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## Not all Blue-Spaces are Created Equal: Variables affecting restorative outcome of indoor blue-spaces-A scoping review

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### Abstract

The Blue-space theory suggests using water in architecture for restoration and stress reduction. Long-term stress increases the risk of mental health problems of anxiety and depression. However, not all blue spaces have the same restorative effects. This study aims to investigate the characteristic variables of restorative blue spaces through a scoping review. Papers indexed in Scopus, WoS, and Google Scholar were sought. Preferred Reporting Items for Systematic Reviews were used as a review methodology. Results showed 12 variables affecting the blue space's restorative outcome. Direct variables; size, type, colour, clarity, texture, and indirect variables; proportion, function, illumination, and geometry.

Keywords: Blue space; Mental health; Emotions; Healing spaces

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### 1.0 Introduction

Projected data shows that the most significant global crisis by 2030 is mental health and depression (WHO, 2012). Several studies worldwide have also established that the current COVID-19 pandemic is a unique factor in increasing rates of stress (Dozois, 2020; Hyland et al., 2020; Kaparounaki et al., 2020). Stress is known to contribute to mental health problems such as anxiety and depression. In this era, it has become clear to scientists that one of the biggest challenges the world is facing is mental health. However, how is mental health related to architecture?

Several approaches can be taken to address this question. One of the most well-known approaches is the theory of multi-sensory experience. Multi-sensory architecture refers to the overall spatial stimuli in built environments which can improve or impoverish the quality of experience for the occupant (Ganatra, 2022). By focusing on the occupant-centred approach, therapeutic architecture studies how to improve human experiences for a healthier mind and body connection physiologically, cognitively, emotionally, behaviorally, and spiritually. Hence, the connection between mental health and architecture is well-established to answer the above question. However, many other theories explain how architecture or environments influence our mental health. The Attention Restoration Theory (ART; Kaplan, 1995) suggests that mental health can be improved by time spent in or looking at natural elements such as green or blue space. Based on this

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theory, many papers have studied the connection between green space and mental health, and fewer studies have studied the blue space theory. One study showed that not all green spaces are equal in terms of healing effects; it presented different levels of restorative and stressful effects (Wood et al., 2018). Moreover, some evidence shows the most significant effect of blue spaces rather than green spaces when it comes to mental health (Pawlowski, 2020).

There is no universal definition of blue space. However, blue space refers to the presence of water elements in a space, creating a therapeutic effect on human emotions and physiology. It points to the healing effect of water on human emotions and mental health. It reduces stress and creates restoration (Zaino, 2020; Zaino & Abbas, 2020c, 2020a). According to Gascon et al. (2015), who conducted a systematic review about the relationship between time-spent and blue space, their research demonstrated that time-spent is a variable affecting the restorative outcomes. Another finding showed that living within 5 km of the coast improves general mental health (Garrett, Clitherow, White, Wheeler, & Fleming, 2019). This suggests that accessibility is another variable that may affect mental health outcomes. However, there is not a comprehensive study to show the characteristics of the blue spaces associated with mental health, and we still know very little about people's perceptions of blue spaces in psychological terms (Gascon, 2015) (Fiantis, 2021).

### **What is blue space theory?**

A universal definition of blue space does not exist, but it refers to the presence of water elements in a space, creating a therapeutic effect on human emotions and physiology. It points to the healing effect of water on human emotions and mental health. It reduces stress and creates restoration (Zaino, 2020; Zaino & Abbas, 2020c, 2020a).

However, one of the research papers concluded that not all green spaces are equal (in terms of healing effect) - some may have different restorative abilities. Some are not even healing but stressful (Wood et al., 2018). This observation is projected into the realm of blue spaces, and we asked the same question of whether different blue spaces can evoke different restorative effects? Logically, the answer seemed to be yes in our heads. As we started the literature review to find the answer, we found that there are several observations about blue space, and all of them say yes - not all spaces are created equal.

