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Egyptian Restorative Urban Spaces Framework: As a Design and Evaluation Guide for Healthy Urban Spaces Reducing Mental Fatigue

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Abstract

In recent years, mental fatigue has gained recognition as one of the major mental health issues that negatively impact social interaction and cognitive function. According to restorative theories, the "Attention Restorative Theory ART" is still the one that targets the restoration of mental fatigue; not a technical nor design guide, so, there is a gap in converting elements of ART into restorative design guidelines. As the pandemic has changed people's mindset toward the significance of their relationships with urban public spaces as a restorative experience. The majority of urban public spaces in Egyptian cities have proven insufficient to provide a restorative experience during the COVID-19 pandemic. The research aims to propose and provide the "Egyptian Restorative Urban Spaces Framework E-RUSF" to support urban designers, architects, and decision-makers in regenerating and providing Egyptian restorative urban space to reduce mental fatigue and improve quality of life. The E-RUSF is composed based on qualitative and quantitative approaches. The theoretical analytical study focuses on mental fatigue definition and its effects, restoration environment; restorative definitions, and ART, and a comparative analysis between features of aesthetic environmental preference based on pioneers' and users' preferences in the literature review. Then, semi-structured interviews and general interviews were conducted to identify the relationship between ART and features of aesthetic environmental preference, and refine and rank the features for each element of ART to provide E-RUSF, by using SPSS. The finding revealed that E-RUSF is considered an initial step to provide an evaluating and designing framework for healthier restorative Egyptian communities.

Keywords

Mental Fatigue, Directed Attention Fatigue DAF, Restorative Environment, Attention Restoration Theory ART, Aesthetic Environmental preference.

1. Introduction

Recently, human attention and cognitive performance have been negatively affected by a phenomenon called "Directed Attention Fatigue DAF" or "Mental Fatigue", which is a result of continuous cognitive activities for a long time (Neilson et al., 2019; Calm, 2023; Healthline, 2023; Kunasegaran et al., 2023). DAF affects mood, focus, and cognitive skills negatively. Furthermore, more than 75% of people worldwide suffered from mental health problems during and after COVID-19, for instance, mental fatigue, stress, and anxiety (Yin et al., 2022).

In the past, psychologists and pioneers of urban design and landscape have explained and identified the significance of the natural environment in physical and spiritual recovery. For instance, Greeks oriented patients' wards to natural views that enhanced dreaming because they believed the subconscious was an instrument in curing. Britain provided monastic cloister gardens, as they believed that access to nature helps to enhance a spiritual mood, which positively affects mental health. During the late 18th century, the "Attention Reduction theory ART"; the first theory concerned with the idea of restoration from mental fatigue by exposure to the natural environment, was established by Stephen Kaplan and Rachel Kaplan. ART is a general theory about recovery from mental fatigue, neither a technical nor a design guide. Consequently, the term and concept of "Restorative Environment" were established, which is defined as a place that helps people recover from mental fatigue, anxiety, and stress. Furthermore, Hartig proposed a questionnaire method called the "Perceived Restorative Scale PRS" that considered a restorative scale for the elements of ART. PRS is a general questionnaire for the users of the place to identify the degree of the restorative experience. Then, in 2001, Hartig explained that "Restoration" includes physical, psychological, and social health (Ruoxi and Leiqing, 2016; Dose of Nature, 2020; Hidalgo, 2019; Borniolia and Subiza-Perez, 2023; Roe, and McCay, 2021; Han, 2001; Malekinezhad and bin Lamit, 2018; Lyu, and Yang, 2023; Thwaites et al., 2005). Hence, there is a connection between people and their environment that influences the human mental restorative experience (Hidalgo, 2019; Borniolia and Subiza-Perez, 2023). Consequently, urban designers, architects, and urban planners have started to be concerned with and focused on the significance of the urban built environment as the significance of natural environments in the attention restoration and recovery from mental issues; fatigue, stress, anxiety, etc. The built environment affects a human's quality of life and restorative experience for their well-being (Borniolia and Subiza-Perez, 2023).

Urban-built environments have been thought to be less emotionally and cognitively restorative than natural environments (Neilson et al., 2019). Urban life is loaded and pressures humans due to noise, crowding, visual and non-visual pollution, life responsibilities, daily cognitive activities, less exposure to the natural environment, etc. So, there is no time with all the daily tasks to escape away by traveling to places different from daily urban environments; places that provide and enhance the restorative experience by exposing to nature. Consequently, humans suffer from mental fatigue due to insufficient urban public spaces in the urban built environment to provide a restorative experience for their users (Bakir and Attia, 2021). Hence, urban-built environments did not become restorative environments that enhance and provide a well-restorative experience, which can help people recover from their everyday life pressures to achieve mental well-being (Kunasegaran et al., 2023; Healthline, 2023; Neilson et al., 2019). Hence, the productivity of the city will suffer in all aspects; economic, environmental, social, etc.

Based on the literature review, there are a lot of restorative theories, but still, the one that targets the restoration of mental fatigue is "Attention Restoration Theory ART". The majority of the studies in the fields of restorative environments and ART are divided into four aspects. Firstly, studies focused on the quality of the restorative environments; outdoor-indoor natural and built environments, or restorative of different types of urban public spaces, and streets. These studies measured the degree and quality of the restorative environments based on a simulation environment; pictures, videos, and "Virtual Reality VR", or based on a questionnaire called "Perceived Restorative Scale PRS", which is proposed especially for measuring the factors of ART to identify the degree of restorative, or based on measuring heart rate and blood pressure (Hartig et al., 1997; Yin et al., 2020; yin et al., 2022; Lindal and Hartig, 2013; Simkins, 2005; Horvat and Ribeiro, 2003; Ruoxi and Leiqing, 2016; Lotfi, 2020). Secondly, studies are concerned with understanding and identifying which environment has the higher restorative experience; natural or built environment (Van den Berg et al., 2016; Weber and Torjan, 2018; Scopellitia, and Giuliani, 2004). Thirdly, studies focused on identifying the effect of one or some of the physical, visual, or non-visual aesthetic elements that contribute to a restorative, and comfortable experience for users to like or dislike the place (Hunter and Askarinejed, 2015; Luo et al., 2023; Chwodhury, 2020; Subiza-Perez et al., 2019; Lindal and Hartig, 2013; Kim and Kim, 2019; Samavati, and Ranjbar, 2017). Fourthly, some studies discussed general frameworks and restorative theories for restorative cities and urban places (Borniolia and Subiza-Perez, 2023; Roe and McCay, 2021).

As a result of the aforementioned, most of the studies in the field of restorative environment relied on a general questionnaire with users, for instance, PRS, without converting elements of ART into design guidelines or principles. Therefore, a gap exists in the identification of restorative urban design guidelines, which could help urban designers, architects, and planners in designing or improving urban spaces to provide and enhance a restoration experience and reduce mental fatigue that results from daily cognitive activities and pressure.

In Egypt, based on a study by Egypt's Ministry of Health in 2018, 25% suffered from mental issues. In addition, in 2020, based on another study after the COVID-19 pandemic, 41.4% suffered from stressors due to the COVID-19 effects, 55.7 % from financial stress, and 34.1% from work stress (Allcock, 2022; Ahmed, 2021). Furthermore, the majority of urban public spaces in Egyptian cities have proved insufficient function to provide a restorative experience during the COVID-19 pandemic. Consequently, the pandemic has changed Egyptian people's mindset toward the significance of their relationships with urban public spaces (Bakir and Attia, 2021).

Hence, the research paper aims to propose an "Egyptian Restorative Urban Spaces Framework E-RUSF" based on the ART, to improve and provide Egyptian urban public spaces to be attention restoration places; reducing DAF, providing a well-restorative experience, and improving the quality of life. The E-RUS is considered an initial step towards developing Egyptian urban public places to be more concerned with their citizens's mental well-being. The E-RUSF is composed and designed based on qualitative and quantitative approaches, as shown in Fig. 1. The theoretical analytical study is concerned with mental fatigue's definition and its effects on humans, the concept of restorative environment; restoration definitions, and ART. In addition, a comparative analysis between aesthetics-environmental preference based on urban design and landscape pioneer's opinions, and previous studies are concerned with restorative environments based on user preference, to identify features of environmental preference. Then, semi-structured interviews and interviews were conducted and implemented with Egyptian experts; urban designers, architects and urban planners, and non-experts; relatives, and neighbors, to identify the relation between elements of ART and features of environmental preference, in addition, to refining and ranking features of environmental preference for each element of ART, to provide "Egyptian Restorative Urban Space Framework". The semi-structured interviews were analyzed by the SPSS program. The sample size is small (20 participants), due to the difficulty of reaching out to or contacting experts who are experts in healing landscapes, and healthy urban communities, have supervised masters or PhDs in the field of health and its relation to urban design, have studied healing landscape course at the post-graduate level or have academic researches in the field of mental health and its relation to urban design, and healing landscape.

2. Literature Review

This section identifies mental fatigue's definition and its effects on humans, the concept of the restorative environment; restoration definitions, and ART, and aesthetic environmental preference.

2.1. Mental Fatigue

Mental fatigue, or directed attention fatigue, is a mental issue resulting from the long performing of cognitive activities or tasks. Due to continuous cognitive load, the human feels like their mental battery is dying, which leads to burnout if the human does not recognize when to take cognitive rest, and may contribute to other mental issues, for instance, depression and anxiety. Humans could be affected by mental fatigue at different stages of their lives, so it has an impact on various ages and has different levels of impact. Mental fatigue has negative effects on human social life, the efficiency of cognitive performance, and the difficulty of doing normal daily tasks, which negatively reflect productivity and a country's prosperity. The symptoms of mental fatigue in humans are being less focused, being stressed, withdrawing from social engagements, losing interest in hobbies, having difficulty making decisions, and being emotionally unstable (Calm, 2023; Healthline, 2023; Kunasegaran et al., 2023).

2.2. Restorative Environment

This section concerns the restoration definitions, attention reduction theory ART, and its relation with the natural and built environment.

1.2.1. Restoration definitions

Restoration; a Latin root term, is the process of recovery, renewal, or rebuilding of psychological and physiological aspects in a specific environment (Hidalgo, 2019; Borniolia and Subiza-Perez, 2023; Horvat and Ribeiro, 2023; Lindal and Hartig, 2012). (Hidalgo, 2019; Malekinezhad and bin Lamit, 2018).

