (Developed by Author).

Table 5 (a). Environmental Features.

Biophilic Design Elements		Selected Gardens		
		Al-Azhar Park	International Garden	Al-Hurriyah Garden
(A) Environmental Features	B01	√	√	√
	B02	√	√	X
	B03	√	√	√
	B04	√	√	√
	B05	√	√	√
	B06	X	X	X
	B07	√	√	√
	B08	√	√	√
	B09	√	√	√
	B10	√	√	√
	B11	√	√	√
	B12	X	X	X

Table 5 (b). Nature shapes and forms.

Biophilic Design Elements		Selected Gardens		
		Al-Azhar Park	International Garden	Al-Hurriyah Garden
(B) Natural Shapes & forms	B13	X	X	X
	B14	√	√	X
	B15	X	√	X
	B16	√	X	X
	B17	√	X	X
	B18	X	X	X
	B19	√	X	X
	B20	√	√	√
	B21	√	√	√
	B22	√	√	X
	B23	√	√	X

Legend

█ √ Very good quality	█ √ Good quality	√ Poor quality	X Does not exist

Table 5 (c). Natural Patterns & Processes

Biophilic Design Elements		Selected Gardens		
		Al-Azhar Park	International Garden	Al-Hurriyah Garden
(C) Natural Patterns & Processes	B24	√	√	√
	B25	√	√	√
	B26	√	X	X
	B27	√	√	√
	B28	√	√	X
	B29	X	X	X
	B30	√	√	X
	B31	√	√	√
	B32	√	√	X
	B33	√	√	√
	B34	√	X	X
	B35	√	X	X
	B36	√	√	√
	B37	X	X	X

Table 5 (d). Light and Space.

Biophilic Design Elements		Selected Gardens		
		Al-Azhar Park	International Garden	Al-Hurriyah Garden
(D) Light and Space	B38	√	√	√
	B39	√	√	√
	B40	√	√	√
	B41	√	X	X
	B42	X	X	X
	B43	√	√	√
	B44	√	√	√
	B45	√	X	X
	B46	√	√	√
	B47	√	√	X
	B48	√	√	√
	B49	√	√	√

Table 5 (e). Place-based relationship.

Biophilic Design Elements		Selected Gardens		
		Al-Azhar Park	International Garden	Al-Hurriyah Garden
(E) Place-based relationship	B50	√	√	√
	B51	√	X	X
	B52	√	√	√
	B53	√	√	√
	B54	√	√	√
	B55	√	√	X
	B56	√	√	√
	B57	√	√	√
	B58	√	√	√
	B59	√	√	√

Table 5 (f). Evolved Human-Nature.

Biophilic Design Elements		Selected Gardens		
		Al-Azhar Park	International Garden	Al-Hurriyah Garden
(F) Evolved Human-Nature	B60	√	√	√
	B61	√	√	√
	B62	√	√	√
	B63	√	√	X
	B64	√	√	√
	B65	√	X	X
	B66	√	√	√
	B67	√	√	√
	B68	√	√	√
	B69	√	√	X
	B70	√	√	√
	B71	√	√	X

Legend

√ Very good quality   √ Good quality   √ Poor quality   X Does not exist

Varieties of biophilic design elements in the three gardens depended mainly on its area and design style. The larger the area the more elements you can find, in addition to the practiced activities. Different contexts offered different views which enriched the users experience as well.

5.1.2. Requirements of Restoration in relevance to Biophilic principles patterns

The three gardens were analysed using the proposed interrelationship matrix between biophilic principles and the four requirements of restoration. Table 6 sums up the results of this mapping and highlights the potentials of each of the biophilic principles in the three gardens and how it contributes to each one of the restoration requirements. AL-Azhar park and the International garden achieved similar percentage (87% of the restoration requirements). On the other hand, Al-Hurriyah park achieved 73%. The difference is in the presence of water feature, though it exists in Al-Hurriyah garden but it hasn't been working for a very long time that's why its impact didn't exist.

It is clearly noticed that the richness of biophilic design elements gave a higher contribution to achieve the four requirements of restoration. Water features and wildlife offered a new experience of Being away and fascination which appeared to be stronger in Al-Azhar park and Al-Hurriyah garden based on the visual survey. On the other hand, the form and structure of the garden contributed to its extent and compatibility appeared in the three gardens.