Nevertheless, before diving into that, it is essential to note that in this paper, we define the extent of the healing quality as "restorative outcomes". For example, according to Gascon et al. (2015), who was the first to conduct a systematic review about the relationship between time-spent and blue space, their research demonstrated that time-spent is a variable affecting the restorative outcomes. Another finding showed that living within 5 km of the coast improves general mental health (Garrett, Clitherow, White, Wheeler, & Fleming, 2019). This suggests that accessibility is another variable that may affect mental health outcomes. After knowing this, it has become clear to us, yes, there are variables affecting the restorative outcome of the blue space, which was not enough until the research concluded that research is needed and more detailed information on the characteristics of the blue spaces that promote better mental health as well as (Fiantis, 2021) wrote in his book that we still know very little about people's perceptions of blue space in psychological terms, which is why we are concerned about this issue. However, although it is justified that we need more research on the characteristics of the blue spaces, this still does not answer the question of why we should shed light on blue spaces rather than green spaces? Here is why our main intention is to maximise the healing effect of spaces as the rates of stress and depression increase, and today we have data showing that blue spaces beat green spaces when it comes to mental health (Pawlowski, 2020).

This paper aims to scope-review the variables affecting the restorative outcome of indoor blue spaces. We used scoping review to gain broader data from different fields, including environmental psychology, evidence-based design, and neuroarchitecture. Denyer and Tanfield's proposals were used to structure the methodology: (1) formulation of objectives, (2) locating studies, (3) selection of studies, (4) analysis and synthesis, and (5) the presentation of the results (Figure 1).

## **2.0 Materials and methods**

This scoping review was conducted by following the reporting checklist of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). A comprehensive literature search was undertaken to identify variables affecting blue space's ability to heal for this study. There were no scoping reviews previously conducted to identify the variables. More detailed information is needed on the characteristics of the blue spaces that promote better mental health (Gascon et al., 2015). More specifically, all the papers published until the end of March 2022 in Scopus, Google Scholar and Web of Science were sought. The title, abstract, keywords and year of publication of the identified records were exported to a MS. Excel spreadsheet. Results were discussed among three researchers. If no agreement could be achieved, the views of a fourth reviewer would have been considered. We included all review papers that, to some extent, showed that the methods they used to identify and select the literature were explicit. Also, studies that reviewed papers published in only one journal were removed. [MB4] We acknowledge that the authors of some of the papers we identified did not aim to identify the variables we are looking for. However, we still cite the variable from their research because it renders a piece of evidence for us that this particular variable has an impact on the restorative outcome of blue space. We utilised Scopus, Google Scholar and Web of Science. We conducted two searches for each database with different keywords because we had to identify two different factors as it is difficult to identify them from one search. (1) Variables related directly to blue spaces restorative outcomes. (2) Variables related to indoor experience perception (because it also affects the restorative outcome when placing the blue space indoors, such as ceiling height or organisation of water features, it may modify the restorative outcome of the blue space. Based on this, we had to identify those variables, too, as they are associated with the restorative outcome of the blue space. But not in a direct way.

The first search was conducted. Only one reviewer screened the titles and abstracts, and papers that were not considering the characteristics of blue space were disregarded, such as the effect of blue space on social issues or the effect of blue space on the elderly wellbeing. We only considered the papers related to the characteristics of blue space and restorative outcome. More specifically, we

focused on the visual characteristics of blue space. Still, we did not consider the word visual when we screened the abstracts and titles because many authors did not look at the problem from this perspective, although the visual aspect is in their paper. That is why we did not exclude papers that did not mention the visual aspect. The keywords search strategy for the first research is as follows - Scopus TITLE-ABS-KEY ((Blue space) AND (mental health) AND (interventions OR characteristics OR size OR quantity OR colour OR scale OR indoor OR organisation OR typologies)). WoS ((TI=(blue space)) AND AB=(blue space AND interventions OR characteristics OR size OR quantity OR colour OR scale OR indoor OR organisation OR typologies)) AND AK=(Blue space OR green space ). Google Scholar ((Blue space characteristics) AND (emotions) AND (mental health) AND (typology OR size OR quantity OR colour OR scale OR indoor OR organisation)).

Furthermore, a second search was conducted. Similarly, only one reviewer screened the titles and abstracts of the records, and papers with repetitive variables were disregarded; some other papers were also unrelated, so we eliminated them, such as the effect of colour on social conditions. We only considered the papers that highlighted any variable that affect the restorative outcome when experiencing an indoor architectural space. Then, the reviewer performed an eligibility assessment by carefully screening the full texts of the remaining papers. And rating the eligibility from 1-3. Whereby, (1=related), (2=maybe related), (3=not related). During this phase, we ended up with 30 related, 30 maybe and 200 unrelated. The keywords search strategy for the second research is as follows - Scopus TITLE-ABS-KEY (architecture ) AND (indoor ) AND ( emotions ) AND (mental AND health ). TI=((architecture OR interior OR space OR indoor) AND (visual )). WoS TI=((architecture OR interior OR space OR indoor) AND (visual )). Google Scholar Architecture AND indoor AND emotions AND mental health. health.

