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Review

A Review of Attention Restoration Theory: Implications for Designing Restorative Environments

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Abstract: The promotion and development of healthy cities are vital for enhancing human habitats and fostering sustainable economic growth. Based on the core databases of Web of Science, PubMed, Google Scholar, and PsycINFO, and the knowledge graph software, this paper presents a quantitative analysis of the literature related to attention recovery abroad. It is found that in recent years, the research on attention recovery has developed rapidly, the number of related studies has been increasing, and the research content presents the characteristics of interdisciplinary integration. By further analyzing the characteristics of the research literature, research context, and knowledge basis, this paper summarizes the empirical research based on the existing quantitative analysis, reviews the research field based on the mechanism of attention recovery, and analyzes the development process and trend based on the research basis of attention recovery. Due to the change in the modern life style, human health problems are becoming more and more prominent. Attention restoration design provides a new research idea and method to balance the relationship between humans and the urban environment.

Keywords: attention recovery; pressure recovery; healthy; quantitative analysis

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1. Introduction

The information age has ushered in intensified social competition. Modern lifestyles have undergone significant changes, resulting in various public health issues. Compact urban environments and the stressful modern urban lifestyle are significant contributors to mental and chronic illnesses. Consequently, the promotion and development of healthy cities are vital for enhancing human habitats and fostering sustainable economic growth. To attain the objective of a health-focused built environment, the worldwide construction industry has prioritized the integration of health concepts into spatial design. The United States has developed the "WELL Healthy Building" evaluation standard, specifically designed to assess the mental and physical health implications of the built environment. To proactively and effectively tackle current prevalent health issues, China has formulated and issued documents related to Healthy China Action [1]. The emergence of concepts such as "healthy city", "healthy community", and "healthy building" has ushered the health concept into the realm of architectural environmental design. Spatial environment design places greater emphasis on enhancing the comfort and enjoyment of the spatial experience.

Scholars have demonstrated that the environment can indeed influence the mental health and attention levels of residents [2]. Prolonged residence in a low-quality environment not only results in various physical and mental health issues, but also leads to reduced work efficiency, enthusiasm, and other adverse effects. Since the 1980s, numerous studies have demonstrated that natural environments can restore attention and alleviate stress [3]. The information overload and stressful urban environments in modern cities expedite the

depletion of individuals' attention resources. A rising demand for rejuvenating environments in the future is anticipated. It is worth highlighting that substantial attention has been directed toward the concept of "attention recovery", which initially emerged within the realm of environmental psychology. In the last three decades, attention-related research has revolved around two primary theories: Stress Reduction Theory (SRT) and Attention Restorative Theory (ART). Roger Ulrich introduced SRT in 1979 [4], while Stephen Kaplan introduced ART in 1983 [5]. Table 1 displays the evolution of pertinent attention recovery theories. SRT centers on immediate and unconscious emotional reactions induced by the environment [6]. ART concentrates on cognitive responses and posits that exposure to nature can facilitate the restoration of depleted directed attention resources, alleviating cognitive fatigue. SRT and ART are not mutually exclusive, and both share a common foundation in biophilic concepts [5].

Table 1. Development process of relevant theories of attention recovery.

Theory			Author	Time	Content
Theories related to attention recovery	Stress Reduction Theory (SRT)		Roger Ulrich	1979	When an individual is in a state of stress or stress, exposure to some natural environment can alleviate the physical, psychological, and behavioral damage caused by the stressor.
	Attention Restorative Theory (ART)	Autonomous attention and involuntary attention concepts	William James	1892	William James developed the concept of voluntary attention and involuntary attention. When the object itself is not attractive but one has to pay attention to it, people mobilize autonomous attention, and vice versa.
		Concept of directed attention	Messalam	1985	Directed attention, which is similar to undirected attention, is considered important for human health in modern neuromedicine.
		Put forward the theory and the characteristics of the recovery environment	Stephen Kaplan	1983	To refine the theoretical framework and fascination, Kaplan added three other features to the restorative environment—being away, extent, and compatibility.
		Psychological perspectives and natural experience	Stephen Kaplan	1989	The environment restores directed attention by providing certain qualities and provides individuals with opportunities for contemplation. This process is called a restorative experience. Accordingly, such an environment is a restorative environment.
		Integration of the natural recovery benefit framework	Stephen Kaplan	1995	Strong and continuous use of directed attention will lead to the consumption of this resource, causing individuals to make frequent errors and engage in impulsive behavior; but in a restorative environment, individuals can effectively recover attention.

Over the past decade, an increasing number of studies have emerged from various fields, including environmental psychology, health psychology, and sports psychology [7]. Analyzing spatial quality through the lens of attention restoration design is beneficial for advancing research. Investigating human psychology and behavior allows researchers to comprehend how enhancing the built environment can contribute to the enhancement that enhance human cognitive function and attention restoration capabilities. The fundamental attributes of a restorative environment serve as a theoretical foundation for crafting artificial environments conducive to restoration. This approach aids in dissecting the positive and negative elements of the surroundings, thereby unveiling the abstract environmental quality. These abstract attributes provide designers with a more diverse range of methods for implementing attention restoration theories, beyond merely incorporating greenery into interior spaces.

This study seeks to enhance the connection between individuals and the urban environment, addressing the growing health concerns through an analysis of attention restoration research processes and trends. Using the core databases of Web of Science, PubMed, Google Scholar, and PsycINFO, and knowledge graph software such as CiteSpace5.8.R3, this paper presents a quantitative analysis of the pertinent literature. The research indicates that attention restoration studies have garnered significant interest from scholars globally. Nevertheless, numerous studies on attention restoration have yet to be translated into practical applications, presenting ongoing challenges that require further investigation and resolution.

2. Methodology

2.1. Data Collection

The Web of Science, PubMed, Google Scholar, and PsycINFO databases are recognized for their comprehensive coverage of academic literature spanning various disciplines, providing researchers with access to a diverse range of attention recovery studies across different fields. This ensures a thorough representation of the current literature. A knowledge graph facilitates quantitative analysis by visually representing relationships and connections among studies. Its visualization capabilities track trends and the evolution of attention recovery research, providing a longitudinal perspective that ensures retrospectives capture not only the current state of the field, but also its historical development, including co-occurrence of research disciplines, publication trends, publication sources, keywords and their evolution trends, main authors, and frequently cited literature. Then, the literature analysis function is used to determine the research context and knowledge basis in this field. The key nodes and hot trends of attention recovery design are explored using a knowledge graph. Based on the analysis of the knowledge graph and the sorting of key knowledge contexts, the empirical research, research field, development process, and trend of attention recovery are identified and summarized.

2.2. Research Framework

The basic data of this paper come from the Web of Science, PubMed, Google Scholar, and PsycINFO core collection databases. By comparing the results several times and by trial and error, the Topic = ("restorative environment" OR "stress recovery" OR "attention recovery" OR "perceived recovery") AND (environment OR architecture OR building OR urban). As a result, 5841 articles were screened, and the obtained literature was screened for intensive reading: ① papers of literature type selection, conference proceedings, and review papers; and ② citation frequency is higher or citation centrality is higher than 0.1. Some literature with a weak correlation was removed, and 571 kinds of literature were screened for analysis. Based on this, the mechanism of ART and research development trend involved in the selected literature were analyzed in the next step. The analysis and retrieval tools of the database, along with knowledge graph software, were utilized to analyze 571 literature records. The research conceptual model is shown in Figure 1.

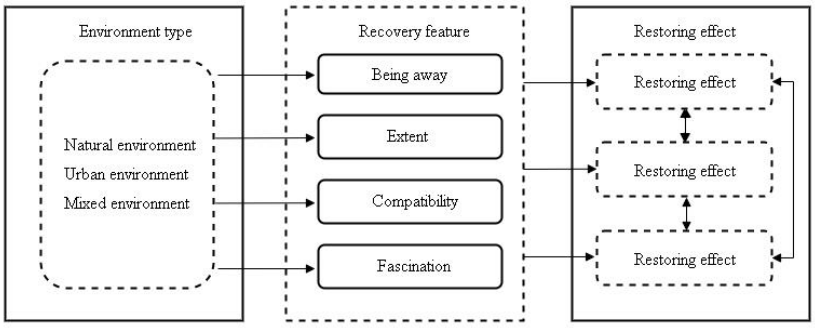

Figure 1. The study's conceptual model.