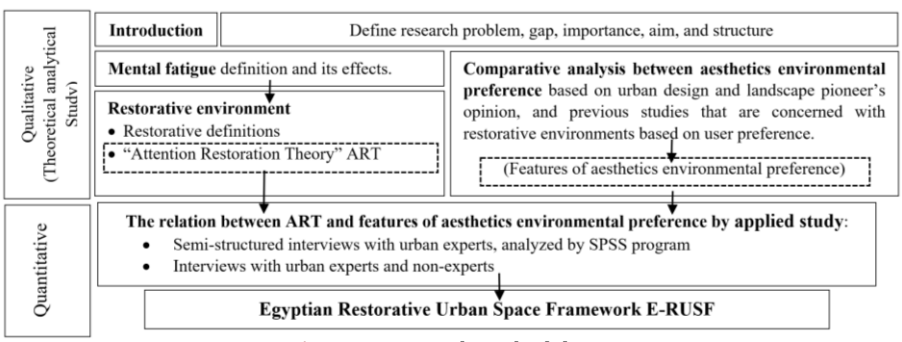

Figure 1. Research methodology

Psychological restoration is the ability of people to relax, distract, and free their minds from everyday life's pressure, so it's a state of mental fatigue reduction (Hidalgo, 2019; Malekinezhad and bin Lamit, 2018).

A restorative environment is a place; a natural or urban-built setting, that helps people recover from mental fatigue, anxiety, and stress (ROE and McCAY, 2021; Han, 2001; Ruoxi and Leiqing, 2016; Borniolia and Subiza-Perez, 2023; Malekinezhad and bin Lamit, 2018; Lyu and Yang, 2023). Restorative places can be either imagined or real environments (Han, 2001). The people's perception of the natural or built environment is considered the link between the natural or built environment and psychological aspects, which is called perceived restorative (Malekinezhad and bin Lamit, 2018). Hence, the restorative experience is the experience of users in a specific environment that can occur at different times and have various intensity levels of restoration (Ruoxi and Leiqing, 2016).

Based on the above, restorative urbanism is an approach that considers mental health and quality of life in urban design and city planning. This approach builds on restorative environment theories and studies (ROE and McCAY, 2021), and one of these theories is the "Attention Reduction Theory ART", which the paper focuses on.

1.2.2. Attention Restoration Theory ART

In 1980, Stephen Kaplan and Rachel Kaplan built their theory on the concept of people's cognitive abilities in the natural environment; environmental preference, and the difference between voluntary and involuntary attention (Hartig, et al., 1997; Malekinezhad and bin Lamit, 2018). ART focuses on the effect of exposure to the natural environment on people's attention restoration, which is concerned with cognitive and affective restoration; especially restoration from direct attention that causes mental fatigue and stress. Natural environments enhance involuntary attention that is effortless. The restorative experience with the natural environment could be direct through activities; for instance, gardening, learning, walking, or indirect; for instance, observing natural environments. ART proposed four qualities or elements of restorative environments; being away, fascination, extent, and compatibility, as shown in Fig. 2, which provide a restorative experience enhancing the recovery from mental fatigue and stress (Chowdhury, 2020; Hidalgo, 2019; Roe, and McCay, 2021; Xie, Mao and Yang, 2022; Borniolia and Subiza-Perez, 2023; Lindal, and Hartig, 2012; Kaplan, 2001; Neilson et al., 2019; Ruoxi and Leiqing, 2016; Dose of Nature, 2020).

A. Being away refers to an environment characterized by features that differ from the ordinary or daily environment to enhance mental restoration and escape from stress and mental fatigue, for instance, a historical place, going to a forest and breathing fresh air, or admiring a painting visually. The environment should be distinct (Hidalgo, 2019; Xie, Mao, and Yang, 2022; Kaplan, 2001; Ruoxi, and Leiqing, 2016; Dose of Nature, 2020; Kaplan, 1995; Hartig et al., 1997; Han, 2001). Being away could be physical, mental, or both (Kaplan, 1995; Hartig et al., 1997; Han, 2001).

Figure 2. Attention Restorative Theory ART
Source: author based on (Kaplan, 2001; Xie, Mao and Yang, 2022)

B. Extent refers to an environment with content and structure, which has a degree of coherence and order that occupies the mind to explore the place without getting lost and to enhance the indirect attention that rests the mind (Chowdhury, 2020; Hidalgo, 2019; Xie, Mao and Yang, 2022; Lindal, and Hartig, 2012; Kaplan, 2001; Dose of Nature, 2020). The environment should be vast enough; vast spaces, that people can get lost in it mentally, explore it, and attract their attention (Ruoxi and Leiqing, 2016). Hence, extent's concept is described by two factors; connectedness and scope. The connectedness is the coherence between environmental elements, while scope is the scale and capacity of the environment or places that provide enough exploration and experience (Malekinezhad and bin Lamit, 2018; Han, 2001).

C. Fascination refers to an environment that has aesthetic features (fascinating objects) enhancing the attraction of people's attention or people's exploration of the environment with moderate effortlessness; this is called soft fascination. The natural settings; water, plants, animals, light, etc., consider the association between moderate fascination and aesthetics (Chowdhury, 2020; Hidalgo, 2019; Xie, Mao, and Yang,2022; Kaplan, 2001; Ruoxi and Leiqing, 2016; Dose of Nature, 2020). Thus, the environment should enhance people's interaction with the surroundings in an involuntary cognitive state outside of the current state of stress and mental fatigue. The soft fascination is related to visual aesthetic variables; Visual complexity and fractal geometry. Visual complexity is a scene that has a high number of visual elements, and if these elements are repeated over a variety of scales this is considered fractal geometry. Hence, the elements of a scene should be interrelated; complexity, and fractal geometry, and not only singular elements; novelty, value, and positive affect. In addition, the fine distinction in a scene could be considered to be a simple complex that is considered enough to achieve soft fascination, which is better than high complexity (Neilson et al., 2019). The soft fascination is, for instance, walking in a natural environment, or watching

clouds, snow, sunsets, and wind moving the leaves (Malekinezhad and bin Lamit, 2018).

D. Compatibility refers to an environment that fits between the people's goals, needs, or expectations from the place, the provided activities, and the environment settings. Hence, people participate in activities that fit their motivations/goals; for instance, people desire to hide and stay alone, so a quiet corner of garden benches would be good (Chowdhury, 2020; Hidalgo, 2019; Xie, Mao, and Yang,2022; Lindal, and Hartig, 2012; Kaplan, 2001; Neilson et al., 2019; Ruoxi and Leiqing, 2016; Dose of Nature, 2020). Not all fun and enjoyable activities are restorative activities, for instance; shopping at malls could be fun but might not have a positive effect (Han, 2001).

The four elements/qualities of ART, that express the restorative environment, are measured by a tool called the "Perceived Restorative Scale PRS", which is a questionnaire for the users to scale their restorative experience in the place. Every element of ART has a group of questions to measure its contribution to restorative experience (Hartig et al., 1997; Yin et al., 2022; Ruoxi and Leiqing, 2016). The PRS is a valid tool for measuring people's restorative experience by evaluating people's perception of the restorative potential of the environment but not monitoring the restorative state of the environment or place (Malekinezhad and bin Lamit, 2018).

2.3. Aesthetics Environmental preference

Environmental preference is considered a complex concept because it depends on human's subjective preference for natural and built environments. The environmental preference is the liking features in the environment that are aesthetically pleasing. As aesthetic environment preferences affect human perception positively, so enhance well-being, and provide a restorative experience. Based on the previous studies in the field of environmental preference, many pioneers; Jack Nasar, Von Meiss, Kevin Lynch, Camilo Sitte, Corden Cullen, Bosselmann, Montgomery, and Kaplans, discussed and identified some visual aesthetic urban features that enhance and provide a positive experience for humans in urbanism. In addition, some studies identified urban visual urban features and non-visual elements that enhance and affect the user's restorative experience (Luo et al., 2023; Carmona et al., 2010; Neilson et al., 2019; Han, 2001; Montgomery, 1998; Lynch, 1960, Chwodhury, 2020, Subiza-Perez et al., 2019, Yin et al., 2022, Lindal, and Hartig, 2012, Kim and Kim, 2019; Samavati, & Ranjbar, 2017).

Jack Nasar identified five features of a like-built environment; natural features, cared and maintained environment, openness and defined spaces with panoramas and vistas of elements, historical features, and a sense of order in terms of coherence, legibility, and clarity (Nasar, 1990; Carmona et al., 2010). Von Meiss proposed the concept of synoptic; the grouping of elements mentally in the visual field based on repetition, continuity, orientation, common ground, closure, and proximity of physical elements, which reflects the coherence in places (Von Meiss, 1990; Carmona et al., 2010). Kevin Lynch identified that the mental image is composed based on what the users see and the distinctions of the environment, so the environment should have identity, structure, and meaning. He suggested 5 features of the visual mental image which are landmarks, nodes, districts, edges, and paths. These features should be distinct, exposed, and have structure, and meaning. The nodes; that the research paper focuses on, should have visual differentiation by shape, wall, activity, floor, skyline, etc., dominance, exposure by introvert and extrovert elements, and the form should be simple, clear, enclosure, and sharpness of edges (Lynch, 1960; Carmona et al., 2010).

Montgomery identified that the place should have an identity and a combination of the identity with the user's perception of the place by feelings and impressions. So, he identified that the sense of place is a combination of form, activities, and image (Montgomery, 1998). Camilo Sitte proposed artistic principles for urban spaces which are enclosure, rejecting the concept of free-standing buildings, the proportion of space should be more than three, and monuments preferred to be off-center or along the edge of the space (Carmona et al., 2010). Gorden Cullen introduced serial vision, which depends on the concept of hereness and thereness. In addition, he discussed some design principles; for instance, identity, surprise, coherence, mystery/exploration by curved turns, enclosed or defined spaces, and visual punctuation, that guide the user's attention (Cullen, 1961; Carmona et al., 2010). Bosselman introduced rhythmic spacing which reflects the measuring of people's walk that is related to visual and spatial experience, so visual and non-visual preferences attract the attention of users to explore and stay in the urban space (Carmona et al., 2010).