The data selected was analysed and synthesised. The content analysis-synthesis approach was selected due to its ability to interpret content and adapt to the heterogeneous nature of reviews (Hsieh & Shannon, 2005). Two approaches were followed. First, we grouped and coded the information collected from PRISMA (conventional content analysis). Second, all coded results were discussed and presented in a framework (summative content analysis). Look at Fig. 1

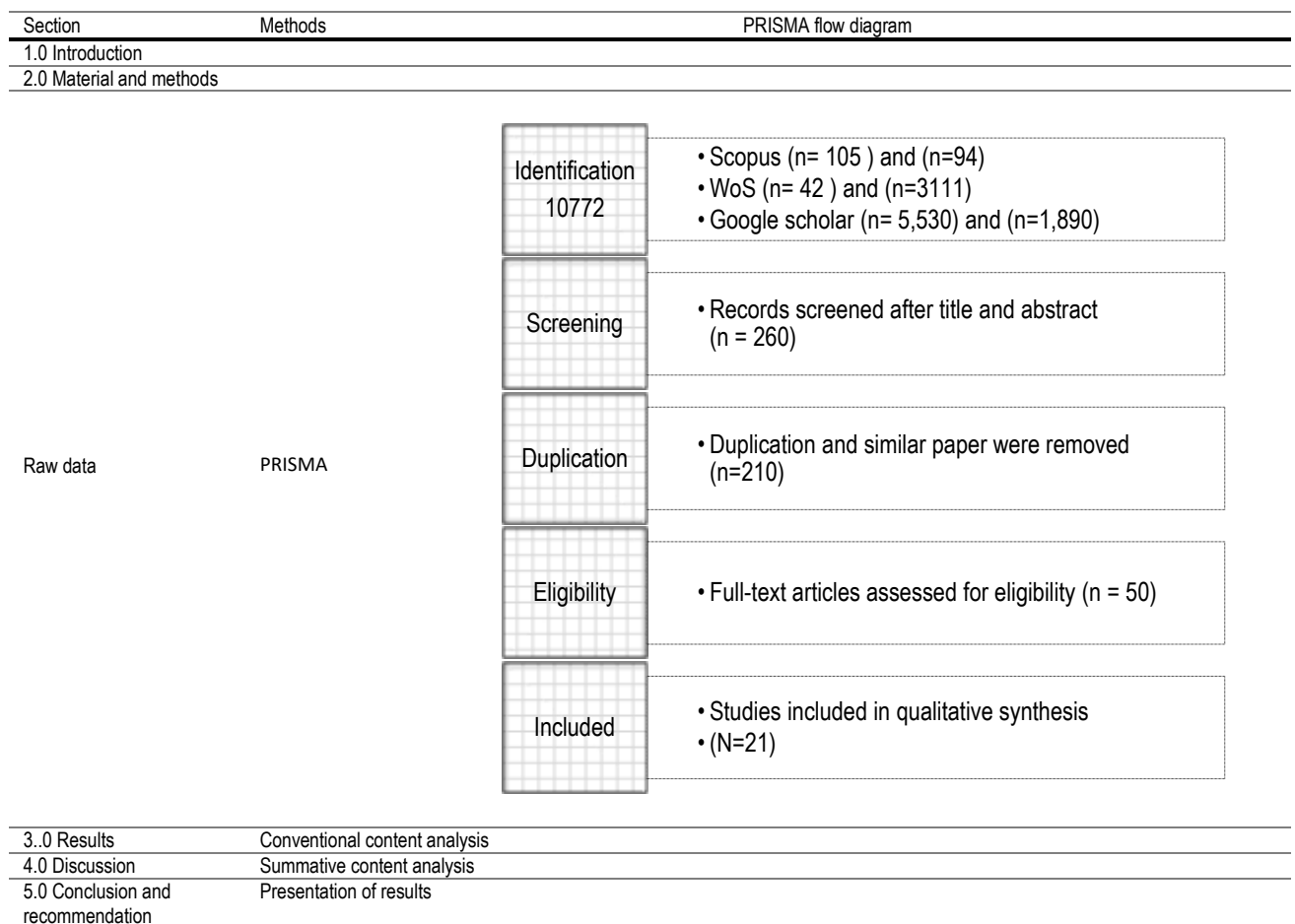


Fig. 1. Methodological structure, including PRISMA flow chart (Author, PRISMA:2022)