3. Results

3.1. Quantitative Analysis

3.1.1. Research Subject Co-Occurrence Analysis

Statistics show that ART covers a wide range of research directions in the database. The main disciplines are "Environmental Sciences", "Environmental Studies", "Ecology", "Social Science", and "Psychology". These have been major areas of attention recovery research for the last decade. These research directions have gradually expanded to such disciplines as Public Administration, Urban Studies, Engineering, Computer Science, and Business. Various research fields are integrated, and there is a strong correlation among research disciplines (Figure 2).

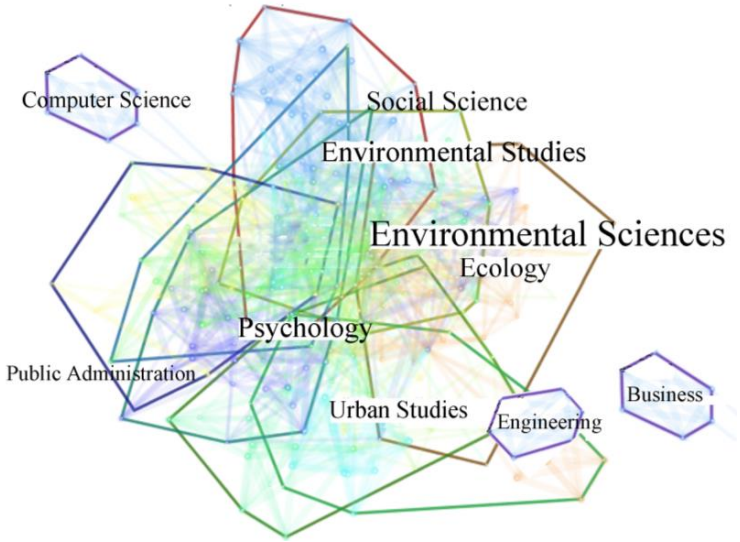

Figure 2. Co-occurrence analysis of research disciplines.

3.1.2. Analysis of Publication Trends and Publication Sources

According to the statistical analysis of 5841 studies found in the databases and 571 studies screened and processed by the year of publication, it can be found that the number of relevant studies has shown an increasing trend in the past ten years (Figure 3), this means that the concept of health is receiving increasing attention nowadays. The design of comfort and livability of the space environment is also paid more attention by the public.

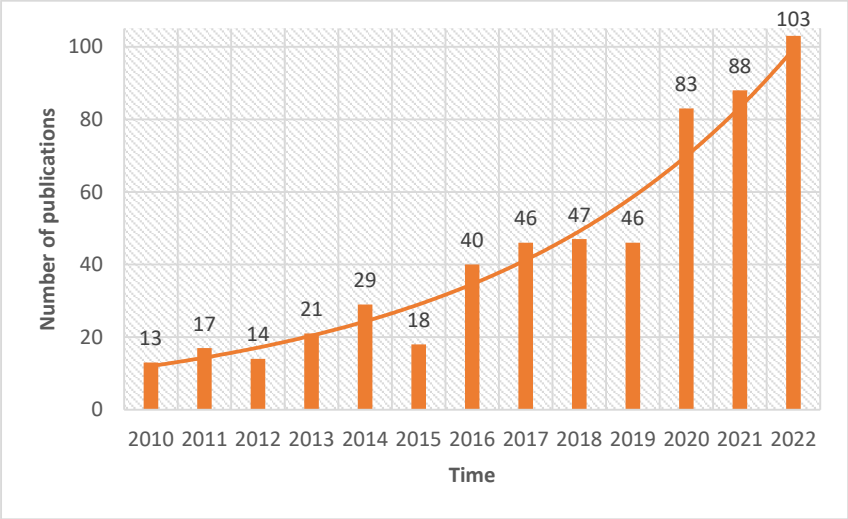

Figure 3. Trends of attention recovery studies published in the past decade.

Through the statistical analysis of literature sources with the tools of the database, it is found that *International Journal of Environmental Research and Public Health* published the most papers. *Frontiers in Psychology*, *Urban Forestry Urban Greening*, *Sustainability*, *Journal of Environmental Psychology*, and other journals followed. It can be seen that in recent years, public environmental health, psychology, urban green space, sustainability, and other relevant journal topics have paid more attention to the study of attention restoration design.

3.1.3. Keyword Atlas Analysis

A total of 571 literature records were imported into the knowledge graph software, and the software was run as a "keyword" node, corresponding to Descriptors and Identifiers in Web of Science, PubMed, Google Scholar, and PsycINFO database records. The threshold was set to 20, Timespan was set to 2010–2022, and the time slice was set to 1. The time slice selected the top 50 studies of each time slice, and node N = 186 was finally obtained, among which the topics that appeared more than 100 times were benefit, environment, stress, exposure, preference, and health. Finally, the line E = 1061 was obtained, indicating that there are more cross-studies among various topics and a strong correlation. With the gradual deepening of the research, the main keywords with high frequency gradually expanded to other related topics. Examples include "environmental psychology", "biophilic design", "directed attention", "nature exposure", and "health benefits" Keywords such as "benefit", "perceived restorative", and "SRT" continued to be the focus of research in 2019–2022 (Figure 4). Subject words with node N > 20 were selected, classified, and summarized in terms of the three directions of effect subject, effect object, and effect mechanism (Table 2). Among them, nodes with centrality greater than 0.1 are called key nodes. There were four key nodes: Attention, Response, Environment, and Landscape. In summary, the research showcases the evolution of the literature and research trends in the specified field, highlighting key topics, their interconnections, and the depth of investigation. It also suggests a continuous focus on certain core keywords alongside the emergence of new and related topics.

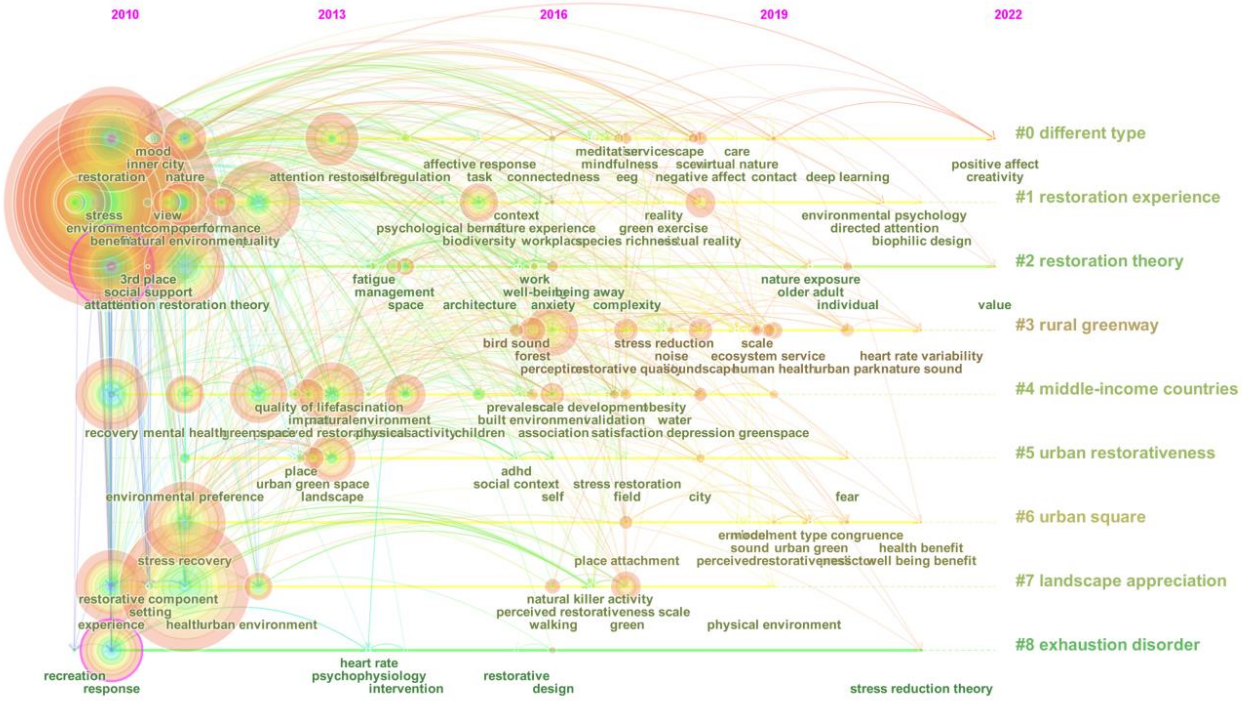

Figure 4. Timeline of keyword and cluster analysis.