Kaplans proposed the "Environmental Preference Framework" that identified aesthetic variables related to environmental preference. The four aesthetic variables are divided into understanding and exploring the environment. Kaplans thought that a place with a good mental map enhances understanding of the environment, and an attractive place inspires the exploration of the place. The understanding of the environment variables is coherence and complexity. The exploration of the environment variables is a mystery, and legibility (Neilson et al., 2019; Han, 2001; Carmona et al., 2010). Coherence is an organization of the elements in the scene. It would be described and defined by continuity, and grouping of elements. Legibility is the ability of the user to predict what he will see or follow in the scene if the place needs to be explored further. The legibility is difficult to measure without asking the user. Complexity is the number of independently perceived elements in a scene; a highly complex environment has many dissimilar elements that are not easily grouped. Although, it is hard to define the complexity because of the difficulty of knowing how people could group the elements in the

environment, but it is simple to count the elements in an environment to define the complexity. The relation between aesthetic preference and complexity is an inverted U shape; the highest level of preference means a moderate level of complexity. Mystery is the environment or scene that has more information or experience, but would if the user explores the environment further; for instance, a hill hides something in the scene or environment, and it is difficult to measure (Neilson et al., 2019). Based on the literature review, aesthetic variables, that proposed by Kaplans, are as difficult to measure as the four characteristics of the restorative environment proposed in their ART theory. Furthermore, it is hard to understand how the proposed aesthetics variable relates to the four characteristics of ART that define the restorative environment (Neilson et al., 2019; Han, 2001).

Furthermore, some previous studies discussed and identified urban preference features that affect positively the user's restorative experience. Firstly, A study focused on the effect of physical and aesthetic environmental quality on user preference; for instance, harmony, mystery, multisensory, nature, and visual openness (Luo et al., 2023). The second study discussed the significant and positive effect of visual and non-visual landscape aesthetic features on users' mental well-being; complexity, coherence, maintenance, disturbance, imageability, visual openness, nature, historic elements, ephemera, pleasure natural sounds, and pleasure smells (Chwodhury, 2020). The third study identified 5 elements of the perceived aesthetic qualities of environments of urban spaces; harmony, mystery, multisensory and nature, visual spaciousness and visual diversity, and sublimity (Subiza-perez et al., 2019). The fourth study focused on identifying the effect of building height, and architectural variation; roofline silhouette, and surface ornamentation, on the user's restorative experience for urban residential streetscape (Lindal, and Hartig, 2012). The fifth study identified the best proportions of urban space that enhance the sense of cozy, comfort, and openness ranging from 1:3 to 1:6 (Kim and Kim, 2019). The sixth study was concerned with identifying physical features that influence human happiness (Samavati, & Ranjbar, 2017).

Based on the above, the research conducted a comparative analysis that expresses pioneers' opinions of urban-aesthetic environmental preference in their theories and studies, and the previous studies that focused on and discussed the urban aesthetic environmental preference based on user preferences as shown in Table (1). Hence, Table (1) contains all the physical/visual and non-visual aesthetic features of environmental preferences that affect positively the user's restorative experience in urban spaces. These features are classified into 5 main domains; natural environment, built environment, general design guidelines, sensory environment (El-Barmelgy, 2013), and activities.

Table 1. Comparative analysis between "Aesthetic Environmental Preference" based on urban design, landscape pioneers, and user's opinion.

Code	Aesthetic Environmental Preference (Visual/physical and non-visual)		urban design and landscape pioneer's opinion								user's preference based on previous studies of restorative experience					
			Stephen Kaplan and Rachel Kaplan	Von Meiss	Kevin Lynch	Jack Nassar	Camilo Sitte	Montgomery	Corden Cullen	Bosselmann	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6
Visual/physical aesthetic preference																
Natural Environment Features (N)																
N1	Presence of Green areas (Greenery)		+			+					+	+	+			+
N2	Presence of water features; rivers, lakes, sea, fountains, ponds, waterfalls, etc.		+			+					+	+	+			+
N3	Presence of wild features; mountains.		+			+					+	+	+			+
N4	Viewing the sky (day-night)		+													+
N5	Ephemera: Landscape changes related to the changes in seasons or weather.											+				
N6	Soft wall for urban spaces; planting or water features				+	+			+		+					
Built Environment Features (B)																
B1	Defined space (Walls of urban space)	Hard wall for urban spaces; buildings.			+	+			+		+					
B2		Continuity or sharpness of space wall.			+		+		+							
B3		The height of the wall gives a sense of isolation from the surroundings.						+						+	+	
B4	Degree of openness	Proportion of space (1:3)					+	+					+		+	
B5		Proportion of space (1:4 – 1:5 – 1:6)													+	
B6	Space Form	Simplicity and clarity of form to easily understand and explore the space.			+											
B7		Curved forms that attract attention to exploring the place (Mystery).	+						+		+		+			

B8		Enclosure/containment space			+	+	+		+				+			
B9	Movement (Physical accessibility)	Curved paths that attract attention to exploring the place (Mystery).	+						+				+			
B10		Presence of Pedestrian paths.														+
B11		Presence of cycle paths.														+
B12	Monuments/ 3D public art	Presence of monuments / 3D public art.					+									
B13		Monuments / 3D public art should be off-center or along the edge of the space.					+									+
General Design Guidelines (G)																
G1	Maintenance (status of building and landscape features)					+						+				
G2	Focal element (Focality), that attracts users.		+		+											
G3	Coherence; is the organization of elements in a place or scene, grouping elements; for instance, floor and wall patterns, forms, colors, details, planting, etc. by similarity/repetition, continuity, and proximity.		+	+			+		+	+	+					
G4	Surprise and mystery concepts in urban space attract attention to exploring the place (The desire to explore hidden objects or places).		+						+		+		+			
G5	Presence of distinct / identity.				+				+							+
G6	Presence of Panoramic viewpoints.				+	+					+	+	+			
G7	Presence of vistas.				+	+					+	+	+			
G8	The location of introverted elements of urban space (buildings and activities) affects the user experience inside the spaces.		+		+	+		+	+			+	+			+
G9	Legibility	Presence of historic and iconic elements/features	+		+	+		+	+			+	+			+
G10		Visual accessibility by extrovert elements of urban spaces (the ability to see significant elements of urban space from outside).	+		+	+		+	+			+	+			+
G11	Moderate Complexity	Diversity of elements or objects in the environment or scene by counting the number of elements.	+								+	+	+			+
G12		Size variation of elements, which means diversity of elements scale.	+								+	+	+			+
G13		Asymmetry of wall or form			+											
G14		Balance (Moderate complexity, so moderate exploration, and soft fascination)										+				
Non-visual / non-physical aesthetic preference																
Sensory Environment Features (S)																
S1	Pleasure sounds; for instance, the sound of birds, water, etc.							+		+	+	+				
S2	Pleasure smells; for instance, the smell of flowers, fruits, water, rain, etc.							+		+	+	+				
Activities (Restorative activities) (A)																
A1	Diversity of restorative activities; a. Watching or meditating activities; for instance; sitting by a lake or, river or pond, watching birds or animals or sunrise or sunset. b. Enabling activities (physical activities); for instance: walking. c. Horticultural activities (gardening activities). d. Events and festival activities.				+			+								+
A2	Diversity bet. daytime and evening activities to enhance safety, livability, and exploration.							+								
A3	Intensity of uses.				+			+								

Source: author based on (Nasar, 1990; Carmona et al., 2010; Von Meiss, 1990; Lynch, 1960; Montgomery, 1998; Cullen, 1961; Neilson et al., 2019; Han, 2001; Luo et al., 2023; Chwodhury, 2020; Subiza-perez et al., 2019; Lindal, and Hartig, 2012; Kim and Kim, 2019; Samavati, & Ranjbar, 2017).

3. The relation between ART and environmental preference

This section is concerned with understanding and explaining the relation between the features of the five domains of environmental preference in Table (1) and the four elements of ART; being away, fascination, extent, and compatibility, to identify the features that have a positive effectiveness and enhance each element of ART. In addition, ranking the importance of these features for each element of ART to provide Egyptian urban spaces reduces mental fatigue.

3.1. Methods

The research relied on two methods; semi-structured interviews, and interviews. Firstly, semi-structured interviews have been designed and conducted with architects, landscape designers, and urban designers who are experts in healing

landscapes, and healthy urban communities, have supervised masters or PhDs in the field of health and its relation to urban design, have studied healing landscape course at the post-graduate level or have academic researches in the field of mental health and its relation to urban design, and healing landscape. The targeted sample size is small; 20 experts, due to the difficulty of selecting participants based on the selection criteria; having awareness about the field of mental health and urban design, and having the willingness and availability to participate. The targeted sample was selected using random stratified cluster samples.

The semi-structured interview consists of two parts; part one aims to collect the participants' data. The second part aims to explain the sufficiency of the relation between the four elements of ART and environmental preference features that consist of the main five domains: natural environment features, built environment features, general design guidelines, sensory environment features, and activities, as shown in Table (1), by identifying the effective degree of each environmental preference feature to the four elements of ART; being away, fascination, extent, and compatibility, to design and regenerate urban spaces that enhance the restorative experience especially reducing mental fatigue. The second part is divided into four sections:

A. Effective degree of environmental preference features to feel being away in urban spaces.
B. Effective degree of environmental preference features to feel fascination in urban spaces.
C. Effective degree of environmental preference features to feel extent in urban spaces.
D. Effective degree of environmental preference features to feel compatibility in urban spaces.

The SPSS program has been used in the statistical analysis; mean analysis, and relative importance index. Some environmental preference features have been proposed and added by the experts in semi-structured interviews. These features are related to sensory environment and activities.

E. S3: Considering touch sense in designing urban space; for instance, the suitability of furniture material for climate.
F. A1e: Water activities; for instance, taking a tour by boat in the Nile.

Secondly, based on the analysis of semi-structured interviews, interviews have been conducted with experts and non-experts to identify and explain the reasons for the difference between experts' opinions in the effectiveness of some of the features based on the difference in their ages; from 25 to 50 years old and more than 50 years old.