Table 6. Mapping Biophilic Principles interrelationship with Requirements of Restoration for the selected gardens

Biophilic Principles and Patterns	Requirements of Restoration (ART)											
	Al-Azhar Park				International Garden				Al-Hurriyah Garden			
	Being Away	Fascination	Extent	Compatibility	Being Away	Fascination	Extent	Compatibility	Being Away	Fascination	Extent	Compatibility
Nature in the Space Patterns	√	√			√	√			√	√		
	√	√			√	√			√	√		
Natural Analogues Patterns	√	√		√	√	√		√	√	√		√
		√				√				√		√
Nature of the Space Patterns		√	√			√	√			√	√	
		√	√			√	√			√	√	
Visual Connection with nature	√	√	√		√	√	√	√	√	√	√	√
	√	√	√		√	√	√	√	√			√
Non-Visual connection with nature	√	√	√		√	√	√		√	√	√	
	√	√			√	√			√	√		
Presence of water	√	√	√		√	√	√		√	√	√	
		√	√			√	√				√	
Connection with natural system	√	√	√		√	√	√		√	√	√	
	√	√	√		√	√	√		√		√	
Natural forms and patterns	√	√		√	√	√		√	√	√		√
	√	√		√		√			√			√
Material connection with nature		√	√			√	√			√	√	
		√	√			√	√			√	√	
Complexity	√	√	√	√	√	√	√	√	√	√	√	√
	√	√		√	√	√		√		√		√
Prospect	√	√	√	√	√	√	√	√	√	√	√	√
	√	√	√	√	√	√	√	√	√	√	√	√
Requirements of Restoration %	**87%**				**87%**				**77%**			

5.2. Perceived Restorativeness Scale (PRS)

The overall PRS mean score for the three gardens was calculated, it turned out to be 3.575, 4.404 and 3.46 in AL-Azhar park, International garden and Al-Hurriyah garden respectively. Which is turned out to be greater than the mid-point. As a result, these values can be used to characterize each one of the three gardens and provide a guide for assessing the perceived restoration levels for the different users (Kim et al., 2017; Tenngart Ivarsson & Hagerhall, 2008).

Mean scores and standard deviations for the 26 indicators in the three gardens were calculated in addition to the overall mean score for each one of the four PRS restoration requirements, as shown in Table 7 and Figure 7 (a-b). PRS for the three gardens showed that it is not affected by the areas of the gardens. However, the difference in their context showed a high contribution to stress restoration qualities. The four requirements of restoration almost perceived similarly in the three gardens. However, slight differences appeared in mean scores that could points out contributions to restorative potentials in each one of the three gardens.

International garden showed the highest scores in the four requirements of restoration in comparison with the other two gardens as shown in Figure 7(a), being away scored M=5.15, fascination scored M=4.33, extent scored M=3.12 and compatibility scored 4.624, this supports the notion that restorativeness would be higher in the context that comprises the four requirements of restoration (Bagot, 2004). In the second place came Al-Hurriyah garden in terms of being away and compatibility (M=4.68 and M=3.11). AL-Azhar park scored the lowest rating for perceived being away and compatibility (M=4.34 and M=3.50 respectively). AL-Hurriyah garden and Al-Azhar park showed almost the same mean score for fascination and extent. For Al-Hurriyah garden fascination and extent scored M=3.72 and M=2.6. While in AL-Azhar park fascination and extent scored M=3.7 and M=2.55.

Being away restorative quality was the strongest in the three gardens comparing to the other three qualities. According to the responses the item scored the highest mean rating was PRS02 "*Spending time here gives me a break from my day-to-day routine*" (M=5.43 and M=4.77 in International garden and Al-Azhar park) and in Al-Hurriyah

garden PRS03 "*a place to get away from it all*" item scored the highest mean rating (M=4.68) which was close to PRS02 (M=4.62). This could be a result of the difference in context structure which appears in vegetation variety and spread that is different from urban surroundings of everyday lifestyle.

Fascination is the second strongest requirement in Al-Azhar park and Al-Hurriyah garden while it is the third in International garden. According to the responses the item scored the highest mean rating was PRS12 "*The setting is fascinating*" in both AL-Azhar park and International garden (M=4.63 and M=5.40) while PRS06 "*This place has fascinating qualities*" has approximately same score (M=5.37) as PRS12 in International garden. And PRS07 "*My attention is drawn to many interesting things*" scored the highest item in Al-Hurriyah garden (M=4.37).

Compatibility is the second strongest requirement in International garden with PRS24 "*I could easily form a mental map*" and PRS26 ""*It is easy to see how things are organized*" *as* highest scored items (M=5.02 and M=5.07). However, it is the third strongest requirement in AL-Azhar park and Al-Hurriyah garden. PRS25 "*It is easy to find my way around* here" (M=4.02) scored the highest mean rating in Al-Azhar park and PRS26 scored the highest mean rating Al-Hurriyah garden (M=4.02).

Table 7. Perceived Restorativeness Scale for the selected gardens (Developed by Author).