Table 2. Clustering analysis of keywords in attention recovery based on node N > 20 in the CiteSpace5.8.R3 computing network.

Effect Object			Effector			Effect Mechanism		
Subject Word	**Total**	**Centrality**	**Subject Word**	**Total**	**Centrality**	**Subject Word**	**Total**	**Centrality**
Stress	142	0.03	Environment	149	0.1	Benefit	174	0.09
Preference	108	0.08	Restorative Environment	99	0.06	Exposure	121	0.09
Health	106	0.08	Green Space	48	0.09	Restoration	90	0.06
Attention	74	0.17	Urban	44	0.02	Stress Recovery	69	0.07
Response	54	0.12	Natural Environment	42	0.05	Experience	60	0.08
Perception	42	0.05	Landscape	42	0.1	Perceived Restorativeness	56	0.06

3.1.4. Knowledge Base Analysis

Applying the database, this research systematically selected and integrated literature based on relevance and citation frequency. Subsequently, this research compiled a list of ten highly cited papers in the field of attention recovery from international sources, each of which was cited more than 100 times in the past decade. These papers serve as crucial theoretical references for studies related to attention recovery (Table 3). Analyzing recent literature and findings from relevant authors in the past decade reveals a consistent focus on specific types of natural environments. The balance between artificial intervention in natural environments and entirely wild environments is approximately 1:1. Nevertheless, there is limited research on urban environments. Exposure durations for environmental testing vary significantly, typically spanning from 1 min to 4 h, with 10–15 min being the most prevalent duration. SRT proposes that exposure to certain natural environments can mitigate the physical, psychological, and behavioral effects of stressors. However, the majority of articles do not incorporate stressors in their studies. In the limited studies that incorporated stressors, these stressors encompassed cognitive tests conducted by Brown (2013) and Hartig (2003) [8,9], mild electric shocks administered by Hedblom et al. (2019) [10], arithmetic tests employed by Valtchanov and Ellard (2010), and the organization of stressful film clip viewings by Park et al. (2020) [11,12]. Notably, Sonntag et al. (2014) did not introduce stressors but instead focused on subjects from high-stress groups [13].

The literature cited in these studies collectively underscores the profound influence of natural experiences on human mental health and cognitive function. These studies offer valuable interdisciplinary and experimental insights, emphasizing the restorative attributes of nature, the potential influence of sound, and the necessity to investigate natural environments with attention-restoring qualities. Furthermore, these studies stressed the significance of a robust theoretical framework and research methodologies in attention recovery research, furnishing a fundamental theoretical foundation and reference for future investigations. Although the current research is dispersed across various fields, including psychology, engineering, physiology, medicine, and environmental science, concentrating on the overarching theme of this emerging field, rather than delving into specific details, facilitates the integration of research content. Moreover, a balance between theoretical and empirical research should be achieved, but currently there exists no model or framework to guide the development of measures or methods for creating restorative natural environments. Furthermore, it is crucial to strike a balance between theoretical and empirical research. However, currently, there is a lack of a comprehensive model or framework to guide developing measures or strategies for creating restorative natural environments.

Table 3. Hot literature on attention recovery in the past decade.

Author	Publication Time	Cited Frequency	Article Title	Research Content
Markevych	2017	866	Exploring pathways linking greenspace to health: Theoretical and methodological guidance	The paper explores the interdisciplinary evidence linking green spaces to health.
Keniger, L.E.	2013	556	What are the Benefits of Interacting with Nature?	The study constructs new typologies of human–nature experiences and employs them to assess the benefits of human–nature interaction.
Bratman, G.N.	2012	526	The impacts of nature's experience on human cognitive function and mental health	The synthesis of multiple disciplines outlines how exposure to nature and an individual's preference for nature may influence the impact of the environment on mental functioning.
Tyrvainen, L.	2014	499	The influence of urban green environments on stress relief measures: A field experiment	The paper experimentally investigated the psychological and physiological effects of short-term visits to urban natural environments.
Bratman, G.N.	2019	461	Nature and mental health: An ecosystem service perspective	The paper extends the assessment of ecosystem services to mental health and proposes a heuristic conceptual model for this purpose.
Berman, M.G.	2012	389	Interacting with nature improves cognition and affects individuals with depression	The study experimentally investigated the benefits of nature walks in patients with major depressive disorder (MDD).
Carrus, G.	2015	387	Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting, urban and peri-urban green areas	Field studies assessed the benefits and subjective well-being of urban residents accessing four different types of green space.
Ohly, H.	2016	260	Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments	The study experimentally explores the mechanism of environmental restorative experience.
Ratcliffe, E.	2013	204	Bird sounds and their contributions to perceived attention restoration and stress recovery	The study found a relationship between bird calls, the most common type of sound in nature, and attention recovery.
Van den Berg, A.E.	2014	193	Evaluating restoration in urban green spaces: Does setting type make a difference?	The study examines the storability of urban public spaces with varying degrees of greening. The results indicate that the restoration of urban public spaces depends on individuals' perceived needs and the physical characteristics of the environment.

3.2. Qualitative Analysis

3.2.1. Summary of Empirical Research Based on Quantitative Analysis

Through meta-analysis of the existing research literature, it can be seen that most researchers have quantified individual psychological and physiological indicators with the help of empirical research methods, including the observation method, conversation method, test method, experiment method, and case method. Experimental sites are divided into the laboratory and field. The test groups include college students, high school students, children, ordinary adults, and patients. The content of the test includes people's psychological reactions, physiological reactions, and cognitive performance [12].

(1) Research Methods and Steps

Experimental methods are commonly employed in attention recovery studies because they allow researchers to control for unrelated variables in a specific environment. This control is essential for investigating the intricate mental processes involved in attention recovery. Researchers frequently utilize experimental methods to intentionally expose

subjects to specific stimuli in a highly controlled environment, eliciting psychological and physiological responses. Following the presentation of the stimulus, researchers analyze the subjects' responses through direct observation, face-to-face conversations, and comprehensive questionnaire tests. Previous studies predominantly employed experimental methods in laboratory settings, conducting randomized controlled experiments to generate empirical data for attention recovery research. Experimental stimuli encompassed sound, analog images, and videos. Emfield and Neider conducted a study in which participants completed a battery of stress tests. Subsequently, participants were exposed to images of a designated environment as part of a restorative experiment. Finally, cognitive tests were administered to assess the recovery effects. Some of these studies incorporated sound variables alongside visual stimuli [13]. Evensen et al. investigated the restorative effects of various environmental settings on subjects using window views [14]. Some studies were conducted in real-world outdoor environments. For instance, in 2015, Bratman et al. investigated the attention-restoring effects of nature by observing how subjects interacted with natural settings, such as walking or jogging in natural surroundings [15]. Some studies also employ a case study approach, aiming to investigate and comprehend the long-term psychological changes in the test group. For instance, in 2015, Pilotti et al. conducted a video-based study on the environmental restorative effects of the test subjects. They also carried out a prolonged follow-up to enhance experimental accuracy [16]. In the current era of rapid technological development, virtual natural environments emerge as a potential solution. The experimental conditions and scenarios in virtual environments have become crucial for studying attention recovery in recent years. Researchers can precisely manipulate variables as needed, making this approach suitable for investigating attention recovery in various fields, including urban planning, medical facilities, and educational environments.