### 3.0 Results

The below table captures the data and codes them. It illustrates the findings of the variables affecting the blue space restorative outcome. In this section of the research, the data was organised and coded. A total of (n=21) papers were selected based on the eligibility criteria explained previously in the materials and methods. It was the results after following the PRISMA flow chart, and from a total (n=10770) papers, we selected 21 papers.

**Table 1.** Blue space characteristics concerning to mental well-being and restoration

References	Findings	Variable extracted
(Völker, Matros, & Claßen, 2016) (Houlden, Weich, de Albuquerque, Jarvis, & Rees, 2018) (Gascon, 2017)	Several studies highlighted that the amount of blue or green spaces affects health outcomes. The amount of blue space has a significant influence on health outcomes. We found no specific information on the exact amounts of water. But we found a significant effect when a green space amount is 43% and above in relation to the local area, considering that green space shares similarities in restoration with blue space. To conclude, based on the data, we believe that greater exposure to blue spaces brings out greater benefits to mental health and wellbeing	Size of blue space
(Völker, Matros, & Claßen, 2016)	There are different types of blue spaces, such as the ocean, fountain, water, pond, and lake Canal. Few studies suggested the relationship between health outcomes and different types of blue spaces. There seem to be different healing outcomes as the blue space varies. It was suggested that the amount of water in each type of blue space was a factor in modifying the therapeutic outcomes.	Type of blue space
(Smith, Croker, & McFarlane, 1995) (Pitt, 2018)	A muddy brown or yellow water has less restorative potential. Green can give rise to thoughts associated with foreboding, flood risk, or fear of drowning; collectively, it may give negative associations that cannot always be considered therapeutic. It is necessary to consider perceptions of blue space quality when considering mental health and wellbeing	Colour and clarity of blue space
When White et al. (2019)	The study explored the time spent visiting nature spaces near home acts as a mediator in the association between the level of residential greenness and perceived mental health. Findings suggest that spending at least 120 minutes a week in nature is associated with good health and wellbeing	Time spent in blue space
(Toet, Henselmans, Lucassen, & Gevers, 2011)	Motion complexity of water was found to have mildly relaxing and nondominant effects. In contrast, motion change complexity was found to be arousing and dominant. The speed of dynamics had aroused dominant and unpleasant effects. The amplitude of dynamics was also regarded as unpleasant	Dynamic textures of water
(Fairchild et al., 2018), (Cracknell et al., 2018).	Several experimental pieces of research that manipulated levels of blue space biodiversity demonstrated greater interest in more biodiverse blue spaces and greater perceived stress reduction from more biodiverse settings (Cracknell et al., 2018).	Perceived biodiversity of blue space
(Fisher et al., 2021)	Specifically, we show how certain perceived green and blue space characteristics (birdsong, perceived bird species richness, perceived naturalness, and safety concerns) contribute positively to the perceived restorativeness of a site through multi-sensory pathways. By comparing these perceptions with objective measurements (species richness of birds, biophonic and anthroponic sounds, and vegetation and water coverage),	
(Chamilothori et al., 2019)	The use to which a space is put influences its psychological evaluation	Use of space
(Meyers-Levy & Rui, 2007) (Erkan, 2018)	High ceilings inspire freedom, and low ceilings calm. High ceilings generate greater creativity and feelings of comfort. Ceiling height positively affects wayfinding	Ceiling height of space
(Todorovic, 2008)	<p>Totality The whole is different from the part. The perception of elements depends on their context</p> <p>Dialectic Establishing entities separate from their background</p> <p>Contrast The entity is better perceived if there is marked contrast with its background</p> <p>Hierarchy The greater the importance of an entity, the more hierarchical its parts are</p> <p>Birkhoff Entities with multiple axes are more positively perceived</p> <p>Symmetry To perceive features as symmetrical, around a centre point Perceiving different entities from the same ambiguous experience</p> <p>Multi-stability To assign more information to a perception than is contained in the base stimuli</p> <p>Reification To perceive forms as closed when they are not</p> <p>Completion To perceive closed forms as better</p> <p>Closure To integrate elements of entities if they are aligned</p> <p>Continuity To integrate elements of entities if they form a regular pattern</p> <p>Good Gestalt To recognise entities, regardless of transformations</p> <p>Invariance Group entities based on their proximity</p> <p>Proximity Group entities based on their similarities</p> <p>Similarity To categorise stimuli based on previous experiences</p>	Arrangement of scenes
(Environment, 1995), (Zhang, Zuo, Erskine, & Hu, 2016)	Mood and cognitive performance alter based on light parameters: colour temperature with a less negative effect on mood, improved cognitive performance, the combination of colour temperature and illuminance with better evaluation in mood, improved cognitive performance	Illumination of space
(Höge, 1995)	Emotional states affect the perception of brightness	
(Höge, 1995)	Certain ratios, such as the golden section, generate greater preference	Proportion of space
(Ruggles, 2018), (Höge, 1995), (Dzubic, Perdue, & Ellard, 2013)	Several geometric concepts are recurring. Geometrical relationships are found to be psychologically effective, such as the nine-square pattern or the golden section. Both have been validated experimentally, using VR and neuroscientific approaches. On the other hand, the new attempts to quantify geometric properties to capture the cognitive-emotional dimension of architecture are worthy of mention. Among these are isovist analysis, the volume of space visible from a given point in space	The geometry of space