Survey items		Selected Gardens									Min	Max	N
		Al-Azhar Park			Internationals Garden			Al-Hurriyah Garden					
		Mean	SD	α	Mean	SD	α	Mean	SD	α			
PRS-BEING AWAY	PRS01	4.58	1.430		4.77	1.609		4.68	1.295		0	6	60
	PRS02	4.77	1.198		5.43	0.831		4.62	1.329		0	6	60
	PRS03	4.68	1.308	0.813	5.23	0.963	0.834	4.68	1.359	0.896	0	6	60
	PRS04	3.73	1.803		5.35	0.917		2.92	1.639		0	6	60
	PRS05	3.92	1.453		5.00	1.221		3.52	1.600		0	6	60
	Mean	4.337			5.157			4.083					
PRS-FASCINATION	PRS06	4.23	1.721		5.37	0.938		3.20	1.811		0	6	60
	PRS07	4.55	1.254		5.02	1.172		4.37	1.573		0	6	60
	PRS08	4.28	1.354		5.00	1.120		4.10	1.724		0	6	60
	PRS09	3.68	1.873		4.52	1.600		3.35	1.849		0	6	60
	PRS10	4.02	1.722	0.726	4.78	1.415	0.828	3.65	1.830	0.896	0	6	60
	PRS11	1.98	1.944		2.27	1.666		3.53	1.918		0	6	60
	PRS12	4.63	1.288		5.40	0.867		3.80	1.603		0	6	60
	PRS13	2.17	2.068		2.28	1.905		3.78	1.728		0	6	60
	Mean	3.694			4.329			3.723					
PRS-EXTENT	PRS14	3.33	1.633		3.73	1.831		3.35	1.964		0	6	60
	PRS15	1.95	1.872		2.82	1.953		2.27	1.831		0	6	60
	PRS16	3.32	1.818	0.800	3.85	1.764	0.830	2.97	1.785	0.887	0	6	60
	PRS17	1.58	1.852		2.08	1.660		1.80	1.603		0	6	60
	Mean	2.546			3.121			2.596					
PRS-COMPATABILITY	PRS18	3.48	1.589		4.33	1.599		3.02	1.722		0	6	60
	PRS19	3.50	1.712		4.67	1.469		2.95	1.661		0	6	60
	PRS20	3.28	1.648		4.70	1.381		2.52	1.501		0	6	60
	PRS21	3.77	1.711		4.97	1.164		2.82	1.692		0	6	60
	PRS22	2.55	1.770	0.874	3.35	1.947	0.903	3.08	1.749	0.909	0	6	60
	PRS23	3.65	1.725		4.57	1.50		2.78	1.627		0	6	60
	PRS24	3.35	1.929		5.02	1.334		2.93	1.894		0	6	60
	PRS25	4.02	1.891		4.95	1.567		3.85	1.840		0	6	60
	PRS26	3.93	1.849		5.07	1.287		4.02	1.935		0	6	60
	Mean	3.504			4.624			3.107					

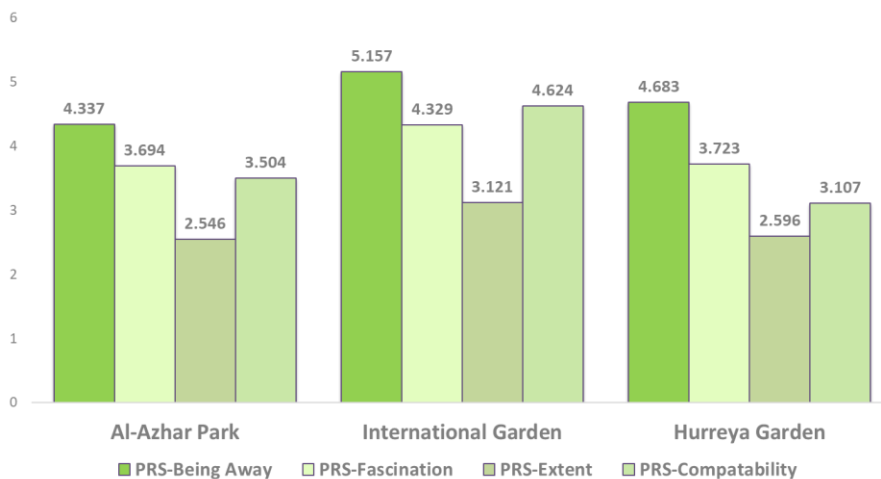**Note: α = Cronbach's alpha. SD= Standard Deviation

Figure 7(a). Mean scores for the four requirements of restoration in each of the three gardens.