(2) Classification of Environment Types

Various studies encompass different environmental types, which can be broadly categorized into three groups: natural environments, urban environments, and mixed environments. In the realm of psychological research, these distinct environmental types exhibit varying impacts on attention recovery. The majority of studies delve into these three main environmental categories to investigate their differential roles in regulating attention recovery. Research consistently indicates that natural environments are generally deemed to be more restorative, and contact with such environments is beneficial for human health and well-being. Beyond the direct influence of environmental quality, the natural environment contributes positively, primarily by enhancing stress and emotional regulation [17]. Being in nature also yields favorable effects on physiological responses, including blood pressure, heart rate, skin conductivity, muscle tone, and cortisol levels [18]. Additionally, a multitude of studies have demonstrated that landscapes incorporating natural elements as stimuli are more restorative compared to those featuring artificial elements [19]. Consequently, many scholars employ natural environments as exemplars of restorative settings in their research. For instance, Beute (2014) examined the impact of nature on attention recovery through empirical research, while Bowler (2010) and Bratman (2015) investigated the positive effects of green spaces on mood enhancement and cognitive function improvement [16,20–22].

Urban environments, characterized by busy streets, crowded spaces, and tall buildings, often harbor potential stress-inducing factors when compared to natural surroundings. While urban environments may not offer the same level of restoration as natural settings, they do provide unique aesthetic experiences that can capture a portion of one's attention. Some researchers have even discovered that attention can be captivated by artificial objects that exhibit visual properties resembling those found in nature. Substituting a natural object with an artificial one possessing similar properties (e.g., color, shape, sound, etc.) can produce a comparable restorative effect [23]. Thus, creating a restorative built environment entails incorporating elements with natural qualities. These natural qualities in a space are not merely achieved through nature simulation but can also involve providing analogous properties (such as structural complexity and cohesion) abstractly to simulate nature,

thereby promoting stress relief. Understanding these principles is paramount in designing restorative urban environments. In recent years, an increasing number of scholars have shifted their research focus from natural environments to urban settings. For instance, Lyu (2022) examined the spatial characteristics within workplaces conducive to enhancing employee work efficiency and mental health [24]. Jeon (2021) explored the potential restorative effects of urban soundscapes [25]. Furthermore, Sonntag et al. (2014) conducted experimental research investigating the disparities in the impact of urban and natural environments on visitors' attention levels and physiological responses [13].

A hybrid environment combines elements of both natural and urban settings, such as a city park or a view that blends both aspects. Research indicates that such mixed environments also exhibit a degree of restorative potential, attributed to the diverse composition of these spaces, which enhances their visual appeal. This heightened attraction contributes to memorable and pleasurable experiences, fostering creativity and cognitive abilities. The richness of content within mixed environments can elevate individuals' sense of pride and belonging, consequently reducing stress levels and improving mood. For instance, studies conducted by Evensen (2015) explored the restoration effects of window views within mixed environments [15,26]. These investigations offer valuable insights into the incorporation of natural elements into urban landscapes to enhance human well-being.

(3) Evolution of Measurement Methods

The most common tool for assessing the restorative potential of the environment is the Perceptual Recovery Scale or its variants. The restorative impact of the environment on an individual can be gauged using psychological questionnaire scales. Hartig and Korpela, among others, initially developed the Perceptual Recovery Scale, which was subsequently modified by Herzog and Colleen. Each scale required participants to assess various dimensions based on their emotional responses to the environment. In their 2014 study, Van den Berg and Jorgensen utilized the self-rated Restorative Scale (RS), while Laumann in 2001 and Stevens in 2014 employed the Restorative Component Scale (RCS) [27–29]. The development and research details of the Perceptual Recovery Scale are presented in Table 4.

Table 4. Development and research contents of the Perceptual Recovery Scale.

Theory	Author	Time	Content
PRICE	Hartig	1997	To measure the restorative nature of human-environment interaction, Hartig et al. developed the Perceptual Recovery Scale (PRS) to measure the quality of the restorative environment.
RCS	Laumann	2001	To make up for the shortcomings of PRS, Laumann et al. developed another set of environmental recovery component rating scales, which were named the Recovery Component Scale (RCS) in subsequent studies.
RS	Han K T	2003	Han K T et al. developed a reliable and effective self-assessment method for the quality of natural environment restoration, called the self-assessment Restoration Scale (RS).
PRCQ	Pals	2009	Pals et al. believe that zoos have restorative features in addition to natural environments. Based on PRS and RCS, they designed the Perceptual Restorative Feature Scale (PRCQ) for five kinds of restorative features of zoo attractions.
PDRQ	Lehto	2013	From the perspective of tourists, based on the theory of attention recovery, a 30-item PDRQ was developed.

Due to the subjectivity of psychological questionnaire scales, researchers have increasingly explored objective assessments of physiological indicators related to attention fatigue and recovery. Biologists have identified two divisions within the human autonomic nervous system (ANS): the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). Stress induces various changes in the human autonomic nervous system. Specifically, stress leads to an increase in sympathetic nervous system (SNS) activity and a decrease in parasympathetic nervous system (PNS) activity. Wearable physiological monitoring systems offer advantages over subjective reports, as they can overcome the limitations associated with subjectivity. Research outcomes frequently involve measuring physiological signals and stress-related indicators such as EEG, EMG, EDA, HR (heart rate),

RR (respiratory rate), HRV (heart rate variability), and BPR (blood pressure). The most frequently used measures include heart rate (HR) and blood pressure (BPR). Additionally, Kang et al. (2022) and Park et al. (2007) assessed cerebral blood flow [30,31]. Zeng et al. (2020) assessed oxygen concentrations before and after the experiment [32]. Kobayashi (2019) and Yu et al. (2018) evaluated salivary alpha-amylase levels [33,34]. Genole et al. (2016) assessed salivary testosterone levels [35]. Li et al. (2011) determined the concentrations of adrenaline and dopamine in urine [36]. Hassan et al. (2018) and Reeves et al. (2019) recorded EEG measurements in their studies [37,38]. Despite substantial variability in the measured variables, no significant differences were observed in the results. Blood pressure was the most frequently employed measure in this research, with approximately half of the previous literature studies utilizing it. Nevertheless, blood pressure has demonstrated low sensitivity, and a substantial body of research suggests that heart rate (HR), heart rate variability (HRV), and salivary cortisol are more appropriate for measuring physiological indicators in this context [39,40].

3.2.2. Analysis of Research Fields Based on Action Mechanism

The process of attention recovery can be defined as a multi-stage experience process, which starts with attention recovery to reduce negative emotions and increase a series of positive emotions [41]. The information provided by the environment can be divided into different types of stimuli according to people's feelings. Stimuli are defined as factors that can affect human organic activities [42]. Individuals can perceive the stimuli of the surrounding environment through basic perception such as vision, hearing, touch, and smell, and produce a series of physiological, psychological, and cognitive reactions [43]. The mechanism model is shown in Figure 5. Previous research fields mainly focus on psychological recovery, physiological recovery, and cognitive recovery [23,44].