3.2. Mean analysis

Based on the statistical analysis, the mean is divided into three effective levels; high (more than 4), medium (ranged from 3.1 to 4), and weak (3 and less than 3), as shown in Figs. 3, 4, 5, 6, 7, 8, 9, 10, and 11. The aesthetic environmental preference features that have been at the weak effective level in four elements of ART have been excluded, as it is not effective and not important in reducing mental fatigue based on semi-structured interviews with experts.

Figure 3 shows that the effectiveness of the five domains of environmental preference is equal in contributing to and enhancing the four elements of ART to reduce mental fatigue; the medium effective level, except the natural environment domain, has a high effectiveness, and the built environment has the weakest effectiveness in the sense of being away. Thus, humans feel away from the daily stressful environment in urban spaces that have natural elements, restorative activities, and sensory environment, but the experts explain that human feels away from their daily stressful places in built environments that have an identity; historical identity, considering coherence, legibility, and human scale.

Regarding the feeling of being away, Figure 4 shows that most of the built environment features; B1, B2, B3, B4, B11, and B13, and features of activities; A1c, A1d, and A3, have weak effects; excluded features, in contributing to feeling being away in urban spaces. On the contrary, natural environment features; N1, N2, N4, and N5, sensory environment features; S1, S2, and features of activities; A1a, and A1e are the most effective features for feeling away from daily stressful environments. The features of the natural environment and sensory environment have various effects between the highest and medium levels, while the features of activities have various effects between the three levels. Features of the built environment have a variety of weak and medium effective levels. On the contrary, all features of general design guidelines have medium effectiveness for feeling away. Figure 5 shows the agreement and disagreement between the experts's opinions on features's effective levels of feeling away. The experts; aged more than 50 years old, identified that N4, N5, N6, B9, S1, S2, A1a, and A1c have higher effective levels of feeling being away in urban spaces than the opinion of experts aged from 25 to 50 years old. On the contrary, the experts, aged from 25 to 50 years old, identified that B2, B4, B5, B7, B8, B11, B13, G12, G13, and A3 have higher effective levels of feeling being away in urban spaces than the experts' aged more than 50 years old.

Figure 6 illustrates how N1, N2, N5, G1, S1, and A1a have a significant impact on the fascination feeling, but B1, B2, B3, B4, A1c, and G10 have the least effective; excluded features. While the features of activities and general design guidelines have different effects at the three levels, the natural environment's and the sensory environment's features have different effects between the highest and medium levels. There are several weak and medium effective levels in the built environment. According to Figure 7, the majority of the features of general design guidelines; G1, G2, G4, G6, G7, G8, G9, G10, and G11, which are space quality, legibility, moderate complexity, mystery concept, panoramic and vista views, as well

as S2; the presence of pleasurable smells, B12; 3D public art, and N5; Ephemera, are what fascinate experts over the age of 50 in their restorative experience in urban spaces. Experts between 25 and 50 years old tend to feel fascinated by N4, B2, B4, B5, B8, B13, A1a, A1e, A2, and A3; the diversity and intensity of activities during the day especially water activities, the degree of openness to viewing the sky, the containment of space, and the continuity of space walls.

Feeling of extent in urban spaces has been highly affected by N1, N2, N5, G1, G3, G5, and S2, but B1, B2, B3, B4, B5, B11, A1c, A1d, and A3 have the lowest effect (excluded features), as shown in Fig. 8. The features of the natural environment, sensory environment, and general guidelines are various in their effect between high and medium effective levels. On the contrary, the effects of features of the built environment and activities are between medium and weak levels. Based on Figure 9, the experts aged more than 50 preferred N5, B12, G1, G3, and G6 more than other experts in feeling extent because they tend to simplicity and coherence, which reflect calmness and reduced direct attention. Experts, aged between 25 and 50 years old, are affected by N4, B1, B2, B3, B4, B5, b6, b7, b8, b9, b13, G2, G8, g10, g11, G14, S2, A1a, A1e, A2, and A3; the diversity of activities during the day, legibility, defined spaces, moderate complexity, and openness of urban space, etc. more than other experts in feeling extent in urban space.

Figure 10 illustrates that N1, N2, N4, N5, and G5 have the highest effect on the feeling of compatibility with urban spaces, while B1, B2, B3, B5, B7, B9, B11, A1c, and A1d have the weakest effect; excluded features. The features of the natural environment and general design guidelines have different effects at the highest and medium levels. There are several weak and medium effective levels in the features of the built environment and activities. In addition, all features of the sensory environment have a medium effective level of feeling compatibility in urban spaces. Based on Figure (11), experts between 25 and 50 years old preferred to feel compatibility with urban spaces more than experts aged 50 years old by N3, N4, B1, B2, B3, B4, B5, B7, G14, and A3; the degree of openness with the ability to view the sky, defined spaces, moderate complexity, mystery concept, and intensity of activities.

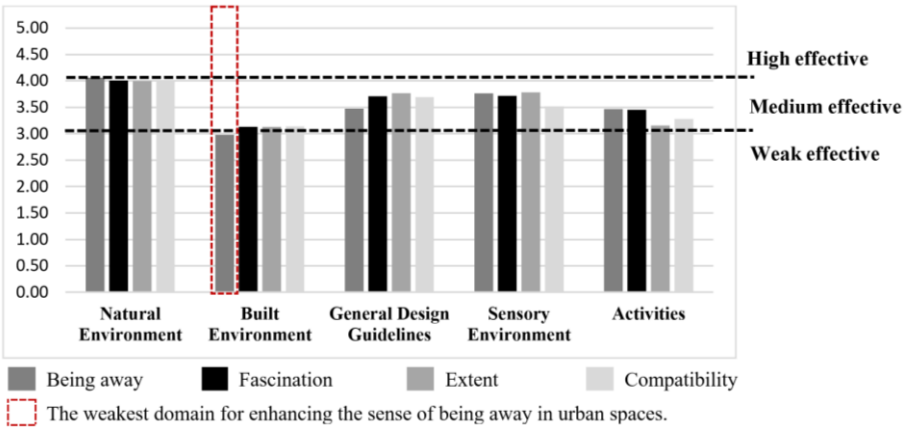

Figure 3. Mean analysis of the effectiveness degree of five main domains for elements of ART

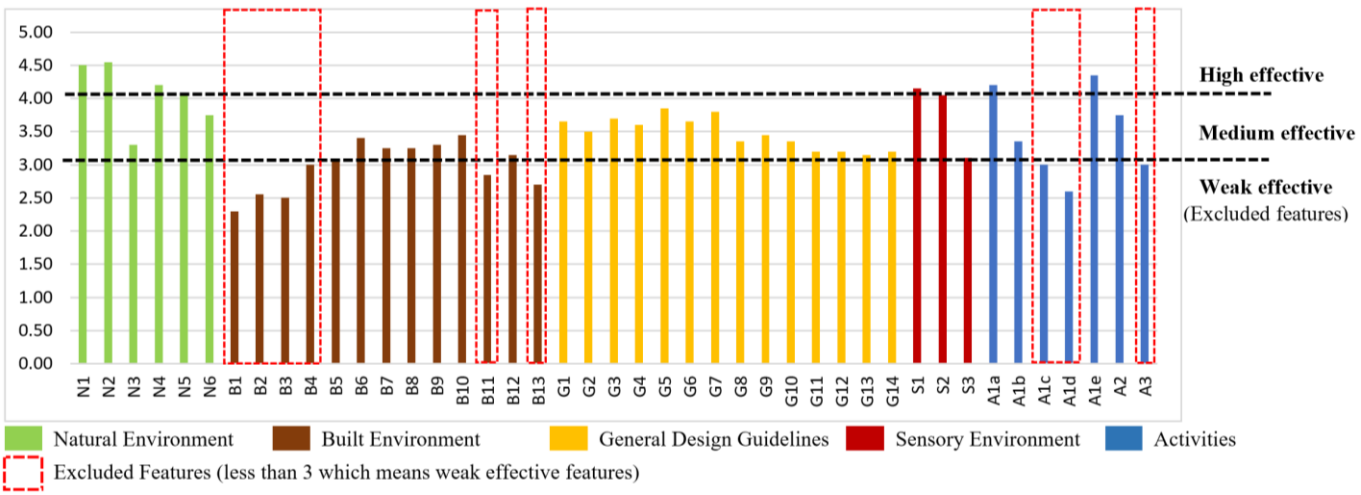

Figure 4. mean of effectiveness degree of environmental preference features for a sense of being away in urban spaces.

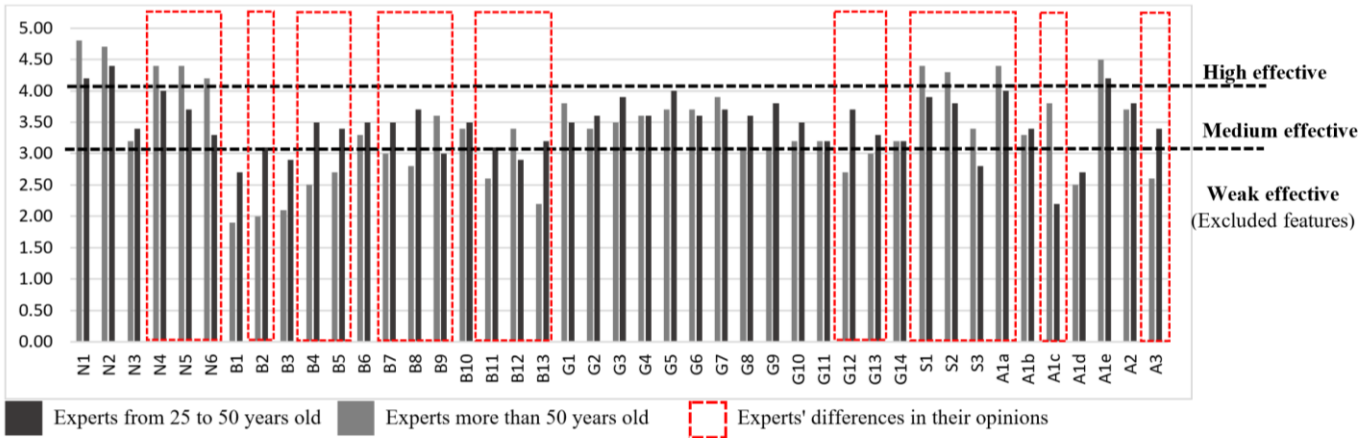

Figure 5. Agreement and disagreement between the experts' opinions on the effectiveness level of each feature to feel being away.