(Authors, 2022)

#### 4.0 Discussion

Through a scoping review, we aimed to determine the variables affecting indoor blue space restorative outcome. We found 12 indoor blue space variables that affect mental wellbeing. We categorised them into two categories - one is directly associated with restorative water outcomes, and the other one is indirectly associated with restorative water outcomes (because of indoor context). However, all these variables may potentially modify the blue space's restorative outcome. Although some data were also addressed about the details of each variable, for example, we found that the size of a blue space or the amount of water in space can change the restorative outcome. Generally, the more water, the higher the healing effect. Yet, some findings have more detailed suggestions; for example, there is a significant effect when the amount is 43% and above in the local area (Houlden et al., 2018).

**Category A:** The following variables are directly associated with water. (1) Size of blue space, (2) Type of blue space, (3) Colour and clarity of blue space, (4) Time spent in space in blue space, (5) Dynamic textures of water, (6) Perceived biodiversity of blue space.

**Category B:** These variables are indirectly associated with water. (1) Use of space, (2) Ceiling height of space, (3) Arrangement of scenes, (4) Illumination of space, (5) Proportion of space, and (6) geometry of space.

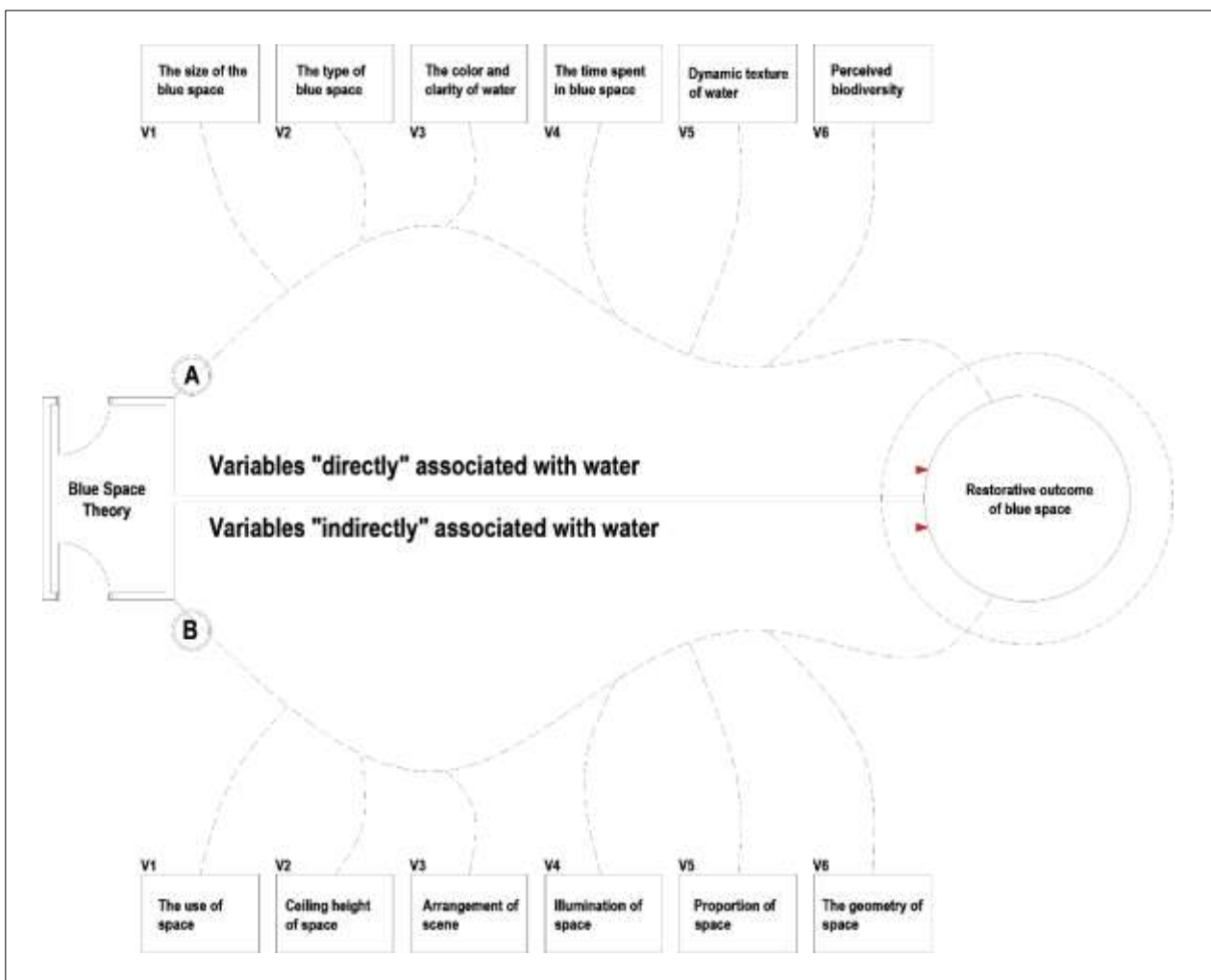


Fig. 2. The variables affecting indoor blue space restorative outcome (Author,2022)

#### 5.0 Conclusion and recommendations

The blue space theory refers to the presence of water elements in a space, creating a therapeutic effect on human emotions and physiology. It points to the healing effect of water on human emotions and mental health. It reduces stress and creates restoration (Zaino, 2020; Zaino & Abbas, 2020c, 2020a). A gap exists in knowing the variables that affect the indoor blue-space restorative outcome - Considering the Preferred Reporting Items for Systematic Reviews Items - this study reviews comprehensive literature to identify those variables. All papers indexed in Scopus, Web of Science and Google Scholar until March 2022 were sought. Results showed 12 variables