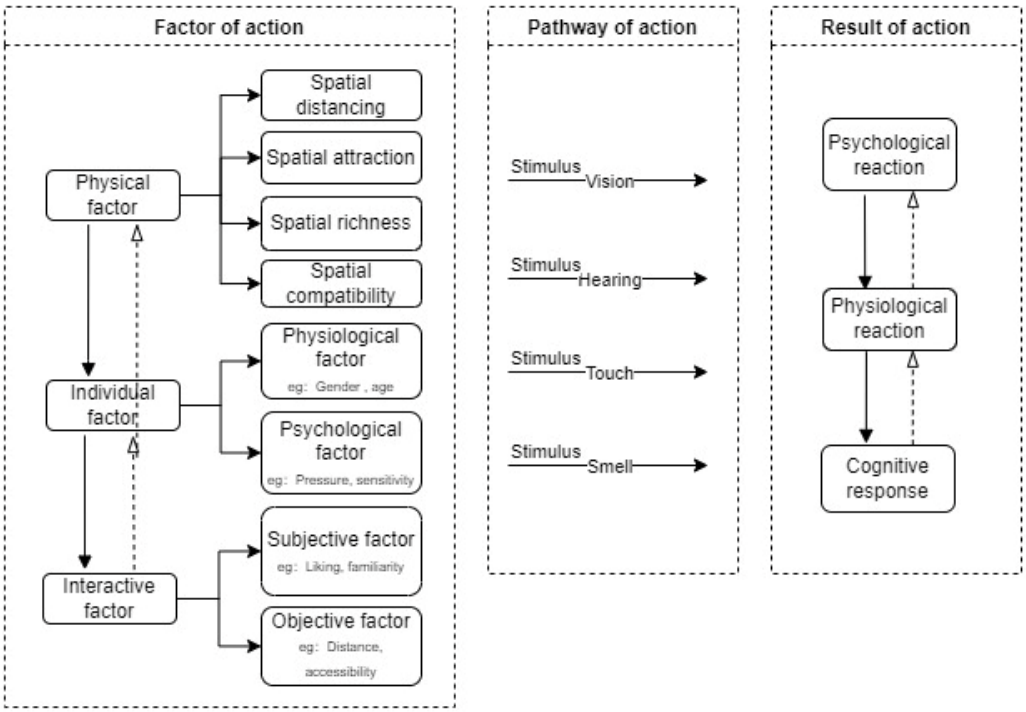

Figure 5. Mechanism model of attention recovery.

(1) Subjective Exploration of the Psychological Level

The keywords in psychological recovery research encompass terms such as "Stress", "Preference", "Restoration", "Psychological", and "Mental", among others. Typically, this research relies on psychological questionnaires to subjectively assess the psychological responses of participants. Psychological recovery studies have commonly explored both

directed and undirected attention [45]. Directed attention involves the intentional allocation of brain resources toward objects or areas linked to specific goals and tasks. Conversely, undirected attention is a cognitive resource that is spontaneously drawn toward salient stimuli without conscious control [42]. This study examines both attention consumption and recovery mechanisms, investigating how replenishing attention resources impacts psychological recovery. Research has demonstrated that prolonged directed attention can result in mental fatigue and, in severe cases, lead to significant mental health issues [7]. The restoration of attention resources leads to a reduction in negative emotions, providing individuals with a renewed sense of security and happiness. The restoration of attention resources can alleviate feelings of burnout, boredom, frustration, and anxiety, leading to positive changes that can benefit mental health [46]. In situations where individuals experience negative emotions due to stress, the environment can aid in reestablishing their focus and improving their mood, resembling a form of psychotherapy. For instance, intriguing and innovative spatial designs can offer individuals a sufficiently enriching spatial experience, allowing them a temporary respite from negative emotions. When the environmental conditions offer individuals a sufficient sense of security and comfort, their psychological state can relieve pressure through sensory healing and transition into the recovery stage.

(2) Objective Exploration on the Physiological Level

The key terms in physiological recovery research include "Health", "Exposure", "Experience", and "Association". This research typically builds upon psychological recovery and delves deeper into identifying physiological indicators for the objective assessment of attention fatigue and recovery. For instance, neuroimaging techniques like functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) are employed to monitor changes in cortical activation during attention recovery and to measure hormone concentrations, such as adrenaline, serotonin, and dopamine, which play roles in regulating attention recovery. Research indicates that attention restoration can reduce stress and fatigue, enhancing physical functioning [47]. This process can lower stress hormones, including heart rate, pulse rate, blood pressure, salivary cortisol, and adrenaline, alleviating physical stress. Additionally, it aids in balancing metabolism, decreasing the likelihood of heart disease, cardiovascular and cerebrovascular diseases, and other stress-related conditions [48]. Physiological and mental health are interconnected, influencing each other significantly. Positive mental health boosts the immune system, motivating physical activity and enhancing overall well-being [49]. Simultaneously, maintaining physical health is crucial for mental well-being.

(3) Validation Research on a Cognitive Level

Key terms in cognitive recovery research include "Attention", "Response", "Performance", and "Perception". Cognitive recovery is the most direct outcome of replenished attention resources. Researchers frequently assess task performance both before and after attention recovery. They also engage in long-term tracking and observation of cognitive behavior. Studies have shown that the relationship between attention recovery and cognitive ability lies in its support for work efficiency and sustainability. If attention resources are not supplemented in time, people may experience memory decline, slower reaction speed, increased error rate, etc., thus leading to a negative attitude towards cognitive tasks [50]. On the contrary, timely replenishment of attention resources can keep people's cognitive ability at an optimal level, and regular attention recovery is conducive to promoting sustainable utilization of cognitive resources, which is crucial for long-term and sustainable work [51]. The recovery of attention also has a series of positive knock-on effects, such as the ability to complete work tasks by providing continuous resources of attention, which in turn increases self-confidence and self-identity, and finally increases enthusiasm and motivation for work. In addition, innovation is a key skill in the knowledge age, and the process of innovation often requires a high degree of concentration. Abundant resources of directed attention are essential for those who engage in mental work for a long time [51].

3.2.3. Development Process and Trend Analysis Based on Research

(1) Review of the Development Process of Attention Recovery Research

Through a comprehensive review of the existing research literature and content, it is evident that the research process can be divided into three distinct stages (Figure 6):

① First Stage: Investigating Psychological and Physiological Recovery Mechanisms Guided by Attention Recovery.

In the initial research phase, scientists concentrated on the psychological and physiological mechanisms of attention recovery, crucial for comprehending the consumption and replenishment of attention resources. In this research phase, significant background and theoretical frameworks provide essential support. Kaplan's Attention Restoration Theory (1989) posits that exposure to natural environments promotes the recovery of directed attention, highlighting nature's role in replenishing attention resources and reducing mental fatigue [4]. Baumeister et al.'s Resource Exhaustion Theory (1998) asserts that self-control and concentration utilize limited cognitive resources, emphasizing the importance of recognizing these limitations in studying attention recovery [5]. Studies on neural mechanisms, including the utilization of techniques like functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) to monitor brain activity during attention recovery, have established a scientific foundation for this process [28]. During this stage, theoretical and empirical studies related to attention recovery mechanisms are particularly active. For instance, Kaplan (1995) delved into the mechanism of directed attention and its influence on emotional and cognitive performance, supported by existing experiments [5]. In 2013, Kirshbaum et al. conducted a study involving 25 patients experiencing moderate to severe fatigue [52]. This research, grounded in ART, employed non-pharmacological interventions aimed at alleviating the patients' illness-related discomfort. Ultimately, it offers valuable theoretical insights for the practical application of related research in clinical settings [52].

② Second Stage: Investigating the Impact of Various Environmental Types on Attention Recovery.

As research advanced, the focus shifted toward understanding the environmental influence on attention recovery. ART continues to be pivotal in this research stage, underscoring the influence of environmental factors [5]. Research in environmental psychology exploring how diverse environments (urban, natural, and mixed) impact human behavior and cognition offers a theoretical foundation for understanding the influence of environmental traits on attention recovery [30]. Researchers like Mark Berman have extensively investigated the impact of urban environments and persistent stressors on attention fatigue, highlighting the significance of bolstering environmental resilience [9]. At this stage, research predominantly centered on the interaction between various environmental types and attention restoration. For instance, Kaylin Adamson (2018) investigated the impact of different plant variables in office spaces on cognitive performance [53]. In a 2018 experiment, Jason investigated the influence of natural elements and auditory stimuli on individuals' attention recovery [54]. This exploration involved various sets of independent variables, such as combinations of natural photos with natural sounds, natural photos with classical music, and natural photos with classical music along with city scenes.