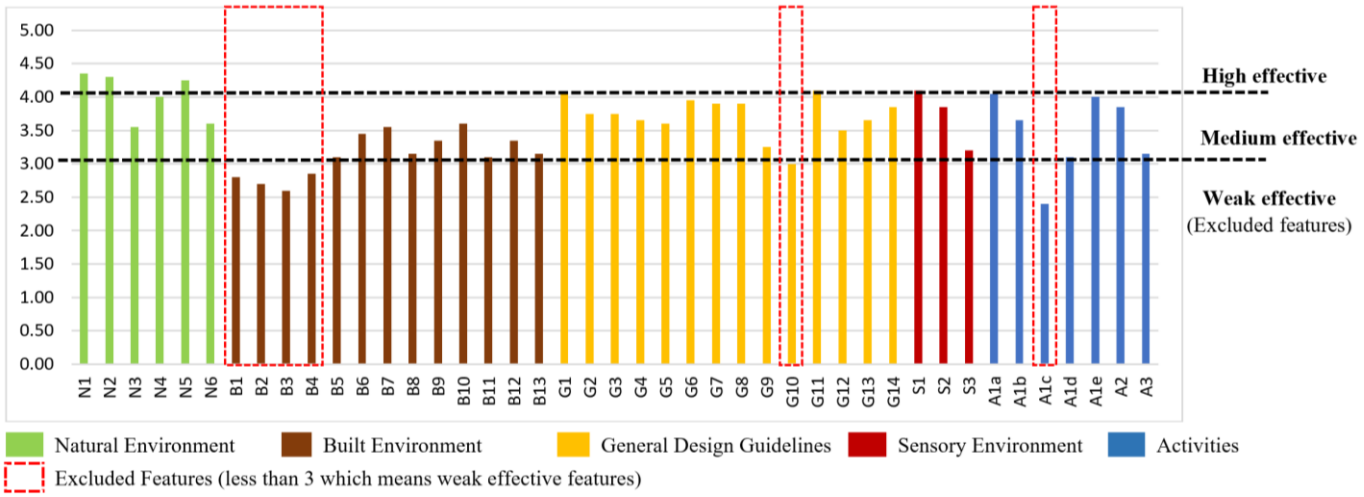

Figure 6. mean of effectiveness degree of environmental preference features for a sense of fascination in urban spaces.

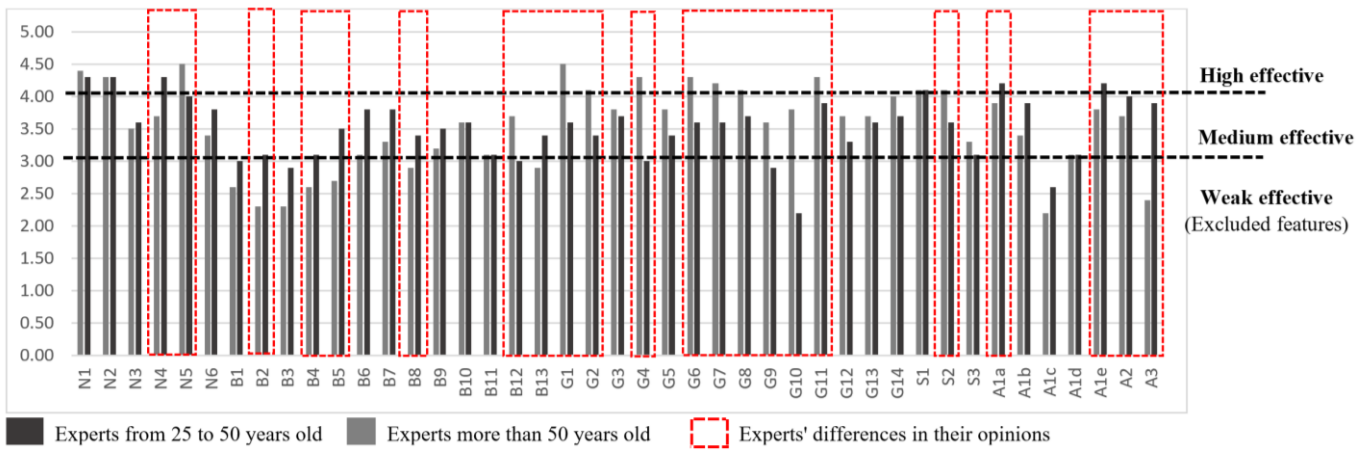

Figure 7: Agreement and disagreement between the experts' opinions on the effectiveness level of each feature to feel fascination.

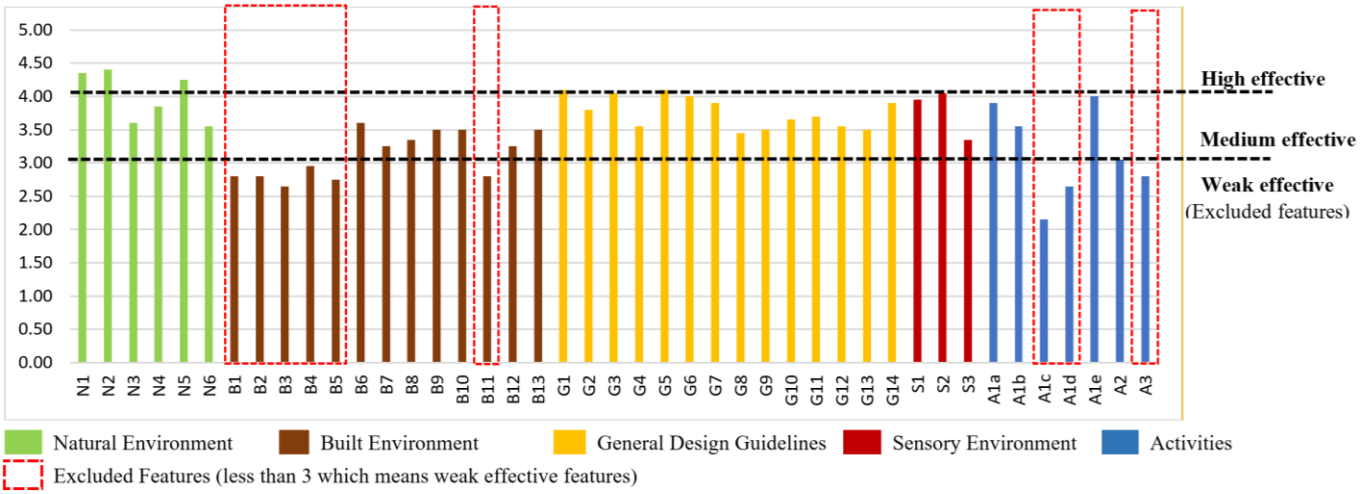

Figure 8. mean of effectiveness degree of environmental preference features for a sense of extent in urban spaces.

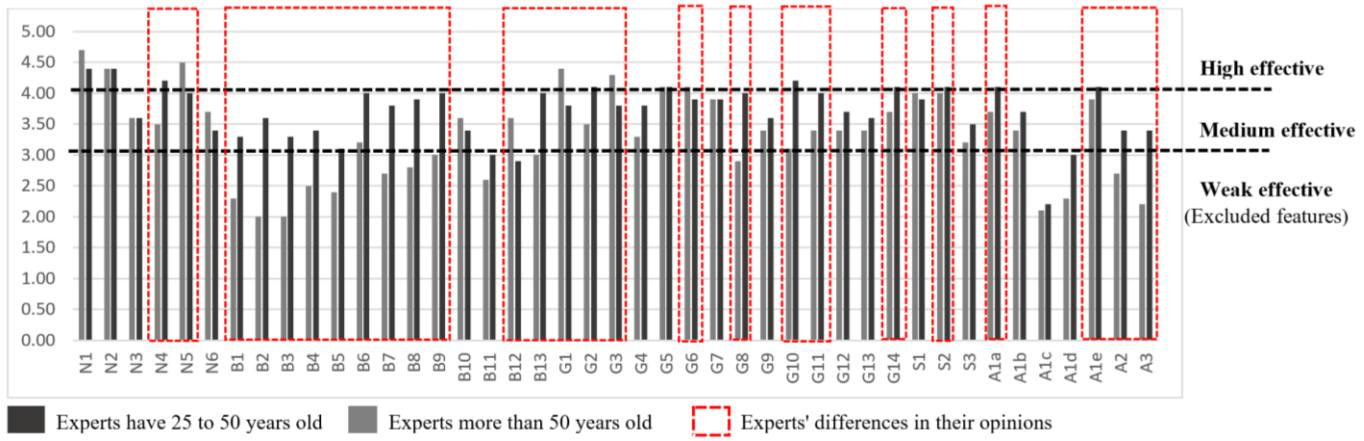

Figure 9. Agreement and disagreement between the experts' opinions on the effectiveness level of each feature to feel extent.

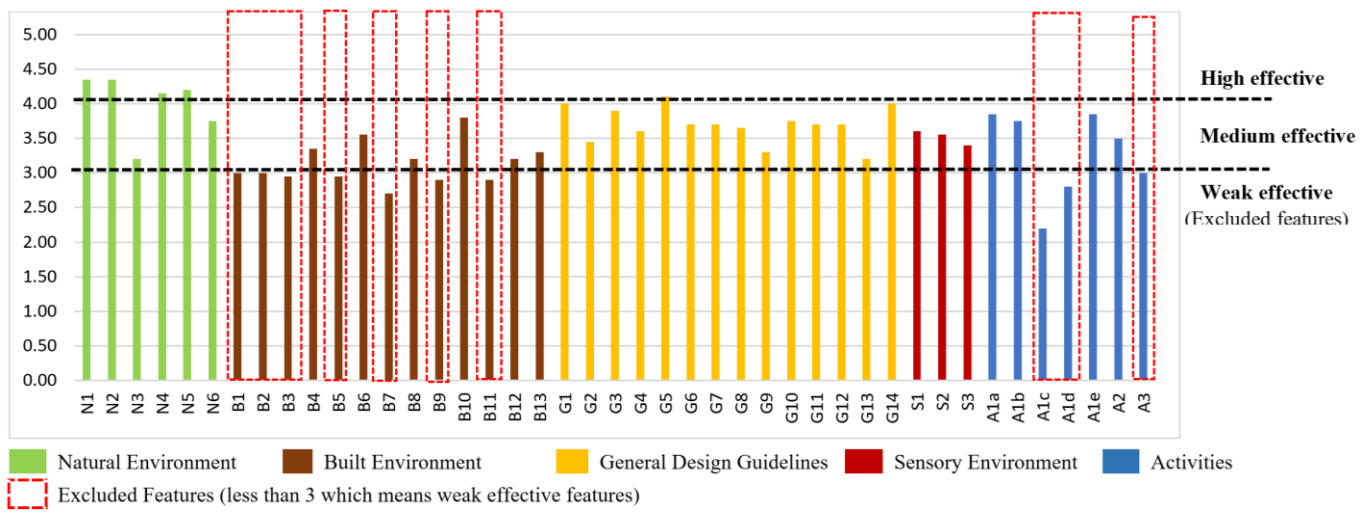

Figure 10. mean of effectiveness degree of environmental preference features for a sense of compatibility in urban spaces.