affecting the restorative outcome of blue space. These variables were further categorised into two - one is directly associated with restorative water outcomes, and the other is indirectly associated with restorative water outcomes (because of indoor context). Category A: The following variables are directly associated with water. (1) Size of blue space. (2) Type of blue space. (3) Colour and clarity of blue space. (4) Time spent in space in blue space. (5) Dynamic textures of water. (6) Perceived biodiversity of blue space. Category B: These variables are indirectly associated with water. (1) Use of space. (2) Ceiling height of space. (3) Arrangement of scenes. (4) Illumination of space. (5) Proportion of space. (6) The geometry of space. Despite its exploratory nature, the findings of this research provide insights into the variables that can be manipulated to affect the restorative outcome of a blue space in general.

This study lays the groundwork for future research into exploring each variable in-depth to understand the possible details required for implementation in designing restorative architecture. A natural progression of this work is to conduct an empirical understanding of each variable, using an EEG device to establish an empirical understanding of each variable. Such as how much time is required to gain the most benefit of a blue space or the size, type, colour and texture.

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## Paper Contribution to Related Field of Study

The prominent contribution of this paper revolves around determining the variables affecting the restorative outcome of indoor blue spaces from comprehensive data in different fields, including environmental psychology, evidence-based design, and neuroarchitecture.

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