③ Third Stage: Practical Application in Different Contexts

In recent years, advancements in psychology, clinical medicine, and related disciplines have revealed that attention's restorative impact varies significantly across the human lifespan. Additionally, different social groups experience varying recovery intensities influenced by their unique factors. Distinct attention consumption patterns and recovery needs emerge among children, adolescents, adults, and the elderly due to physiological, cognitive, and experiential differences [38]. Practical research in fields like architecture, planning, and clinical psychology has increasingly focused on diverse groups, laying the theoretical groundwork for further attention recovery applications. This shift has led to attention to recovery studies exploring practical implications for different demographics. Notably, scholars such as Farhan Asim and Venu Shree integrated ART with biological principles in 2019 [55]. Their work delved into the relationship between psychological

recovery and nature, examining the influence and importance of various built environments in student dormitories on psychological recovery. Similarly, in 2012, Judith investigated design strategies aiming to enhance workplace happiness and attention levels, drawing from the biophile design theory and attention recovery concepts [56].

Overall, attention recovery research across the three stages mentioned has established a solid theoretical foundation, offering valuable guidance for advancing and refining relevant theories. However, the existing research accumulation still presents certain gaps, limiting its applicability in design practices. Notably, restorative environment theory has predominantly focused on outdoor landscapes, with limited application in indoor environment design. Consequently, there is a pressing need for research on attention restoration in artificial settings. The ultimate aim of this field is to translate fundamental attention restoration research into practical architectural design applications. This approach can reshape research content patterns and drive the future development of human-centered building environments.

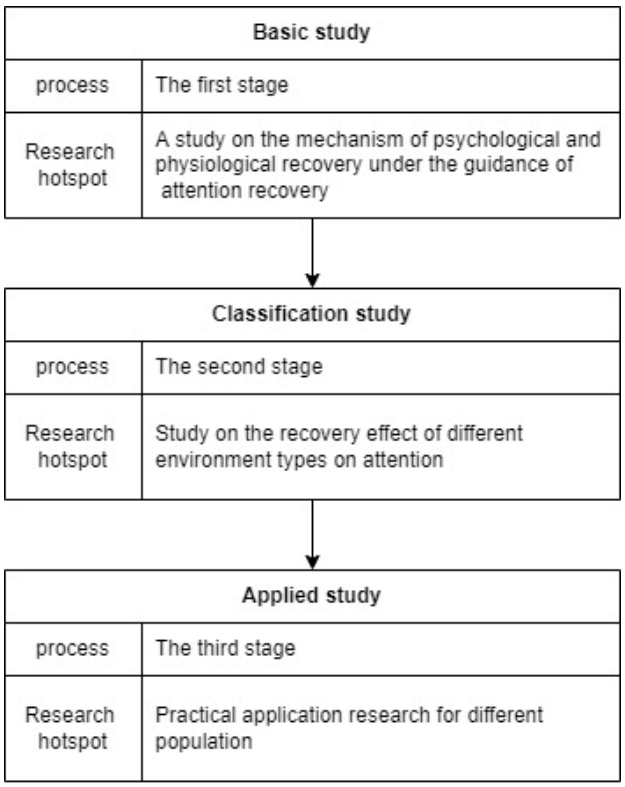

Figure 6. Research process diagram.

(2) Trends in Attention Restoration Research

① Analysis method: From quantitative analysis to the combination of quantitative and qualitative analysis

In the early literature, research often integrated multiple disciplines such as environmental science, psychology, and sociology. Based on the relevant theories of attention recovery, this study sets up various experimental scenes or controls different research independent variables to further study the promoting effect of environmental types and environmental elements on human attention recovery. Then, evidence is gathered through psychological questionnaire surveys and other ways, aiming at quantitative analysis of subjective feelings [57]. However, in recent years, more research has been based on quantitative analysis. The research combines literature analysis, case analysis, participation experience, and other non-quantitative means and methods, discusses and studies the problem from a theoretical perspective, and finally puts forward countermeasures and suggestions. For

example, Ming Lu explored the design strategy of a restorative campus based on students' perceived preferences in 2019 [58].

② Research subjects: The transition from the natural environment to the urban environment

In the early stage of research, scholars often regarded the natural environment and the urban environment as two kinds of opposite environments. The main purpose was to investigate the advantages of the natural environment over the urban environment in promoting mental health [59]. As the study progressed, the researchers discovered how difficult it was to create an entirely natural environment in a highly urbanized area. Resilience is not only a special property of the natural environment but also a spatial property. Beautifully designed and attractive built environments have restoration benefits similar to those of natural environments. Therefore, the main research direction is to integrate the natural environment into planning and design with the artificial environment as the carrier, and finally create an acquired restorative environment [2]. Therefore, scholars began to explore the restorative space design of different building types, such as residential buildings, office buildings, schools, and hospitals, based on the previous theoretical basis. For example, Smith studied and discussed the design of an open office based on the ART and biophile theory in 2013 [60]. In The Green Office, Elzinga studied and discussed the effect of office plants on relieving mental fatigue and stress [61].

③ Limiting factors: From the overall environment to a single environmental element

Most of the research is based on the influence of the overall natural environment or artificial environment on human physical and mental health because the early research is limited by the knowledge background. With further research, scholars began to study how individual environmental factors affect human psychological perception. These environmental elements include cultural background, visual arts, window views, space openness, interior landscape, color design, sound design, and interior environmental quality. For example, Myers studied the restorative effects of visual arts and place culture in 2020 [62]. Evensen analyzed the influence of windowless landscape elements on computer workers in 2015 [15]. Adamson explored the promoting effect of indoor landscape on individual cognitive performance in 2019 [53]. In 2020, Amirbeiki studied the influence of exposure to natural blue elements on the psychological recovery of college students [63]. Ratcliffe studied the restorative effect of sound production in 2021 [64]. Shengxian Kang studied the influence of indoor environment quality on the work efficiency of open scientific research office spaces in 2017 [65].

4. Conclusions

In recent years, attention recovery research has gained significant attention from scholars globally, with the body of related studies growing year by year. The fundamental characteristics of restorative environments offer a theoretical foundation for creating artificial environments with restorative qualities. Strategically applying attention restoration theory (ART) can address issues related to excessive stress and low work efficiency in society. Numerous studies have highlighted the advantages of implementing attention recovery theories in architecture. However, a thorough analysis of the knowledge landscape reveals that many studies of attention recovery have not yet translated into practical applications, and certain challenges require further investigation and resolution:

(1) Standardized Guidelines: The development of standardized guidelines for applying attention restoration theory (ART) in architectural practice could help overcome the inherent subjectivity of design strategies. These guidelines should consider diverse cultural backgrounds and empirical evidence to ensure their applicability across various contexts.

(2) Real-World Studies: While laboratory studies provide valuable insights, efforts should be made to conduct research in real-world environments to better understand the impact of attention recovery interventions. Researchers should strive to replicate

natural settings and conditions as closely as possible to improve the validity and relevance of findings.

(3) Diverse Sample Populations: To enhance the generalizability of research findings, future studies should prioritize diverse sample populations. This includes individuals from different age groups, cultural backgrounds, occupations, and lifestyles to capture a broader range of cognitive responses and experiences.

(4) Multi-Sensory Stimulation: Expanding the scope of research to include multi-sensory stimulation can enrich individuals' experiences and enhance attention recovery outcomes. Researchers should explore the potential of auditory, tactile, and olfactory stimuli in addition to visual stimuli to create more holistic and effective interventions.

(5) Interdisciplinary Collaboration: Encouraging interdisciplinary collaboration between psychologists, architects, urban planners, and other stakeholders can foster innovation and holistic approaches to addressing attention recovery challenges. By leveraging diverse expertise and perspectives, comprehensive solutions can be developed to enhance the restorative qualities of built environments.

By implementing these solutions, researchers can overcome existing challenges and advance the practical application of attention recovery theories, ultimately contributing to the creation of healthier and more supportive environments for individuals.