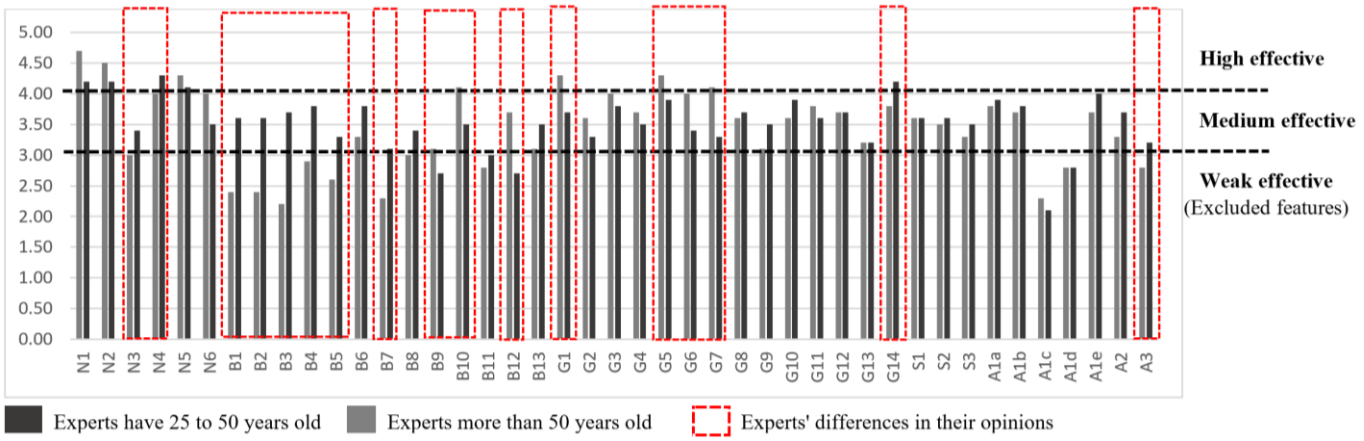

Figure 11. Agreement and disagreement between the experts' opinions on the effectiveness level of each feature to feel compatibility.

3.3. Relative Importance Index RII

According to statistical analyses of the relative importance index, as shown in Tables (2) and (3), the features of five domains; natural environment, built environment, general design guidelines, sensory environment, and activities, are ranked for each element of ART; being away, fascination, extent, and compatibility, according to their importance, and classified into three levels; very high, high, and neutral. Where neutral importance is ranged from 0.41 to 0.60, high importance is ranged from 0.61 to 0.80, and very high importance is more than 0.80. The importance rank of each feature is different for each element of ART. The research excluded all features of each domain at a neutral level in each element of ART, as the focus is on the features that have high and very high effectiveness and importance in enhancing users' restorative experience in urban spaces to reduce mental fatigue.

Table (2) demonstrates the importance ranks of the five domains for each element of ART. The natural environment has the highest rank in its importance for all elements of ART. Then, sensory environment has the second rank in senses of being away, fascination, and extent, but has the third rank in feeling compatibility. On the contrary, the general design guidelines have the third rank in senses of being away, fascination, and extent, but have the second rank in compatibility, and fascination. Activities and the built environment have the lowest ranks. The built environment domain has neutral importance in the feeling of being away. Respondents explain that they feel away from their daily environment by exposure to urban spaces connecting with large areas of the natural environment rather than having buildings and feeling stuck in the city. Hence, they desire one of the urban space walls to be a soft wall; trees, sea, river, mountain, etc. Based on RII analysis, the important hierarchy of the five domains to reduce mental fatigue is the natural environment (0.80), sensory environment (0.74), general design guidelines (0,73), activities (0.67), and built environment (0.62) sequentially, as shown in Fig. 12.

Table (3) shows that walls of urban spaces; B1, B2, B3, and horticultural activities; A1c have neutral importance for all elements of ART. Regarding the degree of openness, B4 has neutral importance for all elements of ART except compatibility, and B5 has a neutral importance level for the feeling of extent and compatibility but a high importance level for the sense of being away and fascination. Hence, degrees of openness; B4 and B5, have neutral importance for a sense of extent. cycle paths B11, events and festival activities A1d, and intensity of uses A3 have high importance for enhancing the sense of fascination but have neutral significance for all three other elements; being away, extent, and compatibility. Water features N2 and Ephemera N5 have very high importance for enhancing all elements of ART in restorative urban spaces.

The importance levels of features of the built environment and activity domains are neutral or high, except for A1a and A1b, which have very high importance for enhancing the senses of being away and fascination. All features of the other three domains; natural environment, sensory environment, and general design guidelines ranged between very high and high levels, except G10 has neutral importance for a sense of fascination.

Table 2. RII of the five domains for ART

Aesthetic Environmental Preference (Five Domains)	ART							
	Being away		Fascination		Extent		Compatibil-ity	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Natural Environment Features (N)	0.81	1	0.80	1	0.79	1	0.80	1
Built Environment Features (B)	0.60	5	0.63	4	0.63	4	0.63	5
General Design Guidelines (G)	0.70	3	0.74	2	0.75	3	0.74	2
Sensory Environment Features (S)	0.75	2	0.74	2	0.76	2	0.70	3
Activities (Restorative activities) (A)	0.69	4	0.69	3	0.63	4	0.66	4

Importance level (very high) Importance level (high) Importance level (neutral)

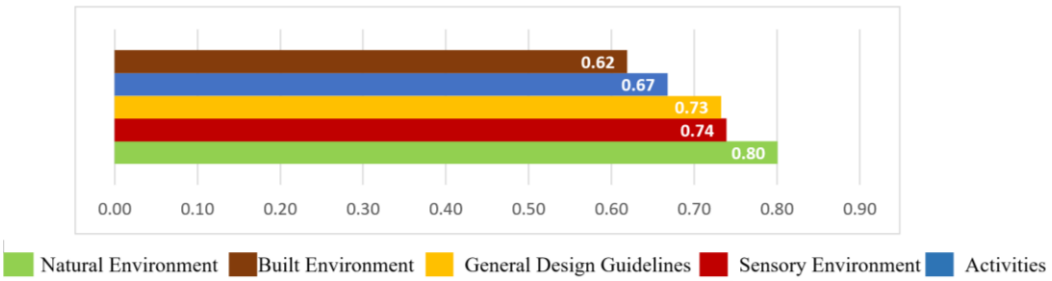

Figure 12: RII of the five domains of environmental preference to reduce mental fatigue

Table 3. RII of aesthetic environmental preference features for elements of ART

Code	Aesthetic Environmental Preference (Visual/physical and non-visual)		ART							
			Being away		Fascination		Extent		Compatibility	
			RII	Rank	RII	Rank	RII	Rank	RII	Rank
Natural Environment Features (N)										
N1	Presence of Green areas (Greenery)		0.90	2	0.87	1	0.79	6	0.89	1
N2	Presence of water features; rivers, lakes, sea, fountains, ponds, waterfalls.		0.91	1	0.86	2	0.88	1	0.87	2
N3	Presence of wild features; mountains.		0.66	17	0.71	13	0.72	12	0.64	20
N4	Viewing the sky (day-night)		0.84	4	0.80	6	0.77	8	0.83	4
N5	Ephemera: Landscape changes related to the changes in seasons or weather.		0.81	6	0.85	3	0.85	2	0.84	3
N6	Soft wall for urban spaces; planting or water features		0.75	9	0.72	12	0.71	13	0.75	10
Built Environment Features (B)										
B1	Defined space (Walls of urban space)	Hard walls for urban spaces; buildings.	0.46	29	0.56	23	0.56	20	0.60	21
B2		Continuity or sharpness of space wall.	0.51	27	0.54	24	0.56	20	0.60	21
B3		The height of the wall gives a sense of isolation from the surroundings.	0.50	28	0.52	25	0.53	22	0.59	23
B4	Degree of openness	Proportion of space (1:3)	0.60	23	0.57	22	0.59	19	0.67	18
B5		Proportion of space (1:4 – 1:5 – 1:6)	0.61	22	0.62	20	0.55	21	0.59	22
B6	Space Form	Simplicity and clarity of form to easily understand and explore the space.	0.68	15	0.69	15	0.72	12	0.71	15
B7		Curved forms that attract attention to exploring the place (Mystery).	0.65	18	0.71	13	0.65	17	0.54	25
B8		Enclosure/containment space	0.65	18	0.63	19	0.67	16	0.64	20
B9	Movement (Physical accessibility)	Curved paths that attract attention to exploring the place (Mystery).	0.66	17	0.67	16	0.70	14	0.58	24
B10		Presence of Pedestrian paths	0.69	14	0.72	12	0.70	14	0.76	9
B11		Presence of cycle paths	0.57	24	0.62	20	0.56	20	0.58	23
B12	Monuments/ 3D public art	Presence of monuments / 3D public art	0.63	20	0.67	16	0.65	17	0.64	20
B13		Monuments / 3D public art should be off-center or along the edge of the space	0.54	25	0.63	19	0.70	14	0.66	19