Figure 7(b). Mean scores and SD for the 26 items for determining the four requirements of restoration in each of the three gardens.
Figure 7. Graphical presentation for PRS (Developed by Author).

Extent is the least strong requirement in the three gardens. According to the responses PRS14 "*There is too much going on*" is the highest in both AL-Azhar park and AL-Hurriyah garden (M=3.33 and M=3.35) and PRS16 "*There is a great deal of distraction*" is the highest scored item in International garden (M=3.85) however PRS14 scored a relatively close mean rating (M=3.73 and M=3.32) in International garden and AL-Azhar park). This could be a result of less sufficient content to keep users' mind busy or engaged to distract its direct attention and allow it to rest.

In the light of the previous results, it could be noticed that the historic context in Al-Azhar park offered a type of variety in its views which enhanced the ability of reducing stress for its users. However, the presence of multiple users practicing different kinds of activities had a negative impact on being away and fascination requirements of restoration. That explains its lower PRS mean score despite its large area and richness of biophilic elements. Furthermore, large area and different zones in AL-Azhar park affected extent and compatibility restorative qualities. Medium area comparing to AL-Azhar Park, and local residential context in the International garden has contributed to being away and fascination requirements of restoration. Limited variety in activities and smaller areas affected extent and compatibility in International garden. On the other hand, small area and less view exposure impacted

being away and fascination in Al-Hurriyah garden, and more activities and smaller areas enhanced extent and compatibility in it.

Considering PRS mean scores for the three gardens in relevance to their different areas supports the concept of being larger in size does not assure higher restorativeness as presented in previous studies (Herzog et al., 2003; Rennit & Maikov, 2015). However, it appeared to be contingent on having interesting content, attractiveness and a context which offers a good fitting between activities occurred in it and its users.

Moreover, responses showed that there are no significant relation between age, gender and frequency of visiting the gardens with perceived restorativeness which is compatible with the findings of Simkin & Ojala (Simkin & Ojala, 2021). Results showed a significant contribution of space characteristics on perceived restorativeness which complies with the findings of Kim, Gin and Sung where they investigated characteristics of people on their Perceived restorativeness (Kim et al., 2017).

The hypothesis that "Restorative experience differs according to the characteristics and context of the garden itself" can be supported combining both results of visual analysis and PRS measurements. International garden with medium area and local context with less distraction from views or activities has scored high potential of restorativeness taking into consideration the sufficient existence and quality of biophilic elements in its design. This also pointed out a significant observation that not all biophilic elements and principles should be applied in one garden to become restorative.

6. Conclusion

It is essential to consider the role played by the built environment in the health of contemporary communities. It is also essential to consider integrating more and more with natural environment to maintain healthy lifestyle. The present research work introduced a biophilic outlook for designing restorative garden. It presented the likely impact for achieving restorative effect through biophilic design elements and principles. It critically reviewed the relevant theories and literature on restorative impact of nature. Furthermore, it identified and illustrated the benefits of biophilic design elements of gardens in terms of stress reduction and achieving restoration.

The study proposed the likely relationship between biophilic design elements and the four requirements of stress restoration which were addressed in Attention Restoration Theory. Then an empirical investigation occurred to identify the relationship between biophilic elements and perceived restorativeness in gardens. Three Egyptian gardens were selected to apply the proposed tool and to assess the biophilic elements impact on stress restoration using PRS. The tool allowed mapping of biophilic principles application in the Egyptian context. It highlighted its features and restorative potentials. Moreover, results of the field study reached several conclusions Identifying the likely contribution of biophilic design elements and principles to perceived restorativeness in gardens and parks. In this context the study answers the two main research questions (RQ1) Biophilic principles has a significant potential in enhancing restorativeness however, it is not necessarily to be all applied to achieve maximum perceived restorativeness. (RQ2) biophilic design principles are applied in Egyptian gardens in a sufficient percentage and with good quality, with a little requirement to be maintained in small context. Additionally, it played a significant role in contributing to its perceived restorativeness. The major contribution of this study is using principles of Biophilia to achieve the requirements of restoration as identified by Attention Restoration Theory. In addition to using ART to highlight the importance for the context of the gardens that impact on perceived restorativeness.

The study addresses some limitations mainly the sample size; since it is an exploratory study so number of participants was considered sufficient for this stage. However, sample size needs to be larger for further confirmation of the outcomes. Findings and conclusions point out suggestions for future research namely; Investigating the impact of biophilic design elements and principles on connectedness to nature and how it influences Attention Restoration principles. And Investigating the impact of biophilic design elements and principles on PRS in more specialized gardens (rehabilitative and healing gardens).

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Conflict of interests

The Author declares no conflict of interest.

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