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References

1. Wang, S. *Research on Design Strategy of University Campus Space Environment in Cold Regions with Attention Restoration Goal*; Harbin Institute of Technology: Harbin, China, 2020.
2. Ulrich, R.S.; Simons, R.F.; Losito, B.D.; Fiorito, E.; Miles, M.A.; Zelson, M. Stress recovery during exposure to natural and urban environments. *J. Environ. Psychol.* **1991**, *11*, 201–230. [CrossRef]
3. Yin, J.; Yuan, J.; Arfaei, N.; Catalano, P.J.; Allen, J.G.; Spengler, J.D. Effects of the biophilic indoor environment on stress and anxiety recovery: A between-subjects experiment in virtual reality. *Environ. Int.* **2019**, *136*, 105427. [CrossRef]
4. Kaplan, R.; Kaplan, S. *The Experience of Nature: A Psychological Perspective*; Cambridge University Press: Cambridge, UK, 1989.
5. Kaplan, S. The restorative benefits of nature: Toward an integrative framework. *J. Environ. Psychol.* **1995**, *15*, 169–182. [CrossRef]
6. Korpela, K.M.; Klemettilä, T.; Hietanen, J.K. Evidence for rapid affective evaluation of environmental scenes. *Environ. Behav.* **2002**, *34*, 634–650. [CrossRef]
7. Berto, R. The role of nature in coping with psycho-physiological stress: A literature review on restorativeness. *Behav. Sci.* **2014**, *4*, 394–409. [CrossRef] [PubMed]
8. Brown, D.K.; Barton, J.L.; Gladwell, V.F. Viewing nature scenes positively affects recovery of autonomic function following acute-mental stress. *Environ. Sci. Technol.* **2013**, *47*, 5562–5569. [CrossRef] [PubMed]
9. Hartig, T.; Evans, G.W.; Jamner, L.D.; Davis, D.S.; Garling, T. Tracking restoration in natural and urban field settings. *J. Environ. Psychol.* **2003**, *23*, 109–123. [CrossRef]
10. Hedblom, M.; Gunnarsson, B.; Iravani, B.; Knez, I.; Schaefer, M.; Thorsson, P.; Lundstrom, J.N. Reduction of physiological stress by urban green space in a multisensory virtual experiment. *Sci. Rep.* **2019**, *9*, 10113. [CrossRef] [PubMed]
11. Valtchanov, D.; Ellard, C. Physiological and affective responses to immersion in virtual reality: Effects of nature and urban settings. *J. Cyber Ther. Rehabil.* **2010**, *3*, 359–373.

12. Park, B.J.; Tsunetsugu, Y.; Kasetani, T.; Kagawa, T.; Miyazaki, Y. The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. *Environ. Health Prev. Med.* **2010**, *15*, 18–26. [CrossRef]
13. Sonntag-Ostrom, E.; Nordin, M.; Lundell, Y.; Dolling, A.; Wiklund, U.; Karlsson, M.; Carlberg, B.; Slunga Jarvholm, L. Restorative effects of visits to urban and forest environments in patients with exhaustion disorder. *Urban For. Urban Green.* **2014**, *13*, 344–354. [CrossRef]
14. Emfield, A.G.; Neider, M.B. Evaluating visual and auditory contributions to the cognitive restoration effect. *Front. Psychol.* **2014**, *5*, 548. [CrossRef] [PubMed]
15. Evensen, K.H.; Raanaas, R.K.; Hagerhall, C.M.; Johansson, M.; Patil, G.G. Restorative elements at the computer workstation: A comparison of live plants and inanimate objects with and without window view. *Environ. Behav.* **2015**, *47*, 288–303. [CrossRef]
16. Bratman, G.N.; Daily, G.C.; Levy, B.J.; Gross, J.J. The benefits of nature experience: Improved affect and cognition. *Landsc. Urban Plan.* **2015**, *138*, 41–50. [CrossRef]
17. Pilotti, M.; Klein, E.; Golem, D.; Piepenbrink, E.; Kaplan, K. Is Viewing a Nature Video After Work Restorative? Effects on Blood Pressure, Task Performance, and Long-Term Memory. *Environ. Behav.* **2015**, *47*, 947–969. [CrossRef]
18. Browning, M.H.; Saeidi-Rizi, F.; McAnirlin, O.; Yoon, H.; Pei, Y. The role of methodological choices in the effects of experimental exposure to simulated natural landscapes on human health and cognitive performance: A systematic review. *Environ. Behav.* **2020**, *53*, 0013916520906481. [CrossRef]
19. Horiuchi, M.; Endo, J.; Akatsuka, S.; Uno, T.; Hasegawa, T.; Seko, Y. Influence of forest walking on blood pressure, profile of mood States, and stress markers from the viewpoint of aging. *J. Aging Gerontol.* **2013**, *1*, 9–17. [CrossRef]
20. Tsunetsugu, Y.; Park, B.J.; Ishii, H.; Hirano, H.; Kagawa, T.; Miyazaki, Y. Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in an old-growth broadleaf forest in Yamagata prefecture, Japan. *J. Physiol. Anthropol.* **2007**, *26*, 135–142. [CrossRef] [PubMed]
21. Beute, F.; De Kort, Y.A.W. Natural resistance: Exposure to nature and self-regulation, mood, and physiology after ego-depletion. *J. Environ. Psychol.* **2014**, *40*, 167–178. [CrossRef]
22. Bowler, D.E.; Buyung-Ali, L.; Knight, T.M.; Pullin, A.S. A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health* **2010**, *10*, 456. [CrossRef]
23. Ohly, H.; White, M.P.; Wheeler, B.W.; Bethel, A.; Ukoumunne, O.C.; Nikolaou, V.; Garside, R. Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *J. Toxicol. Environ. Health Part B Crit. Rev.* **2016**, *19*, 305–343. [CrossRef] [PubMed]
24. Lyu, K.; de Dear, R.; Brambilla, A.; Globa, A. Restorative benefits of semi-outdoor environments at the workplace: Does the thermal realm matter? *Build. Environ.* **2022**, *222*, 109355. [CrossRef]
25. Jeon, J.Y.; Jo, H.I.; Lee, K. Potential restorative effects of urban soundscapes: Personality traits, temperament, and perceptions of VR urban environments. *Landsc. Urban Plan.* **2021**, *214*, 104188. [CrossRef]
26. Stevenson, M.P.; Schilhab, T.; Bentsen, P. Attention Restoration Theory II: A systematic review to clarify attention processes affected by exposure to natural environments. *J. Toxicol. Environ. Health Part B* **2018**, *21*, 227–268. [CrossRef] [PubMed]
27. Van den Berg, A.E.; Jorgensen, A.; Wilson, E.R. Evaluating restoration in urban green spaces: Does setting type make a difference? *Landsc. Urban Plan.* **2014**, *127*, 173–181. [CrossRef]
28. Laumann, K.; Gärling, T.; Stormark, K.M. Rating scale measures of restorative components of environments. *J. Environ. Psychol.* **2001**, *21*, 31–44. [CrossRef]
29. Stevens, P. Affective priming of perceived environmental restorativeness. *Int. J. Psychol.* **2014**, *49*, 51–55. [CrossRef] [PubMed]
30. Kang, M.; Kim, S.; Lee, J. Pilot study on the physio-psychological effects of botanical gardens on the prefrontal cortex activity in an adult male group. *J. People Plants Environ.* **2022**, *25*, 413–423. [CrossRef]
31. Park, B.J.; Tsunetsugu, Y.; Kasetani, T.; Hirano, H.; Kagawa, T.; Sato, M.; Miyazaki, Y. Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest)–using salivary cortisol and cerebral activity as indicators. *J. Physiol. Anthropol.* **2007**, *26*, 123–128. [CrossRef]
32. Zeng, C.; Lyu, B.; Deng, S.; Yu, Y.; Li, N.; Lin, W.; Li, D.; Chen, Q. Benefits of a three-day bamboo forest therapy session on the physiological responses of university students. *Int. J. Environ. Res. Public Health* **2020**, *17*, 3238. [CrossRef]
33. Kobayashi, H.; Song, C.; Ikei, H.; Park, B.J.; Kagawa, T.; Miyazaki, Y. Combined effect of walking and forest environment on salivary cortisol concentration. *Front. Public Health* **2019**, *7*, 480661. [CrossRef] [PubMed]
34. Yu, C.P.; Lee, H.Y.; Luo, X.Y. The effect of virtual reality forest and urban environments on physiological and psychological responses. *Urban For. Urban Green.* **2018**, *35*, 106–114. [CrossRef]
35. Geniole, S.N.; David, J.P.F.; Euz'ebio, R.F.R.; Toledo, B.Z.S.; Neves, A.I.M.; McCormick, C.M. Restoring land and mind: The benefits of an outdoor walk on mood are enhanced in a naturalized landfill area relative to its neighboring urban area. *Ecopsychology* **2016**, *8*, 107–120. [CrossRef]
36. Li, Q.; Otsuka, T.; Kobayashi, M.; Wakayama, Y.; Inagaki, H.; Katsumata, M.; Hirata, Y.; Li, Y.; Hirata, K.; Shimizu, T.; et al. Acute effects of walking in forest environments on cardiovascular and metabolic parameters. *Eur. J. Appl. Physiol.* **2011**, *111*, 2845–2853. [CrossRef] [PubMed]