General Design Guidelines (G)										
G1	Maintenance (status of building and landscape features)		0.73	11	0.81	5	0.82	3	0.80	6
G2	Focal element (Focality), that attract users.		0.70	13	0.75	10	0.76	9	0.69	16
G3	Coherence; is organization of elements in place or scene, grouping elements; for instance, floor and walls patterns, forms, colours, details, planting etc. by similarity / repetition, continuity, and proximity		0.74	10	0.75	10	0.81	4	0.78	7
G4	Surprise and mystery concepts in urban space attract attention to exploring the place (The desire to explore hidden objects or places).		0.72	12	0.73	11	0.71	13	0.72	13
G5	Presence of distinct / identity.		0.77	7	0.72	12	0.82	3	0.82	5
G6	Presence of Panoramic viewpoints.		0.73	11	0.79	7	0.80	5	0.74	11
G7	Presence of vistas.		0.76	8	0.78	8	0.78	7	0.74	11
G8	The location of introverted elements of urban space (buildings and activities) affects the user experience inside the spaces.		0.67	16	0.78	8	0.69	15	0.73	12
G9	Legibility	Presence of historic and iconic elements/features	0.69	14	0.65	17	0.70	14	0.66	19
G10		Visual accessibility by extrovert elements of urban spaces (the ability to see significant elements of urban space from outside).	0.67	16	0.60	21	0.73	11	0.75	10
G11	Moderate Complexity	Diversity of elements or objects in the environment or scene by counting the number of elements.	0.64	19	0.82	4	0.74	10	0.74	11
G12		Size variation of elements, which means diversity of elements scale.	0.64	19	0.70	14	0.71	13	0.74	11
G13		Asymmetry of wall or form	0.63	20	0.73	11	0.70	14	0.64	20
G14		Balance (Moderate complexity, so moderate exploration and soft fascination)	0.64	19	0.77	9	0.78	7	0.80	6
Sensory Environment Features (S)										
S1	Pleasure sounds		0.83	5	0.82	4	0.79	6	0.72	13
S2	Pleasure smells		0.81	6	0.77	9	0.81	4	0.71	14
S3	Considering touch sense in designing urban space; for instance, the suitability of furniture material for climate.		0.62	21	0.64	18	0.67	16	0.68	17
Activities (Restorative activities) (A)										
A1a	Watching or meditating activities		0.84	4	0.81	5	0.78	7	0.77	8
A1b	Enabling activities		0.67	16	0.73	11	0.71	13	0.75	10
A1c	Horticultural activities		0.60	23	0.48	26	0.43	23	0.44	26
A1d	Events and festival activities		0.52	26	0.62	20	0.53	22	0.56	24
A1e	Water activities		0.87	3	0.80	6	0.80	5	0.77	8
A2	Diversity bet. daytime and evening activities		0.75	9	0.77	9	0.61	18	0.70	15
A3	Intensity of uses		0.60	23	0.63	19	0.56	20	0.60	21

Importance level (very high) Importance level (high) Importance level (neutral) (excluded features)

Added features by Semi-structured interviews

3.4. Results of Interviews

Based on the mean analysis, as shown in Figs. 5, 7, 9, and 11, there are disagreements in experts' opinions based on their age for some features in each domain of environmental preference. Hence, the author discussed the difference with some experts: 2 experts aged more than 50, and 1 expert aged from 25 to 50 years old, to understand the reasons for these disagreements in their opinions, and also with 4 non-experts: relatives and neighbors who are ranged in age between 25 and 50 and who are more than 50 years old.

3.4.1. Regarding disagreement in effectiveness levels of natural environment features for ART.

A. viewing the sky N4 is more effective in experts' opinions aged from 25 to 50 years old than experts aged more than 50 years old for the sense of fascination, extent, and compatibility, but vice versa in the sense of being away. Respondents; aged more than 50 years old, explain this disagreement as the majority of outdoor urban spaces are not designed considering their physical needs especially movement and thermal comfort. while other respondents; aged from 25 to 50 years old, explain that they tend to stay in outdoor urban spaces without ceilings because this makes them feel freedom, and comfort, also all their stressful environments are indoors. The difference in the sense of being away is because respondents; aged more than 50 years old, do not go away a lot, so seeing the sky enhances the sense of being away from their homes; their daily environment.

B. Ephemera N5 is more effective in the opinion of experts, who are more than 50 years old, than other experts, aged from 25 to 50 years old, for the sense of being away, extent, and fascination, but all experts agreed that N5 has the same effectiveness for the sense of compatibility. In addition, Soft Wall N6 is more effective in experts' opinions who are more than 50 years old than experts' opinions who

are 25 to 50 years old in the sense of being away. Respondents, aged more than 50 years old, explain that as humans get older, they tend to love nature and be fascinated and comfortable with the changes in nature every season. As watching the details of nature without any effort reduces their mental fatigue, they also love gardening activities that make them calm and reduce mental fatigue

C. Wild features N3 is more effective in experts' opinions who aged from 25 to 50 than experts' opinions who aged more than 50 in the sense of compatibility, Although experts agreed that N3 has a medium effect in all other three elements of ART. Respondents, aged from 25 to 50 years old, prefer places with wild adventures and activities, for instance, camping and hiking, more than older people, aged more than 50 years old, to meditate and reduce their stress that is caused by daily cognitive activities.

3.4.2. Regarding disagreement in effectiveness levels of sensory environment features for ART.

Pleasure smells S2 is more effective in experts's opinions who are more than 50 years old than experts who are 25 to 50 years old for the sense of being away, fascination, and vice versa for the sense of extent, but all experts agreed that it has the same effectiveness for the sense of compatibility. Respondents, aged more than 50 years old, explain that older people have an appreciation for non-visual and non-physical things such as the smells of nature: flowers, seas, etc., which makes them feel senses of freshness, fascination, and being away from their daily environment. The attention of people aged 25 to 50 is attracted and fascinated by their appreciation of visual and physical things more than non-visual things

3.4.3. Regarding disagreement in effectiveness levels of activities features for ART.

A. Meditating activities A1a, water activities A1e, diversity bet: daytime and evening activities A2 are more effective in experts' opinions who aged from 25 to 50 than experts' opinions who aged more than 50 for the senses of extent and fascination, but all experts are equal in their effectiveness for senses of being away and compatibility. Respondents, aged from 25 to 50 years old, explain that the diversity of activities during the day attracts their fascination and attention to stay and explore the urban space throughout the day, and they preferred activities related to water or watching nature. Respondents, aged more than 50 years old, find it very difficult and tiring to stay out of their homes throughout the day, but regarding activities A1a and A1e, they preferred the meditating activities, but it was not the thing that made them fascinated or extent. They considered meditation activities as a need that should be available in the space to feel compatibility.
B. Horticultural activities A1c is more effective in experts' opinions who are more than 50 years old than experts who are 25 to 50 years old for the sense of being away, but they are equal in their opinions in all other elements of ART. This disagreement is explained by the fact that older people tend to love agricultural activities as they are considered memorial activities to some of them in their rural-urban areas, which enhances their feeling of isolation from their daily stressful environment. Other respondents clarified that they typically assist and encourage gardening activities in their residential urban spaces, and they also like to plant on their balconies, as a hobby to assist them in reducing their mental fatigue.

3.4.4. Regarding disagreement in effectiveness levels of built environment features for ART.

A. Experts believe that, except for compatibility, containment space B8 and the position of 3D public art B13 are more effective for those between the ages of 25 and 50 than for those over 50 in the feeling of being away, fascination, and extent. Respondents, aged 25 to 50 years old, clarify that enclosed areas attract their attention and encourage them to stay and explore; they also mention that 3D art is seen as a focal attraction point. Conversely, respondents, aged more than 50, are attracted to and fascinated by places that meet their goals and expectations, especially their physical and comfort needs, and activities.
B. Experts older than 50 agree that curve path B9 is more effective for the senses of compatibility and being away than experts between 25 and 50 years old, and vice versa for the sense of extent. The respondents, who were over 50 years old, explained that curved paths reflected the idea of visual sequences to keep them from getting bored or lost and to attract them in without requiring them to think about their daily tasks, as curved paths also contained moderately complex concepts that attracted their attention easily and reduced mental fatigue.

3.4.5. Regarding disagreement in effectiveness levels of general design guidelines for ART.

A. Maintenance G1 and panoramic viewpoints G6 are more effective in experts' opinions who are more than 50 years old than experts aged from 25 to 50 years old for the senses of fascination, extent, and compatibility, although all experts agreed with medium effectiveness for the sense of being away. Respondents, aged more than 50 years old, tend to prefer the good quality and status of things, which gives them a sense of fascination to explore and feel comfortable with the place. In addition, they prefer the panoramic viewpoints, as it is easy for them to explore and watch the place with physical ease.
B. Balance G14 is more effective in the experts' opinions of those aged from 25 to 50 years old than experts aged more than 50 years old for senses of extent, and compatibility. Respondents; aged from 25 to 50 years old, tend to prefer simplicity and calmness more than the other respondents; aged more than 50 years old, in the number of objects and

their details. All experts agreed in their opinion for the sense of fascination, moderate complexity makes moderate exploration and soft fascination. Hence, reduces mental fatigue and directs attention.

C. The location of introverted elements of urban space G8, and legibility G10, are more effective in experts' opinions who are more than 50 years old than experts, aged from 25 to 50 years old, for the sense of fascination, but vice versa for the sense of extent. Respondents; aged more than 50 years old, always prefer something that guides them on their way to and from their homes as a way finding, so they will need landmarks to guide them in urban spaces that are near their homes.

There are also three added notes and explanations from the experts: firstly, the relation between the proposed feature of five domains for each element of ART and income levels, as these features are compatible with high-income levels for all elements of ART, which already existed in the design of the majority of urban spaces that relate to this category. In addition, these proposed features are compatible with the middle-income level for the senses of being away, fascination, and extent, but not compatible with the low-income level. Furthermore, these features are compatible with low-income levels in the sense of extent but not in the sense of compatibility, as some activities may not be considered basic needs for the low-income category. Secondly, the social dimension is very significant in evaluating the restorative urban spaces to make people feel comfortable and pay attention to exploring them. Thirdly, the design of restorative urban spaces that reduce mental fatigue highly depends on the designer's capabilities and his awareness of restorative urbanism.