37. Hassan, A.; Tao, J.; Li, G.; Jiang, M.; Aii, L.; Zhihui, J.; Zongfang, L.; Qibing, C. Effects of walking in bamboo forest and city environments on brainwave activity in young adults. *Evid.-Based Complement. Altern. Med.* **2018**, *2018*, 9653857. [CrossRef] [PubMed]
38. Reeves, J.P.; Knight, A.T.; Strong, E.A.; Heng, V.; Neale, C.; Cromie, R.; Vercammen, A. The application of wearable technology to quantify health and wellbeing Co-benefits from urban wetlands. *Front. Psychol.* **2019**, *10*, 1840. [CrossRef] [PubMed]
39. Corazon, S.S.; Sidenius, U.; Poulsen, D.V.; Gramkow, M.C.; Stigsdotter, U.K. Psycho-physiological stress recovery in outdoor nature-based interventions: A systematic review of the past eight years of research. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1711. [CrossRef] [PubMed]
40. Kondo, M.C.; Jacoby, S.F.; South, E.C. Does spending time outdoors reduce stress? A review of real-time stress response to outdoor environments. *Health Place* **2018**, *51*, 136–150. [CrossRef]
41. Arnett, J.J. *The Neglected 95%: Why American Psychology Needs to Become Less American*; American Psychological Association: Washington, DC, USA, 2016.
42. Sedghikhanshir, A.; Zhu, Y.; Beck, M.R.; Jafari, A. The Impact of Visual Stimuli and Properties on Restorative Effect and Human Stress: A Literature Review. *Buildings* **2022**, *12*, 1781. [CrossRef]
43. Pinto, Y.; van der Leij, A.R.; Sligte, I.G.; Lamme, V.A.; Scholte, H.S. Bottom-up and top-down attention are independent. *J. Vis.* **2013**, *13*, 16. [CrossRef]
44. Menardo, E.; Brondino, M.; Hall, R.; Pasini, M. Restorativeness in natural and urban environments: A meta-analysis. *Psychol. Rep.* **2021**, *124*, 417–437. [CrossRef] [PubMed]
45. Folk, C.L.; Remington, R.W.; Johnston, J.C. Involuntary covert orienting is contingent on attentional control settings. *J. Exp. Psychol. Hum. Percept. Perform.* **1992**, *18*, 1030. [CrossRef] [PubMed]
46. Fandetti, R. *Attention Restoration Theory: Urban Versus Natural Stimuli Effects on Working Memory*; California State University: Long Beach, CA, USA, 2022.
47. Schumann, F.; Steinborn, M.B.; Kürten, J.; Cao, L.; Händel, B.F.; Huestegge, L. Restoration of attention by rest in a multitasking world: Theory, methodology, and empirical evidence. *Front. Psychol.* **2022**, *1415*, 867978. [CrossRef] [PubMed]
48. Ryan, C.O.; Browning, W.D.; Clancy, J.O.; Andrews, S.L.; Kallianpurkar, N.B. Biophilic design patterns: Emerging nature-based parameters for health and well-being in the built environment. *ArchNet-IJAR Int. J. Archit. Res.* **2014**, *8*, 62. [CrossRef]
49. Timm, S.; Dearborn, L.; Pomeroy, J. Nature and the City: Measuring the Attention Restoration Benefits of Singapore's Urban Vertical Greenery. *Technol. Archit. Des.* **2018**, *2*, 240–249. [CrossRef]
50. Stevenson, M.P.; Dewhurst, R.; Schilhab, T.; Bentsen, P. Cognitive restoration in children following exposure to nature: Evidence from the attention network task and mobile eye tracking. *Front. Psychol.* **2019**, *10*, 42. [CrossRef] [PubMed]
51. Korpela, K.; De Bloom, J.; Kinnunen, U. From restorative environments to restoration in work. *Intell. Build. Int.* **2015**, *7*, 215–223. [CrossRef]
52. Kirshbaum, M.N.; Donbavand, J. Making the most out of life: Exploring the contribution of attention restorative theory in developing a non-pharmacological intervention for fatigue. *Palliat. Support. Care* **2014**, *12*, 473–480. [CrossRef]
53. Adamson, K.; Thatcher, A. Do indoor plants improve performance outcomes?: Using the attention restoration theory. In *Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) Volume VIII: Ergonomics and Human Factors in Manufacturing, Agriculture, Building and Construction, Sustainable Development and Mining 20*; Springer International Publishing: Berlin/Heidelberg, Germany, 2019; pp. 591–604.
54. Boggs, J. *The Roles of Biophilic Attitudes and Auditory Stimuli within Attention Restoration Theory*; University of Nevada: Las Vegas, NV, USA, 2018.
55. Asim, F.; Shree, V. The impact of Biophilic Built Environment on Psychological Restoration within student hostels. *Vis. Sustain.* **2019**.
56. Green, J. Back to Nature for Good: Using Biophilic Design and Attention Restoration Theory to Improve Well-Being and Focus in the Workplace. Master's Thesis, University of Minnesota, Minneapolis, MN, USA, 2012.
57. Jaggard, C.E. *The Effect of Intentionally Engaging Attention when Viewing Restorative Environments: Exploring Attention Restoration Theory*; Indiana State University: Terre Haute, IN, USA, 2014.
58. Lu, M.; Fu, J. Attention restoration space on a university campus: Exploring restorative campus design based on environmental preferences of students. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2629. [CrossRef]
59. Yue, M.; Zhang, X.; Zhang, J. Analysis of knowledge graph of pro-nature building design and its health benefit. *South. Archit.* **2022**, *11*, 12–20.
60. Smith, L.E. Attention Restoration Theory and the Open Office: Addressing Mental Fatigue in Low Stimulus Screeners and Creative Class Workers through Biophilic Design. Master's Thesis, The Savannah College of Art and Design, Atlanta, GA, USA, 2013.
61. Elzinga, L.A.J. *The Green Office: The Influence of Plants at the Office, Effectuating a More Natural Environment, on Restoration from Mental Fatigue and Stress as Mediated by Restorative Characteristics among Office Employees*; University of Twente: Enschede, The Netherlands, 2020.
62. Myers, M.G. *Visual Art as a Restorative, Placed-Based Biophilic Coping Mechanism in the Workplace: A Case Study*; Kent State University: Kent, OH, USA, 2020.

63. Amirbeiki, F.; Khaki Ghasr, A. Investigating the Effects of Exposure to Natural Blue Elements on the Psychological Restoration of University Studentsity Students. *Iran Univ. Sci. Technol.* **2020**, *30*, 1–10.
64. Ratcliffe, E. Sound and soundscape in restorative natural environments: A narrative literature review. *Front. Psychol.* **2021**, *12*, 570563. [CrossRef]
65. Kang, S.; Ou, D.; Mak, C.M. The impact of indoor environmental quality on work productivity in university open-plan research offices. *Build. Environ.* **2017**, *124*, 78–89. [CrossRef]