4. Egyptian Restorative Urban Spaces Framework E-RUSF

Based on statistical analysis of semi-structured interviews, the research concluded the importance ranking of the effectiveness of each aesthetic environmental preference feature for each element of ART; based on Egyptian needs and opinions, to explain and understand the relation between ART and aesthetic environmental preference features to provide and propose an "Egyptian Restoration Urban Spaces Framework E-RUSF", as shown in Tables (4), (5), (6), and (7). The features are ranked based on the RII, and classified into two effective levels based on mean analysis. Hence, Tables (4), (5), (6), and (7) are considered an initial simple attempt to provide "Egyptian Restoration Urban Spaces Framework E-RUSF" which evaluates, regenerates, and designs the Egyptian urban spaces to be restorative urban space that reduces mental fatigue. Furthermore, Table (8) shows the total features score of each domain of environmental preference features of each element of ART, and the percentage weights of each domain, to measure total restorative score of ART elements as Equation 1 and the "Total Score of Restorative Urban Space T_RUS" as Equations 2. The scores of each domain for each element of ART were identified based on the least number of features that affected each element of ART.

Table 4. Importance ranking and levels of environmental preference features for sense of being away.

Effective Level 1								Effective Level 2																							
1	2	3	4		5	6		7	8	9		10	11		12	13	14	15		16			17		18		19			20		21	22
N2	N1	A1e	N4	A1a	S1	N5	S2	G5	G7	N6	A2	G3	G1	G6	G4	G2	G9	B10	B6	A1b	G10	G8	N3	B9	B7	B8	G11	G12	G14	B12	G13	S3	B5

Table (5): Importance ranking and levels of environmental preference features for the sense of fascination.

Effective Level 1							Effective Level 2																												
1	2	3	4		5		6		7	8		9			10		11			12			13		14	15	16		17	18	19			20		
N1	N2	N5	G11	S1	A1a	G1	N4	A1e	G6	G7	G8	S2	A2	G14	G2	G3	G4	G13	A1b	N6	G5	B10	N3	B7	G12	B6	B9	B12	G9	S3	A3	B13	B8	B5	B11	A1d

Table (6): Importance ranking and levels of environmental preference features for the sense of extent.

Effective Level 1						Effective Level 2																											
1	2	3		4		5		6		7			8	9	10	11	12		13				14					15	16		17		18
N2	N5	G1	G5	G3	S2	A1e	G6	N1	S1	G14	A1a	G7	N4	G2	G11	G10	N3	B6	N6	G4	G12	A1b	B9	B10	B13	G9	G13	G8	B8	S3	B7	B12	A2

Table (7): Importance ranking and levels of environmental preference features for the sense of compatibility.

Effective Level 1					Effective Level 2																											
1	2	3	4	5	6		7	8		9	10			11				12	13		14	15		16	17	18	19		20			
N1	N2	N5	N4	G5	G1	G14	G3	A1a	A1e	B10	G10	A1b	N6	G6	G7	G11	G12	G8	G4	S1	S2	B6	A2	G2	S3	B4	B13	G9	N3	B8	B12	G13

Table 5. Total Scores and weights of environmental preference domain and ART elements

Domains of environmental preference EP	ART (scores of each element)				Total Restorative Urban Space Score (T_RUS)	
	Being Away	Fascination	Extent	Compatibility	Total	Weights
Natural Environments N	6/6	6/6	6/6	6/6	24/24	23%
Built Environments B	6/6	6/6	6/6	6/6	24/24	17%
General Design Guidelines G	13/13	13/13	13/13	13/13	52/52	20%
Sensory Environment S	3/3	3/3	3/3	3/3	12/12	21%
Activities A	4/4	4/4	4/4	4/4	16/16	19%
Total restorative score of ART element	B_RUS	F_RUS	E_RUS	C_RUS	100%	

Total restorative score of ART element (B_RUS or F_RUS or E_RUS, or C_RUS):

$$RUS = \left[\sum_{i=1}^{EP} \sum_{j=1}^{EPi} AEP_j * WEP_j\right] \quad (1)$$

Where
EP: Environmental preference domain.
AEP: Score of each environmental preference domain for one of ART elements.
WEP: weights of each environmental preference domain.

Total restorative urban space score T_RUS:

$$T\_RUS = \left[\sum_{i=1}^{EP} \sum_{j=1}^{EPi} EPRUS_j * WEP_j\right] \quad (2)$$

Where
EP: Environmental preference domain.
EPRUS: Total Score of each environmental preference domain in 4 elements of ART.
WEP: weights of each environmental preference domain.

Source: Author based on (El-Barmelgy, 2013)

5. Results and Discussion

The research proposed the E-RUSF as an initial simple framework that can help urban designers, architects, and decision-makers evaluate and regenerate existing Egyptian urban space to be appropriated to reduce mental fatigue and improve quality of life. In addition, the E-RUSF can be an initial guide in designing new Egyptian urban spaces in new communities to be appropriate to mental human needs and provide healthier Egyptian communities. The E-RUSF can be easily applied by considering Tables (4), (5), (6), and (7) as a checklist; yes or no. For instance, if all features are at effective level 1 in all elements of ART, the urban space can be considered a restorative urban space that provides the most priority features that partly satisfy the cognitive human's needs to reduce mental fatigue. This means that the urban space needs some intervention to regenerate and provide the other features in level 2 to fully satisfy the cognitive human needs to reduce mental fatigue, thus improving quality of life. Then, measure the percentage of restorative urban space according to the equations. According to statistical analysis of semi-structured interviews and interviews, the importance hierarchy of the main five domains to elements of ART, based on Egyptian human needs, to reduce mental fatigue and improve quality of life is the natural environment, sensory environment, general design guidelines, activities, and built environment sequentially. All elements of ART have been affected by a medium-effective level and a high-importance level from all five domains, except the sense of being away. The natural environment domain has the highest effective level and RII in the sense of being away, while the built environment has the weakest effective level and neutral importance level in the sense of being away.

Regarding sub-features of each domain and its relation to ART based on Egyptian human needs, the most effective features for each sense of ART are N1, N2, N4, N5, S1, S2, A1a, and A1e for the sense of being away, N1, N2, N5, G1, G11, S1, and A1a for the sense of fascination, N2, N5, G1, G3, G5, and S2 for the sense of extent, and N1, N2, N4, N5, G5 for the sense of compatibility. Walls of urban spaces; B1, B2, B3, and horticultural activities; A1c excluded features for all elements of ART, as they are at the neutral importance level of RII analysis, and have a weak effective level in mean analysis, so they do not have effectiveness in reducing mental fatigue. Hence, soft walls N6 are better than hard walls, which means that the restorative urban spaces should have at least one soft wall that is connected to natural features, for instance, planting, rivers, seas, and mountains. The proportion of space 1:3 (B4) has effectiveness only on the sense of compatibility, but senses of being away, and fascination are affected by the degree of openness of urban space that is greater than 1:3 (B5), while the sense of extent is not affected by the degree of openness or proportion of space. Cycle paths B11, Events, and festival activities A1d, the intensity of use A3 have effectiveness only on the sense of fascination, but they do not affect all other senses. Legibility G10; Visual accessibility by

extrovert elements, has effectiveness on all elements of ART except the sense of fascination.
According to statistical analysis and the interviews/discussions with experts and non-experts, there is disagreement on the effectiveness of some features on the level of the same sense and between different senses of ART based on the needs of each age of the users. In addition, the needs of different income levels should be considered while designing or regenerating any urban space, so the E-RUSF is an initial general framework.

6. Conclusion

Based on qualitative and quantitative approaches, the research identified the definition and effects of mental fatigue, and restorative environment concept; restoration definitions, and "Attention Restoration Theory ART". Following that, the research provides the features of the visual/physical and non-visual/non-physical features of aesthetic environmental preference based on a comparative analysis conducted between pioneers' opinions and the previous studies that focused on and discussed urban aesthetic environmental preference based on user preferences, as shown in Table (1). Then, the research investigates validation of the relation and effect of the features of aesthetic environmental preference for each element of ART through semi-structured interviews that have been designed and implemented with experts; urban planners, architects, and urban designers, who have an awareness of the healing landscape and mental health and its relation to healthy urbanism. Then, interviews were conducted with urban design experts and non-experts to discuss the difference in the effectiveness and importance of some of environmental preference features in each element of ART, which have been noticed in the statistical analysis according to experts' age.
Based on the statistical analysis using SPSS, the research paper refined and ranked the effectiveness and importance of environmental preference features for each sense of ART: being away, fascination, extent, and compatibility. The hierarchy of effectiveness importance of five domains of environmental preference features is the natural environment, sensory environment, general design guidelines, activities, and built environment sequentially. In addition, sub-features of each domain differ in their effectiveness in enhancing each sense of ART, and some features are excluded in each sense of ART. Furthermore, some features: B1, B2, B3, and A1c, are excluded from all elements of ART. In addition, some features have different or the same effectiveness in each element of ART.
Consequently, the research provided the E-RUSF, which is considered an initial simple guide framework that supports and helps urban designers, urban planners, architects, and decision-makers regenerate and provide restorative urban spaces that reduce mental fatigue and improve the quality of life in Egyptian urban areas. The E-RUSF is divided into four parts based on the elements of ART; being away, fascination, extent, and compatibility, and each sense has features of aesthetic environmental preference, which are ranked based on their effectiveness and importance, as shown in Tables (4), (5), (6), and (7).
Hence, the research is considered an initial step and attempts to shed light on the importance of restorative urbanism concerned with human mental well-being and providing healthier Egyptian communities. The research has limitations in sample size due to the difficulty of knowing and contacting the experts who have awareness and research in the field of healthy communities and the healing landscape. Further research is required regarding proving the efficiency of the E-RUSF by applying it to different urban spaces and developing and refining the E-RUSF according to the different income levels' needs. In addition, studies are concerned with identifying the reasons for the neutral importance and weak effectiveness of the space walls, and horticultural activities on all elements of ART in reducing mental fatigue. Furthermore, studies are required to illustrate and investigate the effectiveness of the social dimension in reducing mental fatigue and its relation to ART.

List of abbreviations

- Attention Restoration Theory ART
- Natural Environment N
- Built Environment B
- General Design Guidelines G
- Sensory Environment S
- Activities A
- Egyptian Restorative Urban Spaces Framework E-RUSF

Declarations

- **Availability of data and materials**

All data generated or analyzed during this study are included in this published article.

- **Competing interests**

The author declares that they have no competing interests.

- **Funding